

https://dspace.org/

# Quality Management and Funding Sources of the Water Cleaning Programs of South African Dams.

**Bekker, Wiltie**

**2011-03-18**
http://hdl.handle.net/10539/9177

Downloaded from a DSpace repository. https://dspace.org/

# Quality Management and Funding Sources of the Water Cleaning Programs of South African Dams

**Wiltie Bekker**

**A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Business Administration**

**Johannesburg, 2009**

# ABSTRACT

Eutrophication in South African dams is the process during which water becomes over-enriched with nutrients such as phosphates and nitrates, and this results in uncontrollable, high algal and hyacinth growth. There are a number of reasons for this, including, amongst others, poorly treated water being dumped into the catchment areas of dams.

Hartbeespoortdam is one prime example of eutrophication and currently receives attention from different organisations, including the Department of Water Affairs (DWAF), in order to rectify the situation and establish sustainability in water quality. Funding sources for the effective management of water resources is an integral part of this research report. Hartbeespoortdam was chosen as a case study to identify the priorities regarding quality management and to identify funding sources to ensure both prompt results and sustainability in the longer term.

Interviews were conducted with various involved parties around the dam to establish the critical success factors around quality management and funding sources. Quality management needs to be supported by the three pillars of Measure and Control, Enforcing Quality Management and Legal and Policy Framework. Funding sources include Beneficiation, Environmental Accounting and Privatization.

The key to the success of managing water resources lies in the implementation of legislation and the establishment of innovative funding sources.

# DECLARATION

I, Willem Jacobus Bekker, declare that this research report is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

_____

**Willem Jacobus Bekker**

Signed at ……

On the …….. day of …… 2009

# DEDICATION

I dedicate this research report to my loving wife, Bets, and my son, Luan. Bets, I enjoyed every moment of studying together. I enjoyed the laughter and fun we had as well as the dedication and perseverance to complete assignments. Your example and motivation carried me through to success. Love you forever.

Luan – your future is always on my mind. It is my prayer that God continues to bless you and our family the way He always has.

# ACKNOWLEDGEMENTS

I herewith thank:

- Rick van Rossum of Hartbeespoortdam Water Action Group (HWAG) for the access to resources and contacts given in order to gather the necessary data for the study

- All respondents that availed their time for interviews that formed the basis of this research report

- My supervisor, Terri Carmichael, for her leadership and guidance towards planning and completion of this study

# TABLE OF CONTENTS


**ABSTRACT …… ii**

**DECLARATION ……..……...… iii**

**DEDICATION ……..…….. iv**

**ACKNOWLEDGEMENTS …… v**

**LIST OF TABLES ……...……. ix**

**LIST OF FIGURES ……...……. x**

**CHAPTER 1: INTRODUCTION ……..…….. 1**

1.1 PURPOSE OF THE STUDY ……..... 1

1.2 CONTEXT OF THE STUDY ……..... 1

1.3 PROBLEM STATEMENT ……..... 3

*1.3.1 Main Problem ……...…….....* 3

*1.3.2 Sub-Problems …..…….* 3

1.4 SIGNIFICANCE OF THE STUDY ..……..... 3

1.5 DELIMITATIONS AND LIMITATIONS …….……..... 4

*1.5.1 Delimitations …….……..... 4*

1.6 GLOSSARY / DEFINITIONS OF TERMS …..……... 5

1.7 ASSUMPTIONS ……..… 6

**CHAPTER 2: LITERATURE REVIEW ……... 7**

2.1 INTRODUCTION ……..……. 7

2.2 QUALITY ASSURANCE MANAGEMENT…… 10

*2.2.1 Measure and Control …… 10*

*2.2.2 Enforcing Quality Management ……... 12*

*2.2.3 Conclusion ……..……..…* 15

2.3 FUND RAISING ……... 16

*2.3.1 Legal and Policy Framework ……..... 16*

*2.3.2 Environmental Accounting ……..... 21*

*2.3.3 Privatization …… 23*

*2.3.4 Conclusion ……... 25*

2.4 CONCLUSION OF THE LITERATURE REVIEW ……. 26

*2.4.1 Research Question 1: ……..…… 27*

*2.4.2 Research Question 2 …… 27*

**CHAPTER 3: RESEARCH METHODOLOGY ……..…… 28**

3.1 RESEARCH METHODOLOGY / PARADIGM ……... 28
*3.1.1 Interpretive Paradigm* ……..…….. 28
3.2 RESEARCH DESIGN …… 30
3.3 POPULATION: CASE SITE AND SAMPLE …..…….. 31
*3.3.1 Case site* …… 31
*3.3.2 Sample* …… 32
3.4 DATA COLLECTION ……. 33
3.5 DATA ANALYSIS AND INTERPRETATION ……. 34
3.6 LIMITATIONS …… 35
3.7 VALIDITY AND RELIABILITY …….. 35
*3.6.1 External Validity* ……..…… 36
*3.6.2 Internal Validity* ……... 36
*3.6.3 Reliability* …… 37
**CHAPTER 4: PRESENTATION OF RESULTS …….. 38**
4.1 INTRODUCTION ……..…….. 38
4.2 RESULTS PERTAINING TO RESEARCH QUESTION 1 – QUALITY ASSURANCE MANAGEMENT……..……. 39
4.2.1 *Measurement and Control*……..….. 39
4.2.2 *Enforcing the Quality Management System* …… 43
4.2.3 *Enforcing the Law*……... 48
4.3 RESULTS PERTAINING TO RESEARCH QUESTION 2 – FUND RAISING…….. 51
4.3.1 *Beneficiation*…….. 51
4.3.2 *Environmental Accounting*…….. 53
4.3.3 *Privatisation*……... 55
4.4 CONCLUSION ..…..…… 56
**CHAPTER 5: INTERPRETATION OF RESULTS ..……... 57**
5.1 INTRODUCTION …… 57
5.2 ANALYSIS OF RESPONDENTS…… 58
5.3 RESULTS PERTAINING TO RESEARCH QUESTION 1 – QUALITY ASSURANCE MANAGEMENT……. 59
5.3.1 *Measurement and Control*.....……... 60
*5.3.2 Enforcing Quality Management* ……..……..……... 62
*5.2.3 Legal and Policy Framework*…… ……..……... 65
5.4 RESULTS PERTAINING TO RESEARCH QUESTION 2 – 67

FUNDING SOURCES…….
*5.4.1 Beneficiation*…… 67
*5.4.2 Environmental Accounting*…… 68
*5.4.3 Privatisation*…….. 71
5.5 CONCLUSION ..…..…… 71
**CHAPTER 6: CONCLUSION …… 73**
6.1 INTRODUCTION …… 73
6.2 CONCLUSIONS OF THE STUDY ……... 73
6.3 RECOMMENDATIONS …….. 74
6.4 SUGGESTIONS FOR FURTHER RESEARCH …… 75
**CHAPTER 7: REFERENCES …… 76**
**APPENDIX A: INTERVIEW QUESTIONAIRE…….. 81**

# LIST OF TABLES

**Table 1: List of Respondents..... 32**

**Table 2: Relevance of Interview Questions to Research Questions..... 38**

**Table 3: Measurements Table..... 40**

**Table 4: Association Representation..... 58**

**Table 5: Key Subgroups ..... 59**

# LIST OF FIGURES

**Figure 1: Government Structure ..... 43**

**Figure 2: Legal Framework for Recreational Water Use ..... 44**

**Figure 3: Establishment process of a Resource Management Plan ..... 45**

**Figure 4: Phases of a typical Pilot Project ..... 47**

**Figure 5: Association Representation ..... 58**

**Figure 6: Exponential Pricing of Fresh Water Usage and Sewerage Water Discharged ..... 69**

# 1 CHAPTER 1: INTRODUCTION

## 1.1 PURPOSE OF THE STUDY

The purpose of the research is to establish the presence and the effectiveness of current water quality management programs and to investigate the sources of funding necessary to ensure sustainable water cleaning programs of South African dams.

## 1.2 CONTEXT OF STUDY

Sustainable Water Resource Management (SWRM) and Integrated Water Resource Management (IWRM) are global initiatives that South African authorities have taken part in since the early 1990s (Van Koppen 2002). Everyone has the right to have access to sufficient water. The state is obliged to respect, protect, promote and fulfil this right and should thus take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right as contemplated in Section 27 (1) (b) and Section 7 (2) of the Constitution Act 108 of 1996 (RSA 1996).

South Africa is a water-stressed country with an average annual rainfall of 500mm (60% of the world average). Only a narrow region along the South-Eastern coastline receives good rainfall, while the greater part of the interior and Western part of the country is arid or semi-arid. Sixty-five percent of the country receives less than 500mm per year, which is usually regarded as the minimum for dry land farming; 21% of the country receives less than 200mm per year according to the Department of Water Affairs (DWAF 1994).

The natural availability of water across the country is variable, and rainfall displays strong seasonality. Seasonal and inter-annual variations in rainfall contribute to vulnerability in water systems in Southern Africa, which is amplified by high run-off

production and evaporation rates. Stream flow in South African rivers is at a relatively low level for most of the year. The proportion of stream flow that can be relied upon for human consumption is limited by seasonality. Moreover, as a result of the excessive extraction of water by extensive forests and sugar cane plantations in the relatively wetter areas of the country, only 9% of the rainfall reaches the rivers, compared to a world average of 31% (DWAF 1996). Many urban and industrial developments, as well as some dense rural settlements, have been established in remote locations at a distance from adequate reliable water sources. As a result, the requirements for water already far exceed the natural availability of water in several river basins, and therefore large-scale transfers of water across catchments have been implemented, like the Lesotho Highlands Water Scheme (Mukheibir and Sparks 2003).

Water is an integral part of the ecosystem, a natural resource and a social and economic good, the quantity and quality of which determine the nature of its utilisation. Water is a limiting resource for development in Southern Africa and a change in water supply could have major implications in most sectors of the economy, especially in the agricultural sector. Water scarcity is a problem in many parts of the Southern African Development Community (SADC) region. Poor distribution of water resources and pollution coupled with frequent droughts and floods have led to direct hardship for many people, particularly the poor, since it has affected food security, specifically for subsistence farmers. If the occurrence of drought became more frequent, the impact on water resources, and consequently agriculture, would be significant (Mukheibir and Sparks 2003).

Hartbeespoortdam is one of the many dams in South Africa that is currently under threat of severe long term consequences of excessive phosphate and other harmful compounds in effluent, drained into the surface and sub-surface waters of the dam (Rand Water 2007; DWAF 2005). As a result the dam experiences excessive blue-green algae growth that produces toxins which can be harmful to man and animals. High concentrations of the algal blooms float and form a thick blue-green, foul-smelling scum.

South Africa has, in general, a limited supply of water and the quality of this water is being threatened by pollution and the destruction of river catchments. Water is a vital resource and it is up to all South Africans to act responsibly in their daily lives and look after the available water resources to ensure that this limited supply is usable by all life on earth (Funnell 1974; Rand Water 2007).

## 1.3 PROBLEM STATEMENT

### *1.3.1 MAIN PROBLEM*

The main problem is to establish the presence and effectiveness of current quality assurance management processes and to investigate the sources of funding necessary to ensure sustainable water cleaning programs for South African dams.

### *1.3.2 SUB-PROBLEMS*

- The first sub-problem is to establish the presence and effectiveness of the quality assurance management processes required for a sustainable water cleaning program.
- The second sub-problem is to establish the sources of funding available to ensure an effective and sustainable water cleaning program.

## 1.4 SIGNIFICANCE OF THE STUDY

This study fills a gap by providing guidance and insight to DWAF, Rand Water, Hartbeespoortdam Water Action Group (HWAG) and other stakeholders such as local community members, municipalities, NGO's and businesses, on quality assurance management processes and funding sources considered for sustainable water cleaning programs in South Africa.

The aim of this study is to provide answers as to what an effective quality assurance management process is and what methods can be used to raise funds by examining examples of other similar environmental threats across the globe. Funding methods can be of various types, for example donations, corporate sponsorship, legal enforcements, government budget allocations, tourism and taxes. Findings from this study are of a generic nature and are thus intended to be relevant to similar situations around South Africa.

Funding is the key performance indicator in the Hartbeespoortdam Remediation Project. Rand Water proposed that a task team of interested parties be established to investigate funding options for the establishment of a sustainable water cleaning program (Labuschagne 2002; Rand Water 2007). A dedicated activity needed to be undertaken to raise funds for this project. The results of the study should be useful for stakeholders who are involved in funding structures for a sustainable water cleaning program at any South African Dam.

This study will also provide guidance to key stakeholders such as DWAF, Rand Water and HWAG on the critical success factors of effective quality assurance processes and funding options available to ensure a sustainable water cleaning program.

## 1.5 DELIMITATIONS

The scope of this research is limited to quality management and funding sources for dams and rivers in South Africa only. It includes an assessment of the presence and effectiveness of quality assurance management processes and funding sources available, but excludes the technical or biological quality of the water.

The Hartbeespoortdam will be the research source of data for this study.

## 1.6 GLOSSARY / DEFINITION OF TERMS

| Term | Definition |
|---|---|

| Term | Definition |
|---|---|
| ASCE | American Society of Civil Engineers |
| CERES | Coalition for Environmentally Responsible Economies |
| DEAT | Department of Environmental Affairs and Tourism |
| DWAF | Department of Water Affairs |
| HWAG | The Hartbeespoortdam Water Action Group is a section 21 Company (Not-for-Profit, Non Governmental Organisation). The formation was a direct result of the concerns of the local residents with the extreme algal bloom experienced in the dam, with its consequences affecting all facets of living near or at the dam and the health implications. |
| IPWM | Integrated Pollution and Waste Management |
| IWRM | Integrated Water Resource Management |
| NWMS | National Waste Management Strategy |
| PRP | Potentially Responsible Parties |
| SADC | Southern African Development Community |
| SOP | Statement of Position |
| SWRM | Sustainable Water Resource Management |
| UNCED | United Nations Conference on Environment and Development |
| WCED | World Commission on Environment and Development |
| PPP | Private Partnership Projects |

## 1.7 ASSUMPTIONS

- The findings will be used to suggest appropriate initiatives to ensure long term sustainability of the Hartbeespoortdam.

- All historical data is relevant and accurate.
- The respondents will have the necessary information, knowledge and insight to participate meaningfully in this study.
- The respondents will be honest and open in their responses.
- The respondents will provide individual perspectives and views.

# 2 CHAPTER 2: LITERATURE REVIEW

## 2.1 INTRODUCTION

Sustainability, as defined in the Brundtland Commission's report *Our Common Future,* as well as the World Commission on Environment and Development (WCED) (1987), focuses on meeting the needs of both current and future generations. Sustainable water resource systems are those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental, and hydrological integrity as per the American Society of Civil Engineers (ASCE) (ASCE Task Committee for Sustainability Criteria 1998). It is stated in the same article that sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs (Loucks, Stakhiv and Martin 2000).

The scarcer a resource becomes, the more efficient should be its use. Unfortunately, the South African population generally does not follow this rule with respect to water as it is used in abundance even though it is a scarce resource. It seems that the population is not aware of the reality of the scarcity of water. Limited renewable availability and increasing demands have made scarcity of water resources one of the world's most challenging issues with serious local, national, regional, and global impact (De Azevedo and Baltar 2005).

For the 1992 UN Earth Summit in Rio de Janeiro, a **Declaration of Interdependence** was written to confirm the interrelationship between man and earth (Graham and Trotman 1992; Rand Water 2007). This declaration emphasises the importance of environmental management in order to ensure sustainable economic growth whilst minimising negative impact on the environment. Fourteen years after the publication of this declaration, stakeholders are still faced with the state of the water in Hartbeespoortdam, which has an

increasingly negative impact on the primary as well as secondary water use around the dam.

Failure to invest the necessary time, effort, activities and resources to achieve and sustain the required behaviour changes, will not only render lesser efforts fruitless with wasted resources but will also burden future generations with unaffordable costs and resources to rectify it. Funding is one of the key performance indicators in this project and a dedicated activity must be undertaken to raise funds for this project (Barnes 1998; Rand Water 2007).

The problem at Hartbeespoortdam is Blue-green algae. Blue-green algae are natural inhabitants of much inland water, estuaries and the sea. In still water such as lakes, ponds and reservoirs, these algae may multiply sufficiently in summer months to discolour the water, so that it appears green, blue-green or greenish brown. Sometimes these algae produce toxins which can be harmful to man and animals. High concentrations of the algal blooms float and form thick blue-green scum and can be dangerous to man and animal if either comes into direct contact with it. The existence of toxic algae is neither new nor localised nor even restricted to South Africa. The first known case of livestock poisoning dates back to the 1920's and since then incidents have occurred at Vaaldam, Bospoortdam and Roodeplaatdam. Smaller farms have also had incidents of toxic algae. Algae blooms flourish in warmer summer water, and many areas die down during winter time. Plant nutrients, for example high levels of phosphate and nitrates, promote algal growth as set out by the Department of Water and Forestry (DWAF 2007).

The Hartbeespoortdam Remediation Project Business Plan is a comprehensive document that sets out the action plans initiated by DWAF. DWAF has appointed Rand Water as the implementing agent, to remediate the problem at the dam.

A number of possible steps have been proposed by a variety of people and organisations to improve water quality. These steps intend to address both the in-impoundment nutrients, such as those bound in the sediments, and the nutrients entering the impoundment. The logic followed here is that if the control of nutrients entering the impoundment is not adequate, it will be of little use to address the

sediment bound nutrients. Most catchment management actions are very expensive to implement and it may take many years before any positive result can be measured.

According to the business plan, suggestions range from impractical, through mediocre to brilliant alternatives, all with the following in common: “They are all expensive to implement and very few have been put to the test in practice at laboratory or even pilot plant scale” (Hartbeespoortdam Remediation Program – Business Plan 2007: 5).

The primary focus of the capacity building and training project as part of the Hartbeespoortdam Remediation Program is the development of awareness to facilitate behavioural change and improved land use practices in the three main sectors:

- urban, peri-urban and rural development,
- mining and industry and
- agriculture

These will also include the implementation of best practices, on the guiding principles of waste minimisation, recycling and re-use, and water use efficiency. These will also involve and capacitate communities and stakeholders in the principles of Integrated Water Resource Management. Rand Water has been involved in the upliftment of communities for years to capacitate all levels of society.

The literature review includes examples of similar environmental threats around the globe in answering burning questions like the following:

- Is there a quality assurance process in progress and is it managed properly?
- Where do funds come from to sustain the water cleaning program?

## 2.2 QUALITY ASSURANCE MANAGEMENT

The first sub-problem is to establish the presence and effectiveness of the water quality assurance management processes required for a sustainable water cleaning program.

### *2.2.1 MEASURE AND CONTROL*

Measurements are key to quality assurance management. If something cannot be measured, it cannot be controlled. If it cannot be controlled, it cannot be managed, and if it cannot be managed, it cannot be improved (Harrington 1991).

Therefore it is important to know answers to the following:

- What are the current quality measures in place?
- Who is responsible for the process of quality assurance?
- How is quality assurance enforced and how is its effectiveness ensured?
- What is the legal structure and legislation governing this natural resource?

Sustainability measures provide ways to quantify relative levels of sustainability. They can be defined in a number of ways. One way is to express relative levels of sustainability as separate weighted combinations of statistical measures of various criteria that contribute to human welfare. These welfare criteria can be economic, environmental, ecological and social. For many criteria, the time duration as well as the extent may be important (Loucks *et al* 2000).

According to De Azevedo and Baltar (2005) the realisation that water is finite in quantity led to the development of new concepts and approaches in an attempt to effectively address the multiple challenges facing water resource management. The scope of a new framework has been widely debated in a number of important international events during the past two decades, resulting in a broad global consensus, forged during the Rio Earth Summit process; this recommends that

modern water resource management be based on three fundamental principles known as the Dublin Principles (De Azevedo and Baltar 2005).

First there is the ecological principle, in which it is argued that water management has to be comprehensive, integrated and inter-sectoral, that the river basin must become the unit of analysis, that land and water need to be jointly managed, and that much greater attention needs to be paid to the environment. This statement is also confirmed by Van Koppen (2002) as part of the general principles of Integrated Water Resource Management (IWRM).

Second is the institutional principle, in which it is argued that water resource management is best done when all stakeholders participate, including governments, the private sector and civil society; that women need to be participants in the decision-making process; and that resource management should adopt the guiding principle of subsidiarity, with actions taken at the lowest appropriate level (De Azevedo and Baltar 2005). Women and the youth can also play a very significant part (Van Koppen 2002). These principles are used throughout the world including Asia, Europe, Latin America and the USA. It is thus critical that all parties that could possibly be involved, whether responsible or preventative, are facilitated as a group to ensure integrated solutions that are workable.

The third Dublin principle is the instrumental principle, in which it is argued that water is a scarce resource, and that greater use needs to be made of incentives and economic principles in improving allocation and enhancing quality. Van Koppen (2002) also states the importance of effective economic management of this scarce resource.

As discussed earlier, the first Dublin principle is one of the critical success factors in the Hartbeespoortdam remediation project and this focuses on controlling the nutrient levels entering the impoundment. These nutrients are dumped into the river by activities upstream in the catchment area of the river. According to Pretorius (2006) the yearly inflow of nutrients, specifically phosphate, is between 80 and 300 tons. This results in a phosphate concentration of between 62 and 182

mg P/$m^3$, which implies that the inflow of phosphate needs to be reduced by more than 60% to result in a manageable concentration of between 30 and 50 mg P/$m^3$. At least eight sewage works have been identified that dump processed sewage into the Hennops and Jukskei rivers, and which mounds into the Hartbeespoortdam (Pretorius 2006).

This research will determine if there is a quality assurance standard in place to manage the river basin effectively. It will determine the different parties that need to be involved and which levels of society plays a role in the process.

### *2.2.2 ENFORCING QUALITY MANAGEMENT*

Water resource management is the vector sum of a progression of legislation, policies, regulations, engineering practice, and institutional traditions. Changes in how water resources are managed are often motivated by each flood, drought, environmental disaster, or human health threat. All of these changes could be directed towards sustainable development (Loucks *et al* 2000). There is an underlying tone of continuous improvement in this description of water resource management. The world keeps on changing and so does the way human beings behave and conduct themselves.

A recent detailed review by the Organisation for Economic Cooperation and Development (OECD) (1998) shows that even in the most advanced countries, where sound governance, participation, institutions, and skills do exist, much progress remains to be made on issues such as:

- more consistent application of the polluter pays principle where polluting parties are brought to justice by providing finances for remediation of the pollution;
- prices very rarely reflecting full economic and environmental cost; and
- most work in improving water use efficiency remaining to be done.

The era of environmental concern ushered in by the World Conservation Strategy and the Brundtland Commission in the 1980s (Pigram 1999) was given renewed impetus following the United Nations Conference on Environment and Development (UNCED) (1992) and the adoption of Agenda 21, a wide-ranging blueprint for action to achieve sustainable development worldwide. Water was a key resource singled out for attention and governments around the world have made a commitment to ecologically sustainable management of the resource (Pigram 1999). The impetus for water reform in Australia can be linked to a number of policy shifts in the role of government and the public sector in resource management, along with attitudinal changes in the community to the perception and value of water resources. South Africa was once a nation proud of themselves on the availability of clean drinkable water everywhere, but economic and industrial growth has changed the picture. Change can achieve positive outcomes, but balance to ensure environmental sustainability throughout the change remains a challenge, especially in South Africa as a developing country.

Pigram (1999) further emphasises that the effective operation of water resources assumes the existence of clear, enforceable property rights to water. He continues by arguing that the challenge is to put in place institutional arrangements for the management of river systems which permit the balancing of environmental water concerns with economic demands and social considerations. Are there effective legislation and legal structures in place in South Africa?

The degree of enforcement of regulations and quality standards depends on the seriousness of the pollution and damaged already inflicted on a body of water. According to Tanik, Baykal and Gonenc (2000) in *A long-term management plan for a watershed in a world metropolis – Istanbul, the* adaptation of the protection strategy of Lake Omerli with the status then required certain urgent and short-term measures. This involved some serious steps which included relocating businesses in the catchment area of the lake to new locations outside the catchment area. Only those that did not produce hazardous wastes were allowed to continue their activities, provided they discharged all types of wastewater after treatment via other (expensive) means until they attained acceptable water quality criteria. Septic tank

usage was encouraged for domestic users, among other solutions, to prevent further pollution of the water body. Removal of animal waste from the catchment area of the water was also included in the protection strategy.

In the circumstances described above it was quite impossible to solve the problems with the regulatory and administrative structure in place at that time; the responsibilities of local and individual governmental organisations would have to be integrated in what could be called an “authority”. This organisation became responsible for proper practice of the proposed land use plan to maintain sustainable development of the area. Participation in this association was widespread and based on the principle of sharing the responsibilities. It was capable of enacting the plans developed, according to the new land use plan, which was aimed at supplying water in the long term from the reservoir and arriving at sanitation solutions. This association was to be controlled by an external organisation like the Ministry of Environment (Tanik *et al* 2000). This Ministry of Environment is similar to South Africa’s DWAF (Department of Water Affairs). Funding of this authority is discussed later in this paper.

The Huai river basin is probably one of the most extreme cases ever recorded in Chinese history of pollution rectification. Two major targets were defined for the Huai river basin control effort as per Bai and Shi (2003):

- By 1997, all wastewater discharge from industries was to have met the standards for effluence, and total COD (chemical oxygen demand) was to have been reduced from the 1993 level of 1.5 million tons to 0.9 million tons.

- By 2000, the total COD was to have been further reduced to 0.368 million tons, and the Huai River’s mainstream and main tributaries – and any rivers in the basin that serve as urban water supplies – were to have reached Class III (suitable for drinking and fishing) of the National Surface Water Standard.

The Huai River pollution abatement program was measured along three major axes:

- The first was to shut down small polluting industries, such as paper mills and chemical plants.

- The second was to promote industrial waste water treatment and ensure that all industrial discharge met the designated standards by end of 1997.

- The third was to build 52 municipal wastewater treatment plants in cities to ensure that all municipal wastewater was treated before being discharged into the Huai River.

The sad reality about the severe actions taken by the Chinese to save the Huai River and by the Turkish to save Lake Omerli is that, if conservative interventions had been undertaken some years before, problems could have been prevented. The truth of the matter is that no matter how good an environmental management system appears in theory, if not implemented and controlled effectively it will be ineffective and potentially disastrous in the long term.

### *2.2.3 CONCLUSION*

In summary, the literature suggests that there is a need for proper measures to ensure quality assurance and more importantly, that it should be enforced as per regulation and policy. It is clear that in some cases drastic measures, such as closing down of certain companies that do not comply with the industry standard, need to be taken to create a sustainable ecology.

Research Question 1

How should the water quality assurance process in South Africa be managed and enforced to ensure a sustainable water cleaning program?

## 2.3 FUND RAISING

The second sub-problem is to establish the sources of funding available to ensure an effective and sustainable water cleaning program.

### *2.3.1 LEGAL AND POLICY FRAMEWORK*

What does South African legislation provide for in law in order to protect the rights of their people? The Constitution of the Republic of South Africa (RSA 1996) states that the people of South Africa have the right to an environment that is not detrimental to human health. It imposes a duty on the State to promulgate legislation and to implement policies and procedures to ensure that this right is upheld. Steps taken to date to ensure the environmental right include: the publication of the Environmental Management Policy for South Africa (RSA 1998); the preparation of the White Paper on Integrated Pollution and Waste Management (IPWM) (RSA 2000); The National Water Act (RSA 1998); the National Water Services Act (RSA 1997 and amendment of 2004); as well as the promulgation of the National Environmental Management Act (RSA 1998). A further step was the development of the National Waste Management Strategy (NWMS) for South Africa (RSA 2000), implementation of which is current, with the objective of: reduced generation and environmental impact of all forms of waste, so that the socio-economic development of South Africa, the health of its people, and the quality of its environmental resources are no longer adversely affected by uncontrolled and uncoordinated waste management (Rand Water 2007).

The Policy of integrated Pollution and Waste Management (IPWM) sets the following specific goals in respect of waste and pollution management governed by the Department of Environmental Affairs and Tourism (DEAT) (RSA 1998):

- To prevent, reduce and manage pollution of any part of the environment due to all forms of human activity and in particular from radioactive, toxic and other hazardous substances

- To set targets to minimise waste generation and pollution at source and to promote a hierarchy of waste management practices, namely reduction of waste at source, re-use, recycling and safe disposal as the last resort

- To regulate and monitor waste production, to enforce waste control measures, and to co-ordinate the administration of integrated pollution and waste management through a single government department

- To promote cleaner production and to establish mechanisms to ensure the continuous improvement in all spheres of environmental management

South Africa is a signatory to the Millennium Development Goals (Black and White 2004; Rand Water 2007); Goal 7 sets out by the year 2015 to:

- integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources;

- reduce by half the proportion of people without sustainable access to safe drinking water; and

- achieve significant improvement in the lives of at least 100 million slum dwellers, by 2020.

According to Rand Water (2007) in the Hartbeespoortdam Remediation Program some of the obvious solutions for consideration include:

- the control and enforcement of Waste Water Works in the catchment to comply with the phosphate standard;

- storm water management – to improve the quality of storm water runoff; and

- the development of a practical system through which the bulk of nutrient rich water could be diverted from the dam.

The implementation of the required phosphate standard in treated effluent from sewage treatment works costs organisations like Johannesburg City Council millions of rand to meet and implement.

Environmental laws are globally becoming stricter with major penalties being imposed when laws are not adhered to. The *Clean Water Act of 1972* (USA 1976) requires all facilities that emit pollutants into U.S waters to obtain applicable permits. Traditional large polluters – such as utilities – as well as agriculture, construction, dry cleaning, and mining entities face clean-up, injunctive and cost-recovery actions where an imminent pollution hazard exists. Furthermore, recent federal court decisions, especially the U.S. v. Weitzenhoff (1994) matter, have imposed strict criminal liabilities (e.g. substantial prison sentences for first time offenders), even for unintentional violations of operating permits. The government must prove merely that the discharge permit was violated and that the defendants knew their actions resulted in the discharge. The defendants cannot claim that they did not know they had violated the limitations specified by the permit.

Who needs to be held responsible for implementation of the law? The Coalition for Environmentally Responsible Economies (CERES) (2000) has recently announced that many entities have adopted the Valdez Principles. Under these principles, boards of directors and chief executive officers are fully responsible for all environmental matters. Some of the principles include:

- protection of the biosphere;
- sustainable use of Natural Resources;
- reduction and disposal of waste;
- damage compensation: We will take responsibility for any harm we cause to the environment by making every effort to fully restore the environment and to compensate those persons who are adversely affected; and

- assessment and annual audit: We will conduct and make public an annual self-evaluation of our progress in implementing these principles.

A key question is the sources of funding to ensure conformance with the law. According to Reinstein and Lander (2000) the allocation of cost is a further aspect discussed in the Statement of Position (SOP) issued by the American Association of Certified Public Accountants. To identify its share of total estimated liability an entity should determine all potentially responsible parties (PRPs) who are involved at the particular site and thus face potential remediation liabilities. Participating PRPs should generally allocate remediation liabilities using one of four principal factors:

- *Element of fair share.* Allocate the liability among PRPs based on the amount of waste using such bases as hazardous volume, mass, type of waste, toxicity of waste, or length of time the site was used.

- *Classification of PRP*. Allocate costs depending on classification as site owner, site operator, transporter of waste, or generator of waste.

- *Limitations on payments.* Limit the extent of a party's contribution to the total remediation cost under statute or regulation, such as limitations on the liability of a state or local government regardless of the contribution to the contamination.

- *Degree of care.* Allocate liability based on the degree of care exercised in selecting a site or transporter.

Who needs to be the policeman? Baram (1986) states that communities should rely on state police power to protect health and safety. Over the centuries, use of state "police power" has led to a multitude of state local laws empowering state and local health and fire officials to control accident hazards. Local authority to regulate, site, inspect, and license dangerous activities, and to require industrial disclosures of risk information, is found in every state. Although dormant for many decades in many communities, they are now being used as authority for bold new actions by these officials, including the shutdown of industrial activities deemed to

create health risks to community residents. The principle observed is one of using underutilised state departments in cross functioning in order to be more effective.

In conclusion Baram (1986) expresses that the community exercises their rights under these doctrines; and the authority for the right to know by persons who perceive they may be at risk provides the continuous pressure on industry and agencies to comply with these duties, and assures corporate accountability in carrying out the duties to identify, warn and act.

According to Tanik *et al* (2000) income of authority will include the following:

- credits that are loaned from the Environmental Fund in the stage of establishment
- a specific share collected from provincial administrations
- sale and barter of land
- sale of water to municipalities and industries
- fees collected from people who visit the recreational areas
- participation fees collected from the settlements
- share certificates

As such, this association will have no external financial support and the income will be returned as service.

Another example of government involvement with positive results is described by Bai and Shi (2003). The Huai river basin (also described earlier in this document) was the first in China to have a comprehensive water pollution control program. Initiated and led by the central government in 1994, it was the largest single river basin pollution abatement campaign in China, with a 10-year old total investment estimate of more than US$8 billion. Because a large number of polluting industries were forced to shut down, the social and economic impacts of the campaign were profound. Both the central and local governments put enormous effort into the

campaign. Thus this project became a benchmark for evaluating the effectiveness of environmental protection efforts in China.

### *2.3.2 ENVIRONMENTAL ACCOUNTING*

According to De Beer and Friend (2006) industries are becoming progressively more aware of the environmental and social liabilities pertaining to their operations and products, with associated financial effects. Uncertainties in measuring these financial effects can be addressed by using environmental evaluation and accounting techniques. Environmental accounting assists in expressing environmental and social liabilities as environmental costs.

They emphasise that industrial operations worldwide cause significant environmental liabilities, with associated financial effects. Industries are therefore becoming progressively more aware of the social and environmental liabilities pertaining to their operations and products (Environmental Protection Agency 2000). These liabilities include impacts on the natural environment conveyed through the three principal media: air, water and soil. Financial effects are lately more often portrayed in corporate images and reporting (Goodstein 2002). However some companies still find it difficult to relate environmental liabilities to financial effects (Carte, Perruso and Lee 2001).

Uncertainties in measuring environmental liabilities can be addressed by using environmental evaluation and accounting techniques, such as qualitative matrix evaluation and streamlined life cycle analysis methods (Labuschagne 2002); and quantitative analysis, life cycle costing and total cost assessment (Veefkind 1998). Environmental accounting can be used to demonstrate the potential for environmentally beneficial investments to yield significant financial pay-offs, through the avoidance of environmental liabilities (Hayden 1989). While environmental accounting now forms part of industrial decision making in first world countries, there is a lack of similar commitment to the environment in South Africa (Labuschagne 2002).

In conclusion De Beer and Friend (2006) promote a model that provides the framework for corporate evaluation of alternative projects and processes and for estimating economic and environmental performance in the present and especially in the future. The model can assist South African industries in identifying, recording and allocating environmental cost within environmental media groups, using cost types and cost drivers, to enhance their corporate decision-making processes.

It was further pointed out in the article, Reporting Responsibilities for Environmental Remediation Liabilities by Reinstein and Lander (2000), that the Accounting Standards Executive Committee of the American Association of Certified Public Accountants (AICPA) issued a Statement of Position (SOP) (1996 No.96-1, Environmental Remediation Liabilities), to help entities recognise certain environmental costs. The SOP requires that in measuring their allocable liabilities for a specific site, entities should consider enacted laws, existing regulations, policies, and current remediation technologies, as well as liabilities that the government or other potentially responsible parties (PRPs) will probably not pay. Entities may discount estimated liabilities to reflect the time value of money if the aggregate amount of obligation and timing of cash payments for a site are fixed or reliably determinable, with similar treatment for expected recoveries from insurers and other third parties. The SOP reflects the increasing emphasis on accounting for, and disclosing, environmental remediation liabilities. Hence, both public and private companies and their accountants should be increasingly vigilant in both areas to protect themselves in today's litigious society.

### *2.3.3 PRIVATISATION*

The Huai River project mentioned earlier offers much to be learned. One of the bottlenecks in the Huai water pollution control program was the financial mechanism that was to be provided solely by the government. There is positive evidence that more involvement by the private sector in this mechanism might have improved the situation more quickly (Bai and Shi 2003). Financial involvement and

responsibilities by private companies and organisations creates ownership for each water user.

Alternative financial mechanisms for urban sewage treatment: The Xuzhou Experience described below, was more successful (Gao 2004).

Urban sewage accounts for more than 60 percent of total wastewater discharged into the Huai River. However, there are only 57 municipal wastewater treatment plants in the Huai River basin, which is less than half of the planned number. Even among the constructed treatment plants, more than half are not operating properly. This situation is similar to the Crocodile River catchment flowing into Hartbeespoortdam where sewerage works are under capacity. Many municipal governments in China failed to make the substantial investment required to build municipal sewage treatment plants, and, more importantly, they do not have the constant cash flow required to operate them.

While many others have not resolved their inability to finance water treatment projects, cities like Xuzhou found a solution through the introduction of a market mechanism. In 2003, Xuzhou, a prefecture-level city in North-Western Jiangsu Province, decided to privatise the operation of its sewage treatment plant. A private company from Anbui Province paid the city CNY 160 million for 30 year operation rights. Meanwhile, two other private corporations invested in the construction and operation of the Sanbahe Sewage Treatment Plant and the Jingmahe Sewage Treatment Plant through the build-operate-transfer mechanism. This infrastructure will be transferred to Xuzhou City after 25-30 years.

The reason why Xuzhou is particularly attractive to private investment lies in a well-managed sewage treatment fee collection system, which ensured that the investment would be profitable. The city collects (from all water users) CNY 0.84 per ton of water supply as a sewage treatment fee and pays CNY 0.80 to the treatment plants for each ton of discharge that meets the standards. The city ensures that all the bills are paid monthly and on time. Through successful privatisation, the city of Xuzhou has three sewage treatment plants that are operating well, and the sewage treatment ratio has reached 86 percent, which is

the highest among all cities in the Huai River basin. Xuzhou demonstrated that funding does not have to be a stumbling block if city governments make an effort to look for innovative solutions.

According to Pigram (1999) the impetus on water reform in Australia can be linked to a number of policy shifts about the role of government and the public sector in resource management, along with attitudinal changes in the community to the perception and value of water resources. Development has also been constrained by pressing economic and environmental realities, and financial constraints arising from intensified competition for public funds. Reflecting these policy shifts is the trend towards corporatisation (and ultimately privatisation) of major water authorities, and the transfer of government-run rural irrigation schemes to private management bodies controlled by the irrigators. Pricing of water is only one aspect of water management and price increases and cost recovery measures, alone, are insufficient to secure efficiency gains in allocation and use of water. Pricing reforms need to be accompanied by and integrated with other measures to remove or offset institutional and regulatory impediments to industry restructuring.

Pigram (1999; Funnell 1974; Taviv 1999) concludes that given the perceived advantage of a market-based approach to allocation and use of water, and the trend towards deregulation of economic and financial structures in Australia, water-pricing reforms based on the principle of beneficiary/impactor pays represent sound economic practice. Moreover, the evolution of a system of water markets and enforceable property rights is seen as a logical outcome of growing pressure for more efficient, ecologically sustainable management of scares water supplies.

Azevedo and Baltar (2005) also support privatisation by stating that the World Commission on Water (WCW) has estimated that to meet all water supply and sanitation, irrigation, industrial and environmental management demands, investments in water infrastructure need to increase from the current level of $75 billion to $180 billion a year (World Water Vision 2000). Without adequate pricing mechanisms, consumers have no incentive to use water more efficiently as they receive no signal indicating its relative value. Similarly, if the water service providers are unable to recover the costs to adequately fund their operation,

systems will deteriorate and the quality of service will suffer. The deterioration of water systems can be seen worldwide, particularly in developing countries. Finally, if the cost of maintaining clean water is not incorporated into prices charged to relevant users, then there will be little incentive to reduce water pollution. As result, freshwater supplies will become increasingly unsafe.

They conclude that regardless of the approach taken to implement pricing reforms, it is critical to involve all stakeholders in the process. This includes both the upstream involvement in the design of pricing schemes, as well as downstream in the implementation of the schemes, and the collection and allocation of associated revenues. Once again, this has been a consensus that in practice has proven to be complex and challenging to implement.

### *2.3.4 CONCLUSION*

In summary, the literature suggests that there are various sources of funding that are available and can be explored and subjected to experiment.

Research Question 2

Which methods are currently the most attractive and practical sources of funding in South Africa?

## 2.4 CONCLUSION OF THE LITERATURE REVIEW

It is clear from the literature study that there is a worldwide commitment and renewed effort to restore Mother Nature to an unpolluted, healthy and sustainable state. The stimulus for this process was the 1992 UN Earth Summit in Rio de Janeiro where a **Declaration of Interdependence** (Rand Water 2007) was written to confirm the interrelationship between man and earth. The literature suggests five important principles that can lead to successful remediation projects:

- Firstly there must be a management process of continual measuring to determine the gap and make sure the gap is continually reduced.

- Secondly, the literature suggests that various short- and long-term measures need to be put into place by making use of policies, procedures and action plans.

- Thirdly, the literature calls for vigorous implementation of the above plans with strict apply/do not apply decisions and immediate action.

- Fourthly, it suggests various funding sources of which polluter pays, financial planning through environmental accounting principles and privatisation are three of the most frequently applied methods.

- Fifthly, the literature emphasises the involvement of all community stakeholders so that joint responsibility and ownership plays major roles in continual monitoring and consequential acting on every issue.

Thus to end this section, the two research questions arising from the literature review are re-presented together for ease of reference:

### *2.4.1 RESEARCH QUESTION 1:*

How should the water quality assurance process in South Africa be managed and enforced to ensure a sustainable water cleaning program?

De Azevedo and Baltar (2005), Rand Water (2007), Loucks *et al* (2000), Pretorius (2006), OECD (1998), Pigram (1999), Tanik *et al* (2000), Bai and Shi (2003).

### *2.4.2 RESEARCH QUESTION 2:*

Which methods are currently the most attractive and practical sources of funding in South Africa?

U.S. v. Weitzenhoff (1994), CERES (2000), SOP 96-1 (1996), Baram (1986), Tanik *et al* (2000), Bai and Shi (2003), De Beer and Friend (2006), USA Environmental Protection Agency (2000), Goodstein (2002), Carte *et al* (2001), Labuschagne (2002), Veefkind (1998), Hayden (1989), Reinstein and Lander (2000), Gao (2004), Pigram (1999), Azevedo and Baltar (2005).

# 3 CHAPTER 3: RESEARCH METHODOLOGY

This section describes the methodology that was followed to answer the research questions posed in the previous section. It starts with a description of the chosen method and its implications for the research and includes a discussion of the limitations of the chosen methodology. The research design, case site and sample are examined, followed by a discussion of the processes that were used in the collection of data as well as the data analysis process followed. Validity and reliability as it applies to this study are discussed as a conclusion to the chosen methodology.

## 3.1 RESEARCH PARADIGM

The selection of an appropriate research method is fundamental to any research design (Falconer 1999). The research method chosen was a qualitative case study

conducted in the interpretive paradigm. McPherson, Brooker and Ainsworth (2000) argues in their article that the qualitative case study approach offers valuable research insights for public policy makers and is suitable for this study in investigating and suggesting sustainable cleaning programs for dams in South Africa.

### *3.1.1 INTERPRETIVE PARADIGM*

According to Sandberg (2005:41) “a central focus for researchers within management and organisational sciences is producing knowledge about human action and activities in organisations. Traditionally, knowledge has been produced from quantitative or qualitative approaches within the positivistic research tradition”. More recently interest in qualitative approaches based on the interpretive research tradition has steadily increased in management and organisational sciences, as well as more generally within social sciences (Atkinson *et al* 2003; Lincoln & Denzin 2003).

Previously unexplored questions can now be investigated by using interpretive approaches and thus enable management researchers to conduct research that has led to new forms of knowledge about management and organisation. The emphasis in interpretation is on experience relating to a conscious subject. The interpretive approach explains that the human world is never a world in itself; it is always an experienced world. It basically implies that knowledge is constituted through lived experience of reality (Sandberg 2005).

According to research by Sandberg (2005:43) “the life-world is the subjects’ experience of reality, at the same time as it is objective in the sense that it is an inter-subjective world. We share it with other subjects through our experience of it, and we are constantly involved in negotiations with other subjects about reality in terms of our inter-subjective sense making of it”. This can be interpreted as the objective, inter-subjective reality. In addition to this, the life-world is objective in the sense that it surpasses the subject in that its qualities are not solely tied to the subjects’ lived experience of it. The experience of it is simultaneously inseparable

from the subjects. Sandberg (2005) uses the example of daylight saving in Europe where the inter-subjective agreement between parties creates an objective fact. For those who are not in agreement with the objective fact it becomes difficult due to the unfavorable consequences.

Sandberg (2005) continues to describe that the truth can be assessed by comparing the views and knowledge within a certain research perspective as well as between specific research perspectives. “It can lead to a deeper understanding of the aspect of human activity under investigation, and limitations in specific knowledge claims can be disclosed and replaced by more inclusive knowledge claims” (Sandberg, 2005:45). The conclusion is that interpretive results can never be viewed as cast in stone, but are open to change as perspectives keep influencing one another.

According to Walsham (1995) the interpretive methods continuously change the perceptions of both parties, the interviewer and the interviewee, as they interact through the experience. Pre-conceptions of the interviewer are also used to guide the process and thus value-free data cannot be obtained. To strengthen the above point Kaplan and Duchon (1988) also claim that interpretive researchers attempt to understand the way research subjects interpret, conceptualise, and understand events, concepts and categories as these are assumed to influence individual behaviour.

The interpretive paradigm was used because the case study method and the specific research that needs to be conducted in this case suits the underlying assumptions of this paradigm better than the functional paradigm. It also supports the literature review which underlined the fact that all stakeholders need to be involved and need to be heard in order to create a successful and sustainable environmentally uplifting project (Sandberg 2005).

## 3.2 RESEARCH DESIGN

According to Leedy and Ormrod (2005), qualitative research often starts with broad and general research questions, which are then explored with a small number of people as seen in the list of respondents. The verbal responses are then analysed in an in-depth way, seeking to uncover meaning in specific contexts. The same process was followed for this research in that eleven people directly involved in the remediation project were personally interviewed.

This research study served two of the four purposes of qualitative research identified by Pushkin and quoted in Leedy and Ormrod (2005), namely *description* of the nature of the situation, setting, processes, relationships, systems and people; and *interpretation* to enable the researcher to gain new insights about the phenomenon being researched. Earlier, Myers (1998) had pointed out the necessity of identifying and using appropriate qualitative research methods such as action research, case study research and ethnography, to focus on understanding social phenomena in their natural setting and cultural context. The case study on Hartbeespoortdam clearly falls into this category.

Semi-structured in-depth interviews were conducted, and the researcher was mindful of the influence of personal views and pre-existing bias. The researcher attempted to continuously probe the meaning of the words of interviewees and confirmed understanding in an attempt to avoid personal preconceptions (Leedy and Ormrod 2005).

Since a specific site was studied in-depth for a predefined period of time, the case study method was used (Perry 2001). Leedy and Ormrod (2005) suggest that all forms of qualitative research have two things in common: the focus is on phenomena that occur in natural settings and the phenomena are studied in all their complexity and multiple facets. Qualitative research therefore lends itself well to the case study method used here.

## 3.3 POPULATION: CASE SITE AND SAMPLE

### *3.3.1 CASE SITE*

The Hartbeespoortdam area, inclusive of the catchment area that includes the Crocodile River, Hennops River and Jukskei River, was the case site for this study. Although findings are based on interpretations around this specific site, it will be directly applicable on similar sites around South Africa and the globe.

Hartbeespoortdam is currently in the spotlight due to excessive algal growth and also the vast visibility of hyacinths on the surface of the dam. Hartbeespoortdam is the gateway to the South African bushveld and more than 16 million vehicles drive along its shore on a yearly basis. The bad smell that was generated at the dam wall over the past few years prompted the many stakeholders to get involved and for once solve this long overdue issue. The main reason for algal growth is the high levels of phosphate in the water, originating from point sources around the catchment area and releasing water at up to 18 milligram/liter phosphate against the legal limit of 1 mg/liter.

The recently begun process of compiling the Resource Management Plan is the first step in resolving the problem. Owing to the fact that this problem involves so many stakeholders, it is the ideal case site for providing all the information necessary for an effective case study. Stakeholders include the government, public as well as private sectors, and communication, integration and facilitation of these parties are of critical importance to ensure success. The problem that is experienced on Hartbeespoortdam water surface is the result of conditions created in a vast area upstream called the catchment area. Solving this problem thus involves all stakeholders and even stretches as far as inter-provincial collaboration and co-operation to include funding of the project.

One of the involved parties, HWAG, is an established Section 21 company that basically helped writing the history books around the remediation

process of the dam. This goldmine of experience and information labels the dam as the single most active dam in South Africa in solving environmental problems. Information around the condition of the dam and the process of establishing an RMP is available in abundance from HWAG and contact information for other involved parties is also available.

### *3.3.2 SAMPLE*

The sampling method was one of convenience and included all stakeholders as emphasised by the literature study. All interviewees were involved in one way or another in the remediation project. Respondents were chosen on perception of their knowledge and involvement in the existing project in order to make sure value is created in the information database. Table 1 lists the interviewees.

**Table 1: List of Respondents**

| Company/Association Name | Position / Name |
|---|---|
| Department of Water Affairs and Forestry (DWAF) | Paul van Rooyen |
| Hartbeespoort Dam Water Action Group (HWAG) | Rick van Rossum |
| University of Pretoria | A Pretorius |
| Water User Association (WUA) | G McKay |
| Legal Advisor | Len Dekker |
| Hartbeespoort Dam Water Action Group (HWAG) | Dirk Bouwer |
| Hartbeespoortdam Community (HC) Forum | Pieter Rautenbach |
| Environmental Group for SASOL | Frikkie Botha |
| Department of Water Affairs and Forestry (DWAF) | Cilliers Blaauw |

| Company/Association Name | Position / Name |
|---|---|
| Tourism Africa | Paul Bewsher |
| Property Owners Association | Pete Bain |

## 3.4 DATA COLLECTION

All data was gathered through personal interviews with all the respondents mentioned in Table 1. To facilitate triangulation, alternative sources included observations by the researcher and appropriate, relevant documentation that became available during the interview process. A total of eleven interviews were conducted. By exploring the context of the case, the researcher assists in the audience being able to reach conclusions about the possible applicability of the research to other situations (Leedy and Ormrod 2005).

Appendix A gives the detail of the interview guide structure and content that was used for the interviews.

## 3.5 DATA ANALYSIS AND INTERPRETATION

Given the nature of the research method, data collection and data analysis do not follow in a typical linear fashion where analysis only starts once data collection has been completed: because of the nature of the research (case study in the interpretive paradigm) data analysis and interpretation tended to take place to a certain extent already during data collection (Leedy and Ormrod 2005). The data collection, data analysis and data interpretation were simultaneous and iterative rather than sequential, involving a “constant recursive analysis” (Hopwood 2004:350; Leedy and Ormrod 2005).

Leedy and Ormrod (2005) identify the typical analysis steps followed in this type of research, which applies in this study as appropriate to the emergent nature of interpretive and qualitative research:

- Organising of details about the case into a logical order, such as chronologically, adding notes where appropriate
- Categorization of data by clustering data into meaningful groups or themes
- Interpretation of single instances to explore their specific meanings in relation to the case
- Identification of patterns or themes that emerge from the data during ordering and/or categorisation
- Synthesis and generalisations whereby an overall picture is constructed and conclusions drawn

A content analysis process applied, whereby the data was arranged to identify emerging themes and principles. The organisation of the themes roughly corresponds to the questions posed in the semi-structured interviews. This process involved reviewing each interview to develop categories, applying them to other data, refining and reapplying them to existing understandings and to further data, and so on until all data had been checked against all emerging categories (Hopwood 2004).

## 3.6 LIMITATIONS

By using a qualitative approach as methodology in the interpretive paradigm implies that the results and findings are of a subjective nature as interpreted by the researcher. Thus the results may not necessarily be generalisable although they may usefully be transferred to inform other similar situations where sustainable water cleaning programs are investigated.

## 3.7 VALIDITY AND RELIABILITY

Kvale and Salner (1989) describe validity and reliability as the criteria used for justifying knowledge produced within the positivistic tradition, and are based on an objectivist epistemology that refers to an objective, knowable reality beyond the human mind and that stipulates a correspondence criterion of truth. As Salner (1989:47) observed, the correspondence criterion of truth implies that “facts are out there to which our ideas and constructs, measuring tools, and theories must correspond”. Common forms of validity in positivistic research approaches, such as internal and external validity (Kvale 1989), are used to measure the extent to which our theories and instruments correspond to objective reality. However, it must be remembered that triangulation in qualitative research is to generate richness and depth in the data, and is not for convergence as in quantitative research.

Enerstvedt (1989) states that in cases in which the results differ significantly from one investigation to the next, they are considered to be unreliable. Reliability is said to be established when repeated measurements of objective reality give similar results. It would thus be of value for this study to be replicated, both in the near future (to establish reliability) and a few years hence, particularly if the recommendations are implemented.

Sandberg (1995) claims that given truth as intentional fulfilment, criteria of reliability, such as replicability and interjudge reliability of results relating to objective reality, fall outside the domain of interest in achieving reliability within interpretive approaches. He argues that the most important factor is that researchers must demonstrate that they have studied the lived experience with the correct intentional relationship by continuously checking their interpretations throughout the research process. This needs to be done from formulating the research question, selecting individuals to be studied, obtaining data from those individuals, analysing the data obtained, and reporting the results. As stated earlier it was important for the researcher to interview respondents with direct involvement in the existing project so as to create a platform for knowledgeable results. This is confirmed in this study by selecting respondents that are involved from a number of

different angles in this project. All interviews were also structured around he same questions in order to assure repeatability.

### *3.7.1 EXTERNAL VALIDITY*

External validity is the ability of the research to be generalised across persons, settings, and times. Since this is case research done at a single site, and respondents were selected for their expertise and not randomly, the findings cannot statistically be generalised. However, since the respondents have deep insight into the issues under consideration, it is hoped that the findings will be useful in similar contexts throughout South Africa, particularly as there appears to be a great deal of ignorance about the severity of the problem.

### *3.7.2 INTERNAL VALIDITY*

Internal validity refers to the extent to which the measuring instrument provides adequate coverage of the topic under study and the extent to which the instrument allows appropriate conclusions to be drawn from the data obtained (Leedy and Ormrod 2005).

### *3.7.3 RELIABILITY*

Reliability refers to consistency, ie similar studies should produce similar results, even when conducted by other individuals. The reliability of this study could be judged better were a replication study is conducted on another case site. Since a case study in the interpretive paradigm is used, the interpretations and conclusions are heavily dependent on the researcher. However, it is predicted that similar results would be obtained if conducted by another researcher. Proper record keeping and a

standardised, structured approach to interviewing contributed positively to the reliability of the study.

# 4 CHAPTER 4: PRESENTATION OF RESULTS

## 4.1 INTRODUCTION

The results of the research are presented in this chapter. The correlation between questions posed to interviewees and the two main Research Questions posed in Chapter 2 is showed in Table 2 below. It is important to notice that the breakdown can be directly related to the two research questions covering the topics of Quality Assurance Management and Fund Raising. The research questions posed to interviewees were re-organised in such a manner as to support the two research questions. Interviewees were asked similar questions and responses recorded and combined into results presented in this paper.

**Table 2: Relevance of Interview Questions to Research Questions**

**Relevance of Interview Questions to Research Questions**

| Quality Assurance Management | | | | |
|---|---|---|---|---|
| Measure and Control | | Enforcing Quality Management | | |
| Statistical Measures, timing | Ownership of measurement | Responsibility to ID and act on bad results | Regulations | Private or Gov |
| 1 | 3 | 6 | 2 | 11 |

| Quality Assurance management Continue | | | |
|---|---|---|---|
| Legal and Policy Framework | | | |
| Incentives for good results | Enforcement of penalties for poor results | Penalties to non-compliance? | Compensation to downstream users? |
| 4 | 5 | 9 | 10 |

| Fund Raising | | | | |
|---|---|---|---|---|
| Beneficiation | Environmental Accounting | | | Privatisation |
| Continuous improvement projects/suggestions | Cost to comply with legal phosphate limits | Environmental accounting | Receiving of funds | Privatisation? |
| 7 | 8 | 12 | 13 | 14 |

## 4.2 RESULTS PERTAINING TO RESEARCH QUESTION 1 – QUALITY ASSURANCE MANAGEMENT

In relation to Research Question 1 posed in Chapter 2, which questions the water quality assurance process and how it should be managed and enforced to ensure sustainable water cleaning program, quality assurance management can be divided into three sub-topics as indicated in Table 2:

- Measure and Control (Questions 1 and 3)
- Enforcing Quality Management (Questions 6, 2 and 11)
- Legal and Policy Framework (Questions 4, 5, 9 and 10)

Indicated behind each of the three sub-topics are the questions that were posed to the interviewees in relation to these sub-topics. Answers from interviewees were combined into answers presented in this chapter.

### *4.2.1 MEASUREMENT AND CONTROL*

Quality assurance management was identified by most interviewees as one of the critical factors towards success of the remediation program of Hartbeespoortdam “measure correctly and timely and it will be easier to manage and control”. Critical measurements, standards and frequencies are set out in Table 3. Priorities of water users are different and quality assurance management ensures that all parties contribute to the sustainable usage of this important natural resource.

**Table 3: Measurements Table**

| Measurements in Water Catchment Management Area (CMA) | | | | |
|---|---|---|---|---|
| **Area/User** | **Measurement Position** | **Quality Factors** | **Measured by** | **Freque** |
| Upstream/Downstream | Measure quality above intake and below outlet | Heavy Metals, chemicals, phosphates, nitrates, PH | User | Daily |
| Dam | 12 places on dam including entries of all streams and rivers, wall and other points | Eutrophycation, depth, light, chlorophil A, phosphate, nitrate, biomass | RQS | 2 month |
| Dam | 12 places on dam including entries of all streams and rivers, wall and other points, different depths | Chemicals, cyano bacteria, nimnology report, sediment report, dissolved oxygen, Temperature, pH | DWAF | Monthly |
| Dam | 6 places measurement for phytoplancton for mezzo-cosmos and fish manipulation | Phytoplancton | Fish manipulator | Monthly |
| Package Sewerage Plants/Developments | Measurements on dump water into dam | Phosphates, Nitrates, pH | Estates | Weekly, monthly |
| Major Sewerage Plants | Outgoing water measurement | Phosphates, Nitrates, pH | Sewerage plants | Daily measure monthly reportin |
| Inflow/outflow to dam | Measure volumes of water, need to keep level at 70 -75% to control concentrations | Volume | DWAF | Daily |
| **Results are consolidated by DWAF, they monitor (graph) and re-measure if there are dis** | | | | |

The responsibility for performing all measurements lies with various parties. The owner/user in each area needs to have full control over his portion of water usage and measurements need to be done as indicated in Table 3. Third party verification of results is crucial to ensure policing and to address illegalities, and this role needs to be played by local municipalities across the country. Inspections should occur at facilities randomly as surprise visits to prevent “window dressing” which does not help to solve the problem at all. DWAF needs to conduct random spot checks to ensure compliance. “The ultimate responsibility for providing South Africans with clean water lies with DWAF”, was echoed by most interviewees, but “all of us have the responsibility to ensure things happen!”

DWAF oversees the process, receives all data, monitors results and queries any discrepancies. Ultimately they need to put pressure on municipalities and other water users to act on non-conformances and comply with legislation. The above process will ensure the identification of point sources of pollution that can be seen as the starting point to pollution prevention. The management principle of “solving the weakest link, and then move on to the next one”, needs to be implemented. “Spend money and resources to solve your current biggest problem, get results and then move on to the next biggest problem.” A large portion of interviewees were stressed by the lack of action; “the current problem is that everybody knows what needs to be done, but that no actions are taken”.

Licenses need to be applied for and issued annually by local municipalities and before the start-up of new concerns. Again the lack of action by responsible people surfaced from most interviewees as “licensing is the first step in knowing what needs to be measured”. Eleven different uses of water were identified that form part of the current licensing process and this includes volumes withdrawn and discharged back into sewerage. Official inspection and sign off on premises of water users is crucial to make sure initial approval promises are kept. Official SABS auditors should be involved in this critical stage. Third party inspections must be tightened up as current results are bent by installers of equipment who are taking responsibility for measuring and controlling equipment to protect them from legal action in case of non-compliance. “SABS approved inspectors can be utilised to

randomly verify obtained results by other parties involved", was one of the suggestions posed by some interviewees in order to minimise "corruption and window dressing". Capacity planning of sewerage plants needs to be determined in accordance with the above licensing process and new development approvals.

Current sewerage works infrastructure was said to "fall way short of demand and no licensing principles are applied to any water users upstream or downstream".

Organisations such as HWAG are created as a medium for the public to raise concerns that they observe are not being attended to by authorities such as DWAF and local municipalities. Most interviewees described HWAG as the "mouthpiece of the public" and indicated that regular meetings should be held and a proper process established for the public to report irregularities and to ensure actions being taken to resolve issues.

It is of utmost importance to keep a history of measurements so as to improve quality and speed of the decision making of authorities. They need this information when prioritising problems and allocating funds and resources. The positive results after some actions were implemented need to be communicated and thus stimulate further action towards solving the bigger problem. This data is of utmost importance should affairs end up in court due to non-compliance or due to lack of acting on problems identified. "Any official needs data to evaluate the magnitude of the problem and decide where to allocate the budget."

It is important to mention that effective quality management naturally consumes high quantities of resources. If these are not available, the process invariably becomes ineffective and escalates to overstretched employees and an "unhappy public". Local municipalities seem to struggle with this problem which does not cultivate the right attitude towards solving public problems.

Laboratory equipment is an expensive business if you are serious about obtaining accurate and usable test results. A few suggestions include one that costs to municipalities and involved parties can be alleviated by establishing central laboratories that can be used nationally by all parties. Dedicated personnel need to be employed as utilisation will be higher. The economy of scale principle is used

here to bring costs down so they can then be shared amongst parties as a monthly fixed cost to ensure sustainability. “RQS (Resource Quality Services) is currently a service department to DWAF and they can effectively be used nationally.”

Further to the above the WRC (Water Research Commission) is another service department to DWAF that can be made more effective by utilising established institutions like universities to do research. Costs are thus subsidised by the universities in the form of knowledge.

### *4.2.2 ENFORCING THE QUALITY MANAGEMENT SYSTEM*

As discussed in the previous section, and again stressed here by most interviewees, “DWAF is responsible to receive and analyse all data”. They are accountable as the overseeing body to manage water resources and therefore are also responsible to identify and act on bad results. This government institution needs to apply pressure on municipalities and other water users to manage the natural resource of water effectively.

The Governmental management structure as indicated in Figure 1 shows that there are three levels of management from government level. Responsibility for implementation of national laws stays with DWAF until a WUA is registered as a certain CMA (Catchment Management Agency). This process thus empowers the CMA to have all authority in enforcing the national water laws in the area of responsibility. It creates a focussed approached by dedicated people and this compels results at a rapid pace.

**Figure 1: Government Structure**

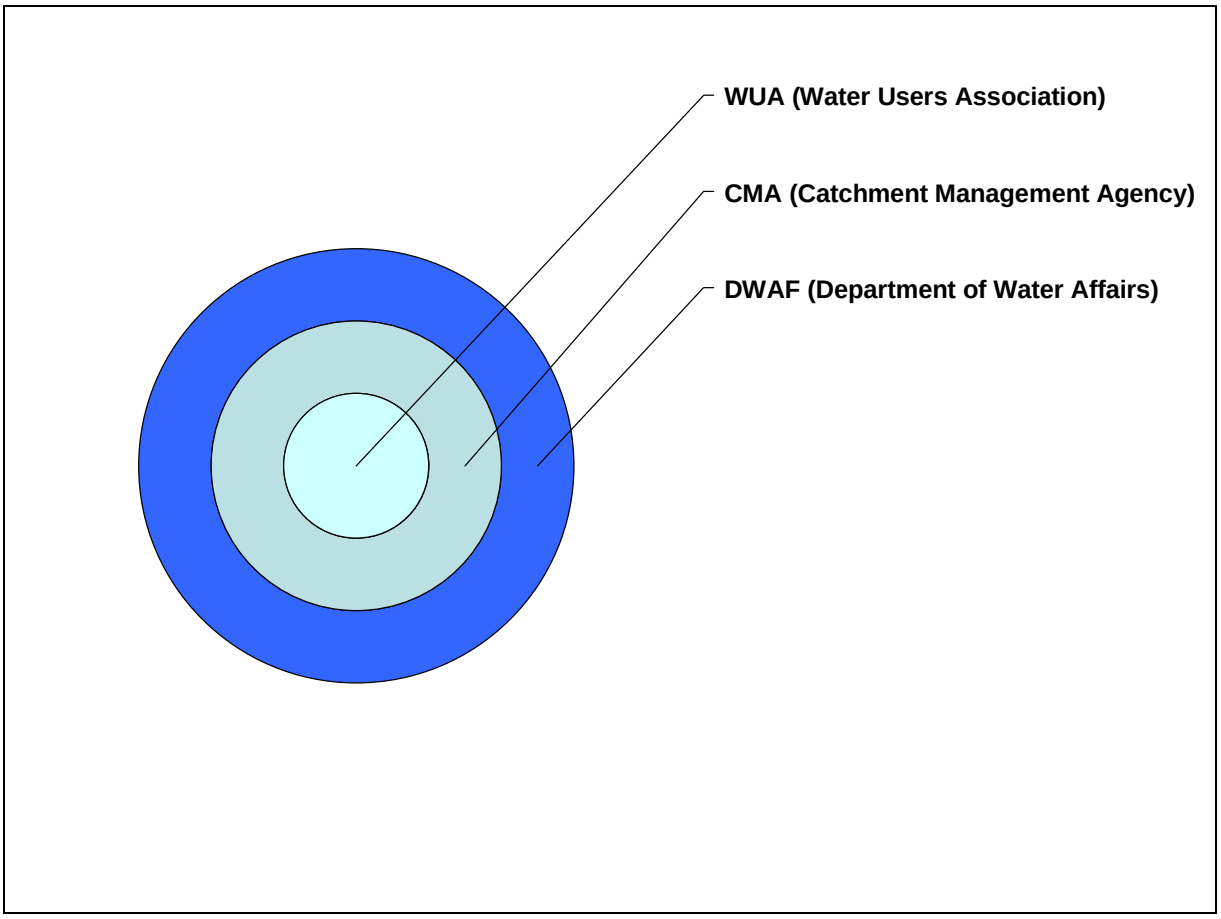
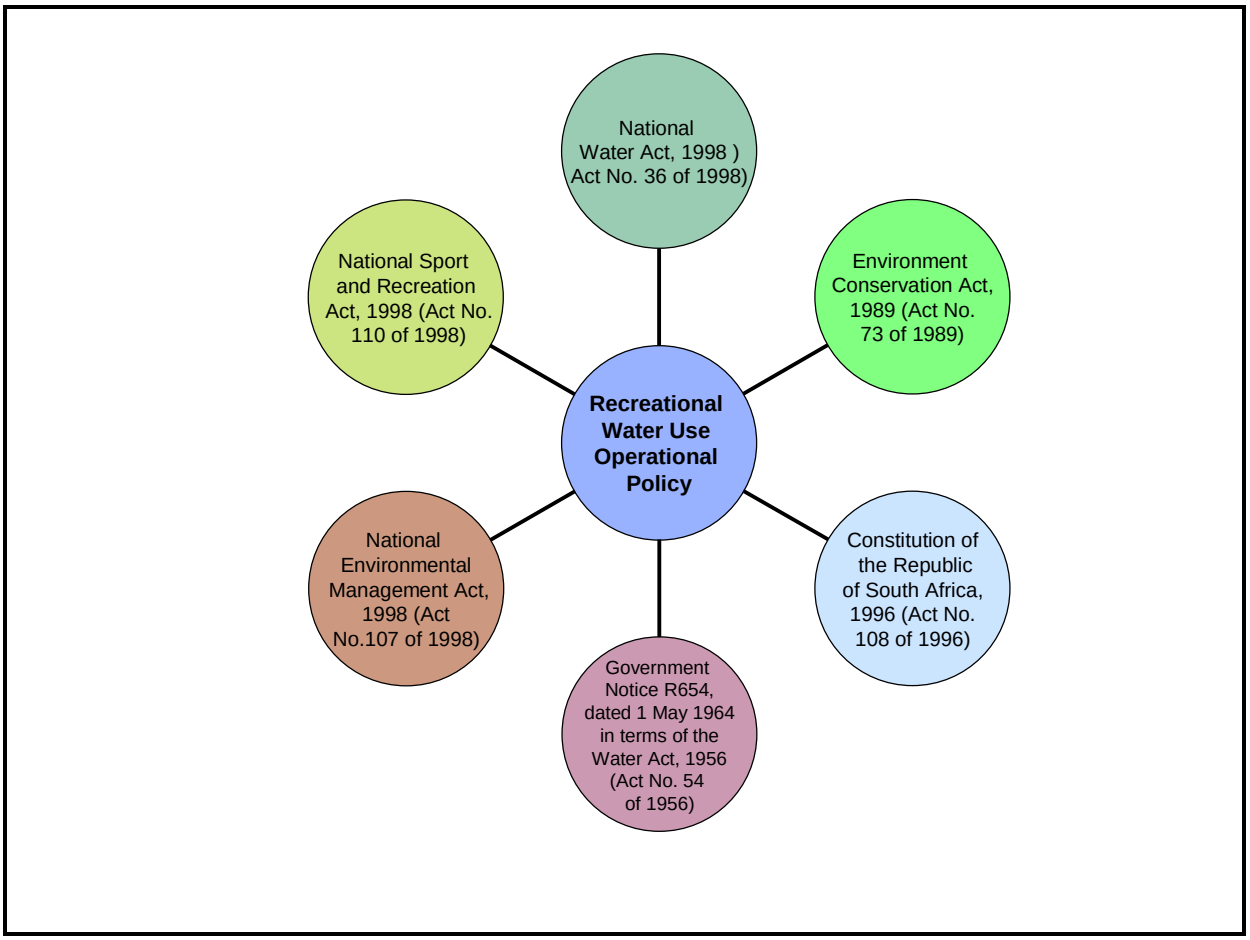


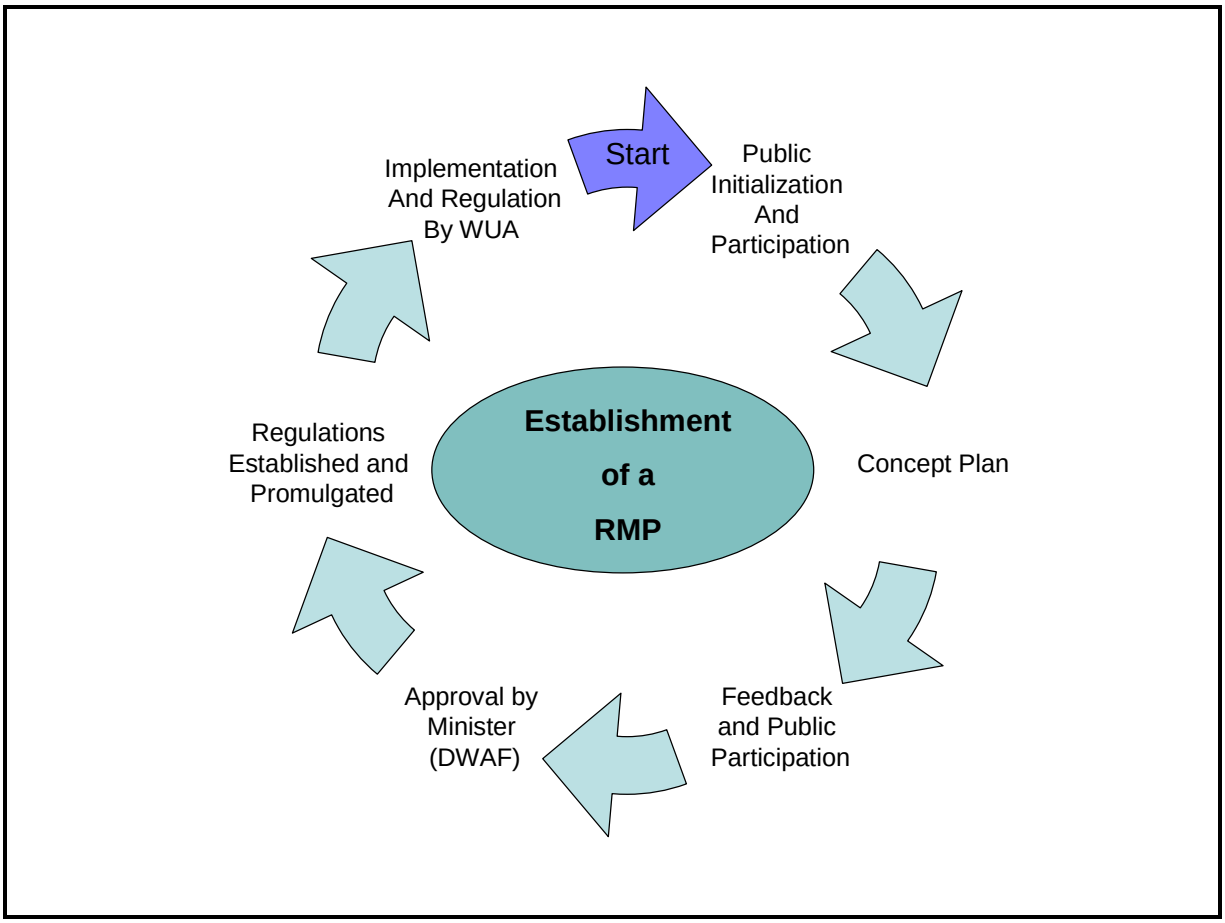

Figure 2 indicates the legal framework surrounding recreational water use in South Africa. Supporting these are various policies and procedures assisting DWAF to fulfil their function. All these laws are incorporated into the Hartbeespoortdam Resource Management Program which serves as the first step in establishing a WUA and CMA as described earlier.

**Figure 2: Legal Framework for Recreational Water Use**




This process of establishing a resource Management Plan is set out in Figure 3. In fact it can be said that the RMP will be promulgated as law as soon as this process is completed. “In short the Water Resource Management Program involves all parties to analyse, charge, license and repair damage.”

**Figure 3: Establishment process of a Resource Management Plan**



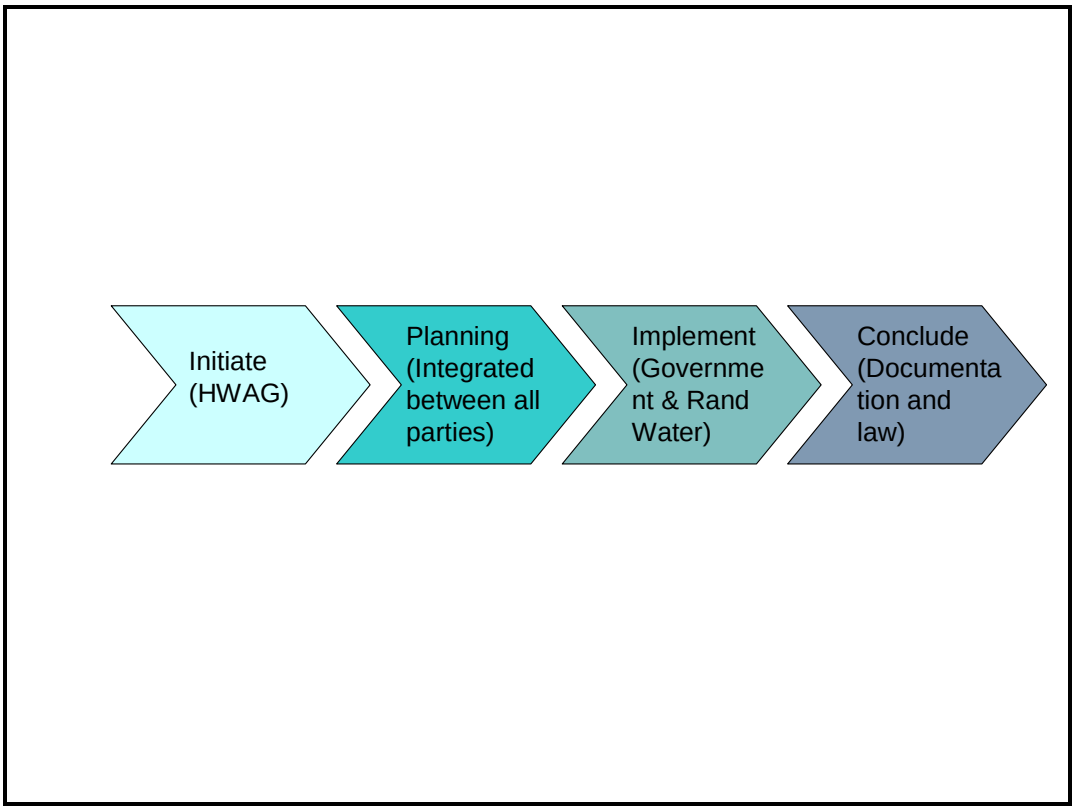

Art 113 of the national Water Act is promulgated already and covers the use of water for recreational purposes. Amongst others it regulates the surface of the dam by implementing the “zoning principle” as described by interviewees. The zoning principle ensures surface control and policing to protect amongst other the remediation projects. Property owners are forced to control access gates to the dam and it was suggested that “this also serves as a central point of information distribution to water users”. Safety is another aspect touched by this law and skipper licenses are now compulsory for users of any motorised water craft on the dam.

“Environmental Impact Assessments (EIA) were done according to law prior to larger developments such as estates or shopping facilities”, but “there exists a gap between what is promised and what is delivered”. Follow-up audits are not done after the project is completed by “official SABS auditors” as discussed in the previous section. Developers should be forced to pay a returnable fee of a

significant amount to government prior to starting with a project and this should only be paid back after the follow-up audit is satisfied with the outcome thereof. In case of non-compliance this money should be used to rectify the situation. “Developers make promises to get project approval, but take their money and run before all commitments are honoured”, was the accusation made by some interviewees. Law is established to ensure that involved parties respect each other’s rights as priorities differ substantially between them. The point was made that “emergency conditions such as power failures and the consequential effects on the environment should also be addressed in the EIA”.

It was noted by almost all interviewees that the Hartbeespoortdam Remediation Project is a pilot project by government and the private sector, and if successful, will be implemented at seven other dams around the country. The ultimate goal is to establish best practices between all parties and as a result we do not have to re-invent the wheel on the next project. Phases of a typical pilot project were set out as in Figure 4.

**Figure 4: Phases of a typical Pilot Project**




### *4.2.3 ENFORCING THE LAW*

In relation to question 1 of the research this section deals with who must make sure the law is enforced and how. The law should be enforced both upstream and downstream to the water containment body. The ways it should be enforced differ under certain circumstances. Some users may receive incentives on complying; others should receive penalties on non-compliance and others as put by one of the interviewees “must comply or simply die”.

The Blue Scorpions unit is DWAF's most effective response to combating water related crimes, including industrial pollution, solid waste dumping and illegal water use. They need to do spot checks for DWAF and put pressure on authorities like local municipalities, companies, developers and so on.

Certain companies may be incentivised if they are continuously complying with the law. Some suggestions include that “some kind of a point system may be set up to record results on a continuous basis as well as the spot checks done by

government". Good performers can be incentivised in the form of a tax rebate or similar monetary means.

On the contrary bad performers need to pay penalties if they are not obtaining enough points as described above. Obviously they will not receive the incentive, but further to that they will be penalised by some monetary means to force them to comply. This is internationally known as the Polluter Pays principle. The penalty should be on an exponential scale; the reason for this is as observed by most "those penalties must be significant enough to justify environmental accounting". On continuous transgression of the law the third dimension of comply or die should apply. It is of great concern to most interviewees that this principle of Polluter Pays does not apply and receives no backing from our authorities – this should change before it is too late.

Organisations that must simply comply or die will be concerned with hazardous waste nature that cannot put the water resources at risk at any time. Such companies need to have stringent measures in place to continuously monitor and shut down in case of non-compliance. Government institutions like sewerage works need to fall under this category. Sewerage works are established according to a certain capacity and the only party that can overload their own systems is the government and they should be held responsible for it.

A natural form of incentive created by voluntary active public participation is the increase of property value to home owners. Another natural form of incentive may be established by simply increasing the price of water. Water is currently too cheap to enforce significant savings to individuals and companies. Water should be managed in a similar way to electricity where price hikes incurred and consequential exponential costs come into play if too much electricity is used. This will put more focus on re-use or use of grey water, which currently receives very little attention.

It was confirmed by one interviewee that "cases have been recorded where companies have been issued with a notice of intention to prosecute, where they

have 14 days to comply. Such issues are usually attended to as a priority. It should not be allowed for such an instance to repeat itself regularly".

Co-operative governance is the "buzz word" when it comes to enforcing the law and this view needs to change to a more aggressive approach where government needs to take on local authorities if no actions are taken. It must be understood that this particular problem at Hartbeespoortdam can reach international proportions due to the Limpopo River being shared between SA, Botswana, Zimbabwe and Mozambique. "Concerns have been raised in the past", was a comment.

No compensation has been paid to downstream users up to date, but there certainly were many repercussions that could have justified compensation and this will definitely change in the future. The tobacco industry downstream closed down owing to too high concentrations of chlorophyll. Eskom and Sasol are developing new facilities downstream and will demand clean water. Brits, a nearby town, receives its drinking water out of the river and they will take steps if water deteriorates as it increases their costs to purify the water.

Farmers downstream have complained about their vegetables not being fit for the export market since high levels of micro cists and coli were recorded. They wash their products with canal water and rely on a cleaner source. They are being charged for the water, but they do not get quality water.

All Acts are aimed at ensuring a proper quality management system to ensure that the rights of the public are protected throughout South Africa. It stipulates boundaries for quality aspects that are in line with international standards. The question that is posed by most parties involved is not if we have substantial laws in place, but rather whether we have the resources to ensure compliance with the law.

## 4.3 RESULTS PERTAINING TO RESEARCH QUESTION 2 - FUND RAISING

This section on Fund Raising relates to Question 2 of the research which questions the sources of funding for sustainable cleaning programs and was clearly put into three sub-topics by most interviewees:

- Beneficiation
- Environmental Accounting
- Privatization

Table 2 in Chapter 4.1 indicates the relevant questions that were posed to interviewees relating to raising funds.

### *4.3.1 BENEFICIATION*

Beneficiation was described by an interviewee as “projects in and around the dam that can be turned into a business opportunity with a feasible payback and at the same time prove beneficial to the remediation of the dam”. These projects create both profit and jobs.

Beneficiation projects are discussed in the following paragraphs.

The sludge in the dam contains high levels of phosphates and nitrates and the sediment has build up to very high levels. A process known as the Bacher process is able to remove the sediment and process the sludge in order to be used to build mine dams or a sellable fertiliser.

Aesthetic improvements to the dam will create a tourism mecca and, as put forward by one interviewee, make it “comparable to world phenomena such as Lake Geneva between Switzerland and France or Lake Garda in Italy”. This will automatically increase the tax base of the local government that can be utilised to clean the dam. Recreational projects like the cable car, toboggan trail down the mountain, boat rides on the dam, and an animal zoo will draw the sixteen million feet from nearby cities to spend their pocket money there. Levies from these projects will go towards remediation of the dam, infrastructure and so forth.

Mezzo-trophycation of the dam by increasing shoreline vegetation and introducing floating mezzo-cosmos will reduce phosphate levels in the dam. Drinking water is purified by using chlorine and activated carbon to get rid of the phosphates. These costs can thus be recovered. Madibeng produces drinking water at lower rates than Rand Water. The above was explained by “the cost can be increased to the same level and savings then utilised to create the above mezzo-cosmos that helps to keep the water cleaner”. These mezzo-cosmos will also provide breeding grounds for fish like Kurper and Tilapia. “Some water reeds are intruder species and may be removed and used as the basis for these floating mezzo-cosmos. Another business opportunity is to use these water reeds for making of baskets, furniture and so on”.

Algae and hyacinths are being removed at the dam wall and dumped on an earthworm farm. Here the plants are transformed into fertiliser that is according to some interviewees “ten times more effective than commercial fertiliser due to the natural process”.

Wetlands and shoreline vegetation need to be established. Wetlands and shoreline vegetation will reduce phosphate and nutrient levels in the water.

Fish manipulation is currently in progress whereby bottom feeders like carp and barber are removed. “These fish stir up the phosphates and nutrients from the sediment and these provide food for algal growth”, and thus explains the excessive high levels of algae in the dam. These fish are caught using long lines and nets and they are sold in the market. Tilapia and other plant-eating fish will later be introduced to reduce algae growth since they feed on these algae.

Training at schools and institutions will emphasise the importance of our natural resources and make people think twice before they pollute them. “The payback is seen in the way these children will treat their environment after receiving such information,” explained one interviewee.

Additional income can be generated by putting up a toll gate at the dam wall. An estimated income of almost R10 million annually was calculated and these fees can be used to establish proper view points and improve the infrastructure around

the dam. This can also be combined with information centres and tourism tours around the dam to view different activities.

It is estimated that 50% of phosphates in the dam originate from the use of washing powders containing phosphates. Eco-friendly washing powders need to be formulated and marketed around the country to reduce overall phosphate levels.

### *4.3.2 ENVIRONMENTAL ACCOUNTING*

Environmental accounting is a term that is used internationally in first world countries that provide for environmental capital to look after the environment in any company. This sustainability concept moves the problem from an external level outside the company to an internal responsibility. According to almost all interviewees “one of the reasons why environmental accounting is not implemented in South Africa is the fact that penalties are virtually non-existent”. If penalties were more severe companies would look after the environment in a much more proactive manner. Capacity plans and maintenance of sewerage works need to receive as much attention during development approvals at all levels. Environmental accounting provides for depreciation of assets the same as any other capital expense.

Tax rebates for effective environmental management should also form part of the process and should be implemented after proper inspection by auditors after a new project is completed. Further to this, continuous monitoring should be done and annual spot checks carried out to make sure the standard is adhered to at all times. Rehabilitation in the mining industry should fall into this category as well as re-use of water on any premises instead of dumping it into sewerage lines. “Companies that re-use water should receive some incentive for that.”

The cost to comply with set legal phosphate levels is high. Amongst other methods a flocculent is used to bind the phosphate that is then mechanically removed. Government facilities are currently over-utilised and not able to handle the huge inflows, so no matter how effective the chemical process is working, the facility is too small and needs expansion to be able to effectively treat the water. Huge

amounts of money are needed for these projects. These works cannot be held liable for penalties if they are under-designed. The bottom line is high capital expenses and high process costs that need to be recovered in the asking price of water. Capital requirements for upgrades should also be sourced from new developments during the approval phase when capacities of established sewerage works are evaluated.

Capital cost to upgrade all sewerage works is estimated at R1billion and these need to be weighed against costs to compensate for the ineffectiveness of current works. Building a pre-impoundment for R400million before the dam and then installing pipelines to take the water to the dam wall will compensate for the ineffectiveness of sewerage works by reducing the dwell time of phosphate rich water in the dam. “This is only a temporally solution and will create problems further downstream.”

Estates with their own package plants can incentivise themselves by using their treated water as irrigation. Further to this it should be part of the license agreement issued to re-use their water. The full amount applied for should not be approved before all treated water is utilised effectively.

Irrigation income from downstream canals is received, but this income is very small. Bigger future users like Eskom and Sasol should also contribute to funding in order to receive better quality water.

The main source of income for remediation is sponsored by the government in cases where there is no beneficiation to private entities. The fact that pollution is created upstream from Madibeng in the neighbouring province of Gauteng, makes co-operation between municipalities and DWAF as the overseeing management critical. The principle of Polluter Pay once again come into play to make sure pollution points are directly addressed and paid for by the relevant party. At the end of the day the government should receive the money from their tax base, new developments, pricing structure of water itself, permits and licensing.

HWAG is funded by the community that contributes thirty rand per household. These moneys are paid to HWAG to fund investigations and general management

of the organisation. A lot of controversy surrounds the payment of these funds as it is voluntary: some households do not pay; some payments are not paid over from estate accounts to HWAG at all. Easier means of direct payment to HWAG should be established. Voluntary sponsorships are also received from interested companies.

Estates should also do their own environmental accounting in revamping the shoreline vegetation, mezzo-cosmos, access fees to the water, and monitoring of licensing, for example skipper license access.

### *4.3.3 PRIVATISATION*

Privatisation needs to play an important role in the remediation project. Government should outsource functions regarding certain aspects like quality laboratory management and auditing, to private companies in order to get results more quickly and effectively. Owing to return on investments for private entities being managed as an incentive, these companies deliver more effective results. Nothing succeeds like success - it creates momentum and yields results and high levels of interest.

Private Partnership Projects (PPP's between DAWF, Madibeng Municipality and a Private Company) was put forward as the solution and "creates more effective management of funding invested as a return on investment is one of the goals of the private investor".

## 4.4 CONCLUSION

Information received from all involved parties around the dam is rich in knowledge, experience, passion, forward thinking and solution creation. There is a clear message that solutions are right around the next corner, but that a lack of implementation stands out as the stop street on the road to success.

# 5 CHAPTER 5: INTERPRETATION OF RESULTS

## 5.1 INTRODUCTION

The interpretation of results is based on a qualitative case study conducted in the interpretive paradigm. The results are presented in direct relation to the two Research Questions posed in Chapter 2.

Along with some other principles from Leedy and Ormrod (2005), this chapter includes the following:

- Analysis of interviews
- Organising of details about the case into a logical order and adding notes where appropriate
- Categorisation of data by clustering data into meaningful groups or themes
- Interpretation of single instances to explore their specific meanings in relation to the case
- Identification of patterns or themes that emerge from the data during ordering and/or categorisation
- Synthesis and construction of an overall picture and conclusions drawn
- Relating findings back to literature review

## 5.2 ANALYSIS OF RESPONDENTS

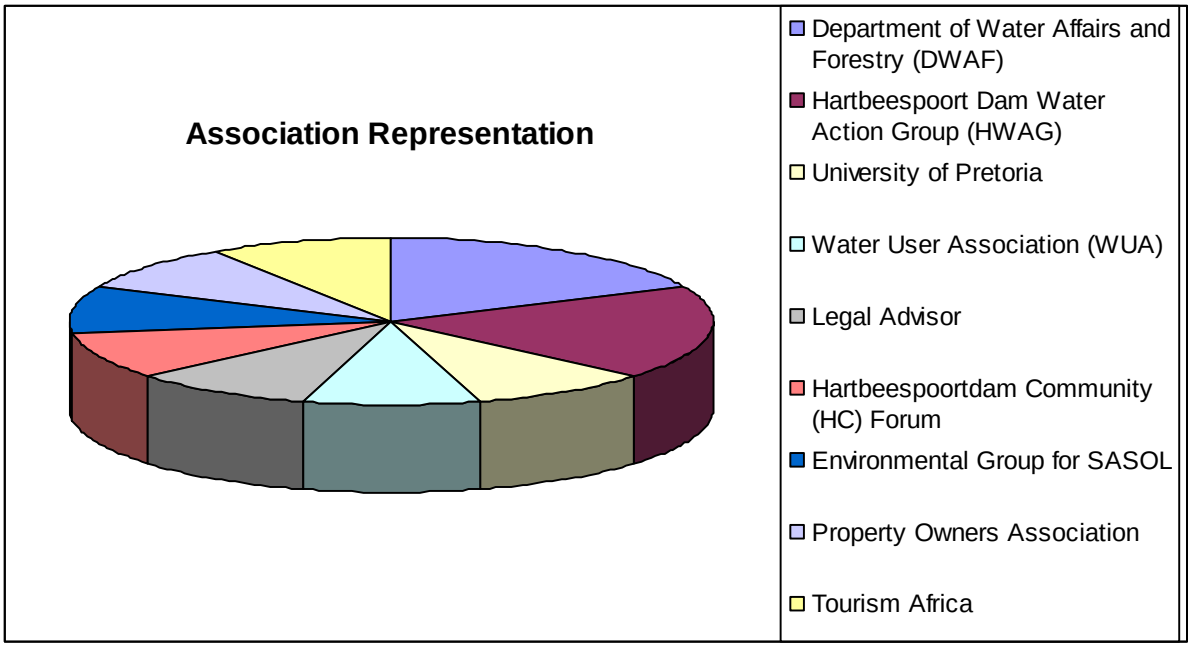
Table 1 in Chapter 3 lists the different Associations and names of interviewees. Table 4 below further breaks the list up into association representation. These associations are all involved in different areas and on different levels in the remediation project.

**Table 4: Association Representation**

| Company/Association Name | Position / Name |
|---|---|
| Department of Water Affairs and Forestry (DWAF) | 2 |
| Hartbeespoortdam Water Action Group (HWAG) | 2 |
| University of Pretoria | 1 |
| Water User Association (WUA) | 1 |
| Legal Advisor | 1 |
| Hartbeespoortdam Community (HC) Forum | 1 |
| Environmental Group for SASOL | 1 |
| Property Owners Association | 1 |
| Tourism Africa | 1 |

Figure 5 is a graphic representation of Table 4 and indicates the wide spread of associations that were represented in the interviews. The key to success of the RMP lies in involvement, communication and collaboration between all involved parties in the CMA.

**Figure 5: Association Representation**



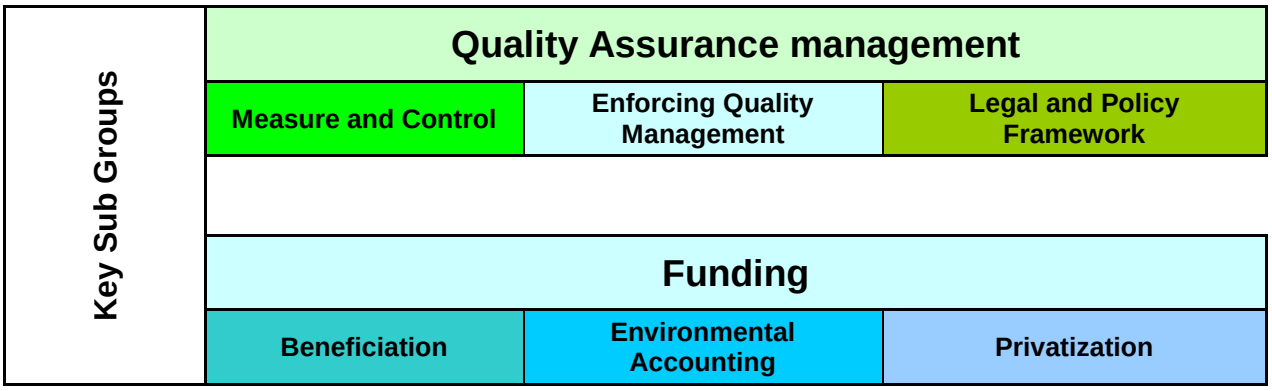

## 5.3 RESULTS PERTAINING TO RESEARCH QUESTION 1 – QUALITY ASSURANCE MANAGEMENT

In relation to Research Question 1 which questions the Quality Assurance Management process and control thereof, it can be divided into three key subgroups as tabled in Table 5.

Quality Assurance Management is divided into:

- Measure and Control
- Enforcing Quality Management
- Legal and Policy Framework

**Table 5: Key Subgroups**




Each of these subgroups will be discussed in this chapter in order to provide comprehensive answers to the research question.

### *5.3.1 MEASUREMENT AND CONTROL*

Accurate and regular measurements are key to effective quality assurance management. If something is to be improved, it must be manageable, controllable and measurable (Harrington 1991). Point source identification of pollution is the primary goal of effective measuring and draws a storyline all the way through this report in supporting the Polluter Pays Principle. Effective measuring needs to capture quantities of pollutants at constant intervals to ensure that proper trends can be established and monitored in leading up to effective water quality management.

DWAF, as the custodian of information and total resource management, must ensure that all information is received by users as regularly as necessary. They have the ultimate authority to act against non-conformers. They must perform or arrange third party checks on all levels to ensure legal compliance and to make sure no artificial results are generated by any users and regulating authorities. This may be done by using independent auditors or private entities. DWAF needs to have an information data base where tracking of all measurements are done. Tracking of results enables them to identify out of spec measurements that may either be from incorrect measurements or major operational problems at the point source. Problems need to be divided into two categories: DWAF responsibility or municipality/user responsibility. DWAF needs to prioritise their own problem

responsibilities and attack major problems first. Further, they should put pressure on municipalities/users to comply with regulations. Data is of utmost importance where affairs end up in court to provide proof and prosecute effectively.

Municipalities need to play an important role in the information gathering process by:

- physically measuring the quality of discharge water from all users including government, private and domestic, utilising their own staff or outsourcing of the function to private entities;
- comparing results with the process owner's own results. This is important to verify that the user is controlling his waste on a continuous basis and eliminates window dressing. As soon as the water user demonstrates full control of his measurements, fewer spot checks are necessary from the municipality and resources can thus be utilized at problem areas.
- ensuring that all measurements stipulated in Table 3, Chapter 4, are strictly monitored as indicated. Take into consideration that these measurements are only the ones being emphasised by interviewees and should not be viewed as the comprehensive list. DWAF does have much more detailed information on measurements and intervals thereof.
- enforcing non-compliance by issuing a penalty according to established law;
- ensuring all government institutions like sewerage works are in good working condition, have enough capacity to handle sewerage inflow and to control the capacity design process from the approval phase of new developments to completion and verification;
- ensuring all concerns raised by the public through associations such as HWAG receive prompt attention by identifying point sources and holding the polluter responsible according to law;

- ensuring that the biggest problems are solved first and that necessary funds and resources are made available to resolve. Sub-contracting to private entities needs to be arranged where there is a shortage of staff; and

- issuing licenses to all water users and signing off compliance of new installations. Eleven different uses of water were identified that form part of the current licensing process and this includes volumes withdrawn from raw and discharge back into sewerage.

Resource Quality Services (RQS) comprise the current laboratory experts used by DWAF to complete testing on water samples. This resource needs to be expanded into a National Service Resource and all testing should be done centrally. This will create economy of scale and reduce capital expenditure as laboratory equipment is of high cost. Labour costs will also be reduced as resources will be effectively utilised.

Further to the above the WRC (Water Research Commission) is another service department to DWAF that can be made more effective by utilising established institutions like universities to do research. Costs are thus subsidised by the universities in the form of knowledge.

### *5.3.2 ENFORCING QUALITY MANAGEMENT*

Interviewees are in agreement with De Azevedo and Baltar (2005) in realising the fact that water is finite and now face the challenges of effective water resource management. The first Dublin Principle according to them is the ecological principle and this principle argues that the environment must be jointly managed as land and water. The registration of a CMA is the first step towards this ecological principle and will be discussed in detail later in this report. The government structure responsible for the enforcing of quality management is illustrated in Figure 1 in Chapter 4.

The second Dublin principle of involving all stakeholders, including governments, private sector and civil society, plays a critical role and is confirmed by the establishments such as HWAG as well as the PPP (Private Partnerships Projects)

suggested by interviewees. The RMP forms the basis of all discussions between the above parties. As described above, the establishment of a CMA is critical in order to strengthen law and policy implementation and enforcement by using power equal to that of government institutions. This means that the current policing of policies will become more effective. The proclamation of the RMP (Resource Management Plan) is the basis from which the CMA functions. Penalty clauses must be clearly stipulated in order to empower them to act on non-compliance as and when necessary without lengthy law suits. CMAs will be in a position to issue penalties or even close certain companies down if serious non-conformance is observed.

Tanik *et al* (2000) emphasise the fact that policing of policies is critical and give the example of businesses being closed and relocated if necessary to positions outside the catchment area if they do not comply. During the interim period of non-compliance the problem is bridged by discharging waste through other expensive means. Baram (1986) states that communities should rely on state police power to protect health and safety. Over the centuries, use of state “police power” has led to a multitude of local state laws empowering state and local health and fire officials to control accident hazards. Local authority to regulate, site, inspect, and license dangerous activities, and to require industrial disclosures of risk information, is found in every state. Although dormant for many decades in many communities, they are now being used as the authority for bold new actions by these officials, including the shutdown of industrial activities deemed to create health risks to community residents. The CMA will have the power to act in the same capacity as described by Baram (1986) and resources will be effectively applied as described in the RMP.

DWAF, as the overseeing body and accountable party, must have a legal arm to keep all intact. The Blue Scorpions was established for this purpose to combat crimes like industrial pollution, solid waste dumping and illegal water use. This force needs to be expanded into a national force that also assists DWAF with third party verification of results from municipalities, companies, developments, estates and so on.

Act 113 of the National Water Act stipulates amongst other things the following important points regarding the use of water for recreational purposes and needs implementation by DWAF:

- Regulation of the surface of the dam by implementing effective zoning principles. This ensures surface control and among other things protects remediation projects being implemented on the dam.

- Property owners/developers/estates to take responsibility for access control onto the dam. Safety aspects like skipper licenses, signing in and out of boats and so on.

- Distribution of information on activities on the dam regarding environmental affairs should be distributed at these access gates to the water.

The EIA process forms the basis of any new development being approved by any municipality or local government. This study involves capacity planning of existing sewerage works, to which new projects will articulate. It also stipulates stringent rules and regulations that promote the re-use of water and treatment before discharge into sewerage systems. A critical factor that needs to be introduced here is signing off of projects and developments after completion. The EIA should not just be a document that gets attention before a project, but should get even more after completion. It is at this point that the substantial returnable fee, paid to authorities before project start, is released or held back to complete the project according to what has been agreed prior to the start of the project. Emergency condition preparedness i.e. power failures, should be discussed and signed off as part of the EIA process.

### *5.3.3 LEGAL AND POLICY FRAMEWORK*

South Africa can be divided into nineteen CMAs (Catchment Management Agencies). Currently not one of them is properly established and effectively managed. This can only be done by establishing a proper RMP (Resource Management Plan) and the official proclamation of such as law. Each one of the

CMAs should also have a registered WUA (Water User Association) to manage the CMA.

Pigram (1999) emphasises that the effective operation of the water market assumes the existence of clear, enforceable property rights to water. Most interviewees confirmed that this is in fact the case, but that effective implementation and policing of these rights do not exist; however, the CMA will take care of this. Furthermore, as seen in the literature review, recent federal court decisions, especially the U.S. v. Weitzenhoff (1994) matter, have imposed strict criminal liabilities (e.g. substantial prison sentences for first time offenders), even for unintentional violations of operating permits. The government must prove merely that the discharge permit was violated and that the defendants knew their actions resulted in the discharge. The defendants cannot claim that they did not know they violated the limitations specified by the permit. Clearly the WUA must be a very tough organisation that does not tolerate any violation of the established law and furthermore creates a culture of true environmental protection.

Non-profitable organisations such as HWAG need to be established as part of the WUA. These organisations are the voice of the public to the CMA. They are involved in identifying public concerns and ensuring that they receive the right amount of attention and are resolved as soon as possible. Regular meetings of members must be held to ensure the public is fully informed on activities regarding the environment around them and also as to where they can be involved in making a difference.

Figure 2 in Chapter 4 indicates the legal framework surrounding recreational water use in South Africa. Supporting this are various policies and procedures assisting DWAF to fulfil their function. All these laws are incorporated into the Resource Management Plan (RMP) that serves as the first step in establishing a CMA as described earlier.

This process of establishing a resource Management Plan is set out in Figure 3 in Chapter 4. In fact it can be said that the RMP will be promulgated as law as soon as this process has been completed. In short, the Water Resource Management

Plan involves all parties to analyse, charge, license and repair damage. Each of the nineteen CMAs should have such an RMP promulgated as law to enable effective implementation and enforcement.

It is important to mention that international laws are also applicable and can be enforced against South Africa if water coming into direct contact with neighbouring countries such as Botswana, Mozambique and Zimbabwe is found to be hazardous to human consumption. It should be borne in mind that all these countries are poor and people use river water as a major resource for drinking and washing, for example..

South African Law also provides for compensation for downstream users as in the following examples:

- Brits town – withdrawing water from the river and treating it for domestic supply
- Tobacco Industry - irrigation of tobacco plants: the chlorine content is too high and the tobacco industry has closed down
- Eskom and Sasol – both companies will draw water from the river and will demand cleaner water
- Vegetable farmers – export products are downgraded due to high levels of the faecal bacterium *Escherichia coli.*

These users are in a position to sue government if water is of poor quality. They in turn need to turn to point out sources of pollution and take action against the perpetrators. The legal structure and legislation are in place, so implementation and enforcement should also be effective.

## 5.4 RESULTS PERTAINING TO RESEARCH QUESTION 2 - FUNDING SOURCES

In relation to Research Question 2, which questions the Funding sources for sustainable cleaning programs, the findings can be divided into three key sub groups:

- Beneficiation
- Environmental Accounting
- Privatization

### *5.4.1 BENEFICIATION*

Beneficiation includes various forms, but basically it is about some kind of monetary benefit to the user of natural resources, as a result of exploring current problems and converting them into financial opportunities. Job opportunities comprise part of the benefits to the community and good results lead to bonus benefits, for example, an increase in property and tourism activity.

Such projects were described in detail in Chapter 4 and include the following initiatives:

- Sludge removal from dam basin
- Aesthetic improvements and toll gate
- Recreational projects
- Mezzo-trophycation like shoreline vegetation, floating mezzocosms and wetlands
- Package plant management by estates and developments
- Earthworm farm producing fertilizers

- Fish manipulation
- Training at schools and community
- Eco-friendly washing powders

All of these projects can be a shared responsibility and viewed as a profitable opportunity in the form of PPP (Private Partnership Projects) between DWAF, municipalities and private companies and lead to monetary benefits for all.

Public and community involvement, in the form of donations, is necessary in making non-profit organisations such as HWAG successful. A small amount from all households can go a long way and should be made official and not optional. Payments should be included into levies and paid over into the official bank accounts of HWAG. The benefits reaped from this contribution by the community are an increase in property value and tourism activity.

### *5.4.2 ENVIRONMENTAL ACCOUNTING*

The third Dublin principle, as described by De Azevedo and Baltar (2005), is the instrumental principle, which argues that water is a scarce resource, and that greater use needs to be made of incentives and economic principles in improving allocation and enhancing quality. Van Koppen (2002) also underlines the importance of effective economic management of this scarce resource. Without adequate pricing mechanisms, consumers have no incentive to use water more efficiently as they receive no signal indicating its relative value. Consistency in applying the law will promote this important principle.

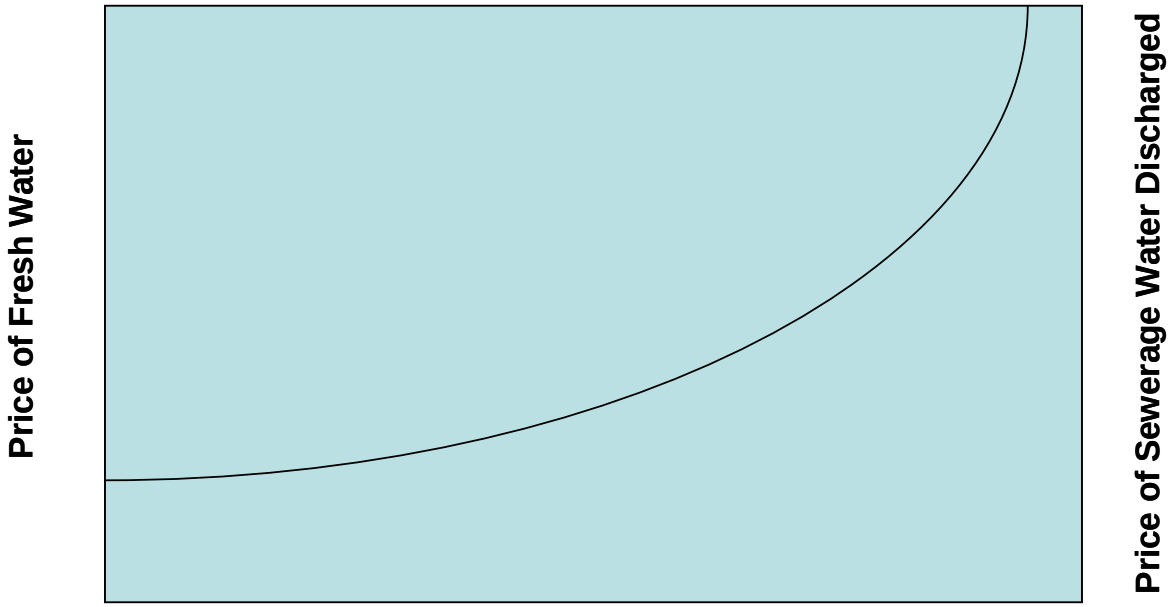
De Beer and Friend (2006) state that environmental accounting assists in expressing environmental and social liabilities as environmental costs. This sustainability concept moves the problem from an external level outside a company to an internal responsibility and monetary incentive. The Coalition for Environmentally Responsible Economies (CERES) (2000) has recently announced that many entities have adopted the Valdez Principles. Under these principles, boards of directors and chief executive officers are fully responsible for all

environmental matters. This approach should be adopted in South Africa to enforce results.

Environmental accounting can be used to demonstrate the potential for environmentally beneficial investments to yield significant financial pay-offs, through the avoidance of environmental liabilities (Hayden 1989). All water users should be managed on a point system. You earn points for complying with law and legislation. A questionnaire should be drawn up and used to evaluate users. Non-compliance leads to financial penalties while the point system progressively incentivises responsible users with tax rebates or water pricing. Quantities of fresh water used and quantities discharged need to form part of this evaluation. The price of water must be determined on an exponential scale. The more you use, the more you pay. Discharge into sewerage systems should be treated similarly: the more you discharge, the more you pay. See Figure 6 for details. This principle is similar to the current electricity pricing and penalty system in South Africa.

Environmental accounting is also based on the internationally known principle called the Polluter Pays principle. Again the enforceable penalty is on an exponential scale of significant monetary value in order to enforce and justify environmental accounting. After continuous transgression serious steps must follow and the closing down of companies must be enforced.

**Figure 6: Exponential Pricing of Fresh Water Usage and Sewerage Water Discharged**




Reinstein and Lander (2000) developed a document on Environmental Remediation Liabilities, to help entities recognise certain environmental costs and include these in their financial planning. Incentives and payment of penalties need to be integrated into the financial model. Again penalties and pricing of water must be significant enough to justify this principle. Depreciation of capital expenses needs to be provided for and tax rebates or similar monetary benefits should apply.

As discussed earlier, EIA's should clearly take into consideration size and capacity of sewerage works during approval of new developments, and capital requirements need to form part of environmental accounting to municipalities. Running costs for these facilities are also of great importance and pricing strategy for new developments should provide funds to keep plants running at optimal efficiency and result in the necessary funds being available. If this process is followed with due diligence from the start, interim emergency measures should not be necessary.

In order for the above to be successful, government and municipalities should work together closely and take into account cross provincial pollution. The Polluter Pays principle should compel each province and municipality to provide for necessary

funding from national budgets, tax bases, water price structures, new developments, permits and licensing and general PPP projects.

### *5.4.3 PRIVATISATION*

Privatisation needs to play an important role in the remediation project. Government should outsource functions regarding certain aspects such as quality laboratory management and auditing to private companies in order to get results more quickly and more effectively. Due to return on investments for private entities being managed as an incentive, these companies deliver more effective results. Nothing succeeds like success - it creates momentum and yields results and high levels of interest.

Innovative solutions in the Huai River Basin even included privatised sewerage treatment plants. These were successful due to the fact that fees were collected from companies per ton of discharged water that needed treatment and the government payed them per ton of good water discharged into the rivers (Bai and Shi 2003).

## 5.5 CONCLUSION

Quality Assurance Management is an involved program that does need procedures, legislation, manpower and significant funding to be implemented and managed successfully. Since its principles are generic throughout the world, the paperwork can be obtained fairly easily. The effectiveness of such a program actually relies on manpower and funding management. In South Africa the paperwork in terms of procedures and legislation are in place, but implementation needs major changes and restructuring and this is mainly the responsibility of DWAF, who also need to be accountable.

# 6 CHAPTER 6: CONCLUSION

## 6.1 INTRODUCTION

This chapter gives a summary of the research project. Main findings are summarised and recommendations made on possible solutions and improvements.

## 6.2 CONCLUSIONS OF THE STUDY

In theory South Africa does have a Water Resource Management Plan, supported by laws, policies and procedures. In practice the trails of lack of effective management and absence of implementation of legislation are evident on the surface of the dam.

The establishment of CMAs around the country in the form of RMPs can bridge the gap between theory and physical implementation. The three basic pillars for quality management areas follows:

- Measure and Control
- Enforcing Quality Management
- Legal and Policy Framework

Funding of effective management seems to be a daunting task, but is not impossible. Three pillars for funding mechanisms are as follows:

- Beneficiation
- Environmental Accounting
- Privatisation

Implementation of the RMP and absolute discipline in execution of law will define the long-term success of every CMA in South Africa.

## 6.3 RECOMMENDATIONS

This study provides guidance and insight for DWAF, Rand Water, Hartbeespoortdam Water Action Group (HWAG) and other stakeholders such as local community members, municipalities, NGOs, as well as businesses on quality assurance management processes and funding sources considered for sustainable water-cleaning programs in South Africa. The results of this study should be used extensively in dealing with environmental management in south Africa.

The above mentioned stakeholders and many others in South Africa in similar circumstances should use this study in assisting them in the process of establishing RMPs (Resource Management Plans) for each of the nineteen CMAs in South Africa. These RMPs must be promulgated as law and then implemented and managed accordingly. This process will create a strong power base from which to leverage results in protecting natural resources.

The results of this study should be used by all involved parties when establishing funding structures for the management of water resources. Funding structures are not part of the current legislation and these should be provided for on a national level by critical role players such as DWAF. Government in particular will find useful information on funding responsibilities and means of funding. It also assists private and public concerns in dealing with funding methods to take care of environmental issues around them.

Beneficiation projects described in this study show that seemingly bad situations can be managed differently to yield beneficial results. Parties involved in the management of natural resources can utilise the way of thinking around these beneficiation projects to produce similar results. New SMME start-ups may be established as a result of this information.

## 6.4 SUGGESTIONS FOR FURTHER RESEARCH

- Replication studies both in South Africa and other African countries

- Larger quantitative studies to establish generalisability of issues identified in this research
- Ethnographic research into the effects of issues identified on rural communities
- Research into ways to enhance the tourism potential of water resources in South Africa
- Potential business opportunities in environmental management in South Africa

# 7 CHAPTER 7: REFERENCES

ASCE Task Committee for Sustainability Criteria (1998) In *Sustainability Criteria for water resource systems,* Division of Water Resource Planning and Management, ASCE, Reston, Va.

Atkinson, P., Coffey, A. and Delamont, S. (2003). *Key themes in qualitative research: Continuities and change,* Walnut Creek, CA: AltaMira Press

Bai, X. and Shi, P. (2003) Pollution Control, In *Environment,* 38(7), pp. 24 – 37

Baram, M. S. (1986) Chemical Industry Accidents, Liability, and Community Right to Know, In *American Journal of Public Health,* May 1986, 76(5), pg. 570

Barnes, N. J. (1998) Chronic pollution in freshwaters, evaluation of ecological impacts and implications for water resource management, In *Environmental management and Health,* 9(2), pp. 49 – 53

Bichi, M.H. and Anyata, B.U. (1999) Industrial waste pollution in the Kano river basin, In *Environmental Management and Health,* 10(2), pp. 112 – 116

Black, R. and White, H. (2004) *Targeting development: critical perspectives on the millennium development goals,* Routledge, New York

Carte, D.W., Perruso, L. and Lee, D.J. (2001) *Full Cost Accounting In Environmental Decision Making*, University of Florida, http://edis.ifas.ufl.edu, 26 Feb 2004

De Azevedo, L. and Baltar, A. (2005) Water Pricing Reforms: Issues and Challenges of Implementation, In *Water Resources Development,* 21(1), pp. 19 – 29

De Beer, P. and Friend, F. (2006) Environmental accounting: A management tool for enhancing corporate environmental and economic performance, In *Ecological Economics;* 58, pp. 548 – 560

Department of Environmental Affairs and Tourism (DEAT, 1998 a) *White Paper on Environmental Management Policy for South Africa*, Notice 749 of 1998, Government Gazette, 15 May 1998

Environmental Protection Agency, (2000) *The lean and Green Supply Chain: A Practical Guide for Materials Managers and supply Chain Managers to reduce Costs and Improve Environmental Performance,* United States Environmental

Protection Office, Office of Pollution Prevention and Toxics, Washington, DC, http://www.epa.gov.. 26 Feb 2003

Falconer, D. J. Mackay, D. R. (1999) the Key to the Mixed Method Dilemma, In *Proc. 10th Australasian Conference on information Systems,* pp. 286 – 297

Funnell, B.J. (1974) *The Management Of Water Resources In England And Wales,* Saxon, 1974

Gao, J. (2004) Urban Sewage Treatment Should go Market In *People's Daily,* 12 August 2004

Goforth, G., Jackson, J. and Fink, L. (1994) Restoring the Everglades, In *Civil Engineering,* 64(3), pp. 52

Goodstein, E.S. (2002) *Economics and the Environment*, 3rd edition. Johan Wiley and Sons, Inc., New York

Graham and Trotman (1992) *The earth summit: the United Nations Conference on Environment and Development (UNCED)*, Boston

Hayden, F.G. (1989) *Survey of Methodologies for Valuing Externalities and Public Goods,* Department of Economics, University of Nebraska, Lincoln, Nebraska

Harrington, H.A. (1991) *Business Process Improvement: The Breakthrough Strategy for Total Quality, Productivity and Competitiveness*, McGraw-Hill, Inc, New York

Hartbeespoortdam Remediation Program – Business Plan (2007)

Hopwood, N. (2004): Research Design and Methods of Data Collection and Analysis: Researching Students' Conceptions in a Multiple-method Case Study, In *Journal of Geography in Higher Education*, 28(2), pp. 347 – 353

Kvale, S. (1989). *To validate is to question*, In S. Kvale (Ed.), Issues of validity in qualitative research (pp. 73-91), Lund, Sweden: Student literature

Kvale, S. (1995). The social construction of validity. In *Qualitative Inquiry*, 1, pp. 19 - 40

Labuschagne, C. (2002) *Sustainable Project Life Cycle Management: Incorporating environmental criteria into project management frameworks*, Msc (Eng) dissertation, Department of Industrial Engineering, University of Pretoria, Pretoria.

Leedy, P.D. and Ormrod, J.E. (2005): *Practical Research: Planning and Design*, Eighth Edition, Upper Saddle River: Merrill Prentice Hall

Lincoln, Y. S. and Denzin, N. K. (2003) The seventh moment: Out of the past. In N. K Denzin & Y. S. Lincoln (Eds.), *The landscape of qualitative research: Theories and issues* (pp. 611 - 640), Thousand Oaks, CA: Sage

Loucks, D. Stakhiv, E. and Martin, L. (2000), In *Journal of water resource planning and management*, March/April 2000, pp. 43 – 47

Macpherson I. Brooker, R. and Ainsworth, P. (2000), Case study in contemporary world of research: using notions of purpose, place, process and product to develop some principles for practice, In *Int. J. Social research Methodology,* Vol. 3, No 1, pp. 49-61

Mukheibir, P. and Sparks, D. (2003), Water resource management and climate change in South Africa: Visions, driving factors and sustainable development indicators, In *Report for Phase I of the Sustainable Development and Climate Change project,* Energy and Development Research Centre, University of Cape Town

Myers, M.D. (1998), *Qualitative Research in Information Systems,* last accessed 10 July 2007, 2007, from *http://www.auckland.ac.nz/msis/isworld/.*

OECD (1998), *Water Management: Performance and Challenges in OECD Countries* (Paris: Organization for Economic Cooperation and Development)

Pigram, J. (1999) Economic Instruments in the Management of Australia's Water Resources: A Critical View, In *Water Resources Development,* 15(4) pp. 493 - 509

Pretorius, W. (2006) Notes and Ideas by A Pretorius on dealing with Nutrients in the Dam Basin, In *Hartbeespoort Dam Remediation Project,* Appendix C, pp. 1

Rand Water (2007) *HBP Remediation Project – Business Plan, Final*, January 2007, pp 2 - 4

Reinstein, A. and Lander, G.H. (2000) Reporting Responsibilities for Environmental Remediation Liabilities, In *Southern Business Review;* Fall 2000; 26(1) ABI/Inform Global; pp. 1

Republic of South Africa (1996) *Constitution Act* [No. 108 of 1996], accessed 16th January 2009, from http://www.info.gov.za/documents/constitution/1996/a108-96.pdf

Republic of South Africa (1996) The Water Services Act number 108. *Government Gazette number 17678*, Government Printer, Pretoria.

Republic of South Africa (1998). The National Environmental Management Act number 107. *Government Gazette 19519*, Government Printer, Pretoria.

Republic of South Africa (1998). The National Water Act number 36. *Government Gazette 19182*, Government Printer, Pretoria.

Republic of South Africa (1997). The Water Services Act number 108. *Government Gazette 18522*, Government Printer, Pretoria.

Salner, M. (1989) Validity in human science research. In S. Kvale (Ed.), *Issues of validity in qualitative research* (pp. 47 - 72), Lund, Sweden: Student literature.

Sandberg, J. (2005) How do we Justify Knowledge Produced within the Interpretive Approaches? In *Organizational Research Methods,* 8(1), January 2005, pp. 41 – 68.

Tanik, A., Baykal B. and Gonenc, I.E. (2000) A long-term management plan for a watershed in a world metropolis – Istanbul, In *Environmental Management and Health,* 11(3), 2000, pp. 208 – 215

Taviv, I. (1999) A philosophy and methodology for the implementation of the polluter pays principle, *WRC report* (South Africa. Water Research Commission); no. 793/1/99.

United States (1976) *Environmental Laws. Resource Conservation and Recovery Act* number 42, *U.S.C s/s 6901 et seq.*

Van Koppen, B. (2002) Water reform in Sub-Saharan Africa: What is the Difference?, *3rd WaterNet/Warfsa Symposium 'Water Demand Management for Sustainable Development'*, Dar es Salaam, 30-31 October 2002, pp 1

Van Weitzenhoff, U.S. (1993, as amended Aug. 8, 1994). U.S. District Court, 1 F.3d 1523.

Veefkind, M. (1998) *Literature Study: Life Cycle Costing for Green Product Development.* Delft University of Technology, Netherlands

WCED (World Commission on Environment and Development) (1987), *Our Common Future ("The Brundtland Report"),* Oxford University Press, Oxford, UK

# 8 APPENDIX A: INTERVIEW GUIDE

- What statistical measures are currently used to measure incoming water into the dam/out of water treatment operations and where and how often are they recorded?
- What regulations, policies, licensing bodies, operating permits are to be adhered to? ISO14001.
- Who are the stakeholders that take ownership of regular measurements and review results timeously? Have you received government inspections?
- What incentives are given to organisations achieving good quality results?
- What penalties are enforced if poor quality results are measured?
- Who takes responsibility of identifying and acting on poor results? Government, community, senior management (self management), quality department, operations manager, inspectors?
- Which continuous improvement projects have recently been completed? Re-use, re-cycling, safe disposal? What long-term action plans are in place?
- What are the current costs associated with complying with the legal Phosphate levels?
- Have you ever received or heard of penalties due to non-compliance?
- Has compensation ever been paid to downstream users?
- Are you a private business or government institution? What are basics of your income and expenses cycle?

- Do you practise environmental accounting to assist in expressing environmental and social liabilities as environmental costs? Do you have an environmental expense code? Capital expenditure for environmental purposes? Expenses in order to prevent fines?
- Are you receiving any funds from Government, NGO’s and sponsors?
- Would privatisation work? Is it financially viable?