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Does the South African water resources management regulatory governance framework achieve its constitutional responsibilities in regard to Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996?: To determine whether South African water resources management regulatory framework is achieving its constitutional responsibilities in respect of Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996?

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2016
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DOES THE SOUTH AFRICAN WATER RESOURCES MANAGEMENT REGULATORY GOVERNANCE FRAMEWORK ACHIEVE ITS CONSTITUTIONAL RESPONSIBILITIES IN REGARD TO SECTION 24 OF THE CONSTITUTION OF THE REPUBLIC OF SOUTH AFRICA, ACT 108 OF 1996?

by

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A thesis submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor of Philosophy.

Johannesburg, 2016

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

SIGNED:

DATE:

ABSTRACT

Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996 provides the environmental right in the Bill of Rights, and states that:

Everyone has the right –

(a) To an environment that is not harmful to their health or well-being; and

(b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

i) Prevent pollution and ecological degradation;

ii) Promote conservation; and

iii) Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

This right places a duty on the State to implement reasonable legislative and other measures in order to protect the environment, to ensure that it (the environment) is not harmful to our health and wellbeing. Should the state not implement, or not implement adequately or sufficiently, a regulatory framework (including legislation and other measures), then the right of having the environment protected may be jeopardised. Therefore there is an onus on the State to monitor, regulate and enforce compliance of those activities that are likely to cause serious damage or ecological degradation of the environment which includes water resources. Similarly, the State needs to ensure appropriate rehabilitation of degraded environments, so as to not infringe on the environmental right.

The aim of this research is to determine whether the South African water resources management regulatory governance framework is achieving its constitutional responsibilities in respect of Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996. If it is not, then identify how to make enforcement-driven rehabilitation of water resources more effective to achieving this constitutional responsibility.

Firstly the research set outs and defines the theoretical foundations of the research, including the environmental right, integrated water resources management, riverine functions versus river health, good governance and the role of enforcement-driven rehabilitation. The research then outlines and discusses the formal regulatory framework in terms of compliance and enforcement with

regard to watercourses. A critical evaluation of this regulatory framework identifies some key gaps in the framework including the lack of provision for rehabilitation of environmental degradation at a legislative, institutional and operational level. The evaluation also identifies the lack of qualitative monitoring and reporting of environmental health; coupled with the lack of a formal policy review. This results in there being no measure of achievement of the regulatory framework and its policies, measures and mechanisms. The compliance and enforcement operational process is outlined and challenges illustrated through a case study of the Bryanston Bicycle Park. The related operational challenges are identified and discussed.

The thesis found that the regulatory framework, although generally appropriate, despite lacking provisions for rehabilitation of environmental degradation, was limited by its implementation. Challenges in implementation of the framework range from capacity and capability constraints, to anthropocentric based resource management, and fragmentation of legislation and institutional mandates, amongst others. One of the key findings from the evaluation and review is that enforcement-driven rehabilitation is currently not effective in contributing towards the achievement of Section 24 of the Constitution. This can be attributed to the lack of guidance in the legislation, as well as the poor ability of officials to identify the extent of ecological impacts and/or effects of contravening activities on the surrounding environment. In an effort to remedy this, the research conducted a comparative review of existing river assessment methodologies and their suitability for application in the enforcement screening process and to guide enforcement-driven rehabilitation. While these methodologies contained some applicable sections, they were not applicable in their entirety to the context of enforcement-driven rehabilitation in South Africa. The research therefore develops tools to assist officials in their day to day functions. These tools include:

i. The Legislation Search Tool provides a searchable database of all the applicable environmental legislation to rivers. The database enables an enforcement official to search by specific section of legislation or by search word. The search highlights all the relevant adjacent legislation and institutions responsible for the overlapping or adjacent sections of legislation.
ii. The Site Inspection Checklist provides a uniform record of site inspection and site characterisation that can be understood by “laypersons”, and

across institutions and officials. The indicators to be described on the site inspection form guide the officials to specifically observe particular aspects of the site, and resultant impacts. The checklist was developed through applied science and research of existing assessment methodologies applied to the enforcement context. The indicators are answered by selecting the appropriate description from a list of prescribed descriptions. The information from the Site Inspection Checklist are captured into the Dashboard Tool.

iii. The Dashboard Tool, based on the descriptions selected to describe the site, assigns values to the selected description measure in order to calculate using a fuzzy synthetic evaluation process to produce an illustrative indication of the potential impacts that the activities on the site are having on the potential of the site to provide ideal riverine functions. The Dashboard does not provide a quantitative assessment but rather flags to the enforcement official to request specialist studies, and which functions and impacts should be investigated further in detailed technical assessments and addressed in the rehabilitation plan. The Site Inspection Checklist and Dashboard Tool were tested amongst various enforcement and other officials, and updated and adjusted through an iterative process. The key case studies are presented and discussed. The research closes with concluding remarks on the findings, discussions and outcomes of the research.

The research contributes to the body of knowledge in the framework for review of the knowledge. In the absence of a formal policy review of the regulatory framework, the research conducted a critical evaluation of the regulatory framework for water resources management, in terms of its contribution towards the achievement of Section 24 of the Constitution, the environmental right. With the identified failure of the regulatory framework to contribute effectively towards the environmental right, the research developed key tools to guide and support enforcement officials, in order to improve the effectiveness of enforcement-driven rehabilitation and contribute more effectively towards achievement of the environmental right.

ACKNOWLEDGMENTS

- When I was a Green Scorpion (Environmental Management Inspector), I identified a problem in my administrative working tools. This research is the culmination of effort, sweat and passion to fix that problem. The road to this point has been long with many obstacles, frustrations, victories and late nights; all of which required the input, support, discussion, and guidance of numerous people at various scales to get to this point. I am grateful to everyone I have encountered through this research and for all the inputs information and support. In particular I would like express my gratitude to the following groups of people for their roles in this research.
- My gratitude to my supervisor, **Chris James**, for his patience while I completed this research; for always making time when I was available; for trusting that as a part-time student I would one day finish; and for positive consultations that kept me enthusiastic about the work at hand.
- I would like to thank the **Water Research Commission** for making this research possible through a three-year funding grant.
- To **Mark Rountree** for understanding the mission, for the many discussions, questions, guidance, shared enthusiasm and support.
- To the many specialists and officials, **Mark Rountree**, **Nico Rossouw**, **Natalie Newman**, Stephanie Coetzee for making the time to answer my questions, have discussions and of course test the tools.
- To **Deshni Pillay**, **Willie Enright** and my dad **Ian Braid** for late night reading and providing access to information.
- To my friends, family and colleagues for their support and patience over the years until this research was finally finished.
- To the environmental enforcement officials that I engaged with at the various stages of this research, from concept to completion, your support of the research and enthusiasm for the tools helped keep me interested and focused on the work over the years. This work is for you.

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LIST OF ABBREVIATIONS

AMD	:	Acid Mine Drainage
AUSRIVAS	:	Australian River Assessment System
B-IBI	:	Benthic-Index of Biotic Integrity
C&E	:	Compliance and Enforcement
CARA	:	Conservation of Agricultural Resources Act, Act 43 of 1983
CD	:	Chief Director
CFO	:	Chief Financial Officer
CHR	:	Commission on Human Rights
CITES	:	Convention on International Trade in Endangered Species
CMA	:	Catchment Management Agency
CPA	:	Criminal Procedures Act, Act 51 of 1977
D	:	Director
DDG	:	Deputy Director General
DEA	:	Department of Environmental Affairs
DEAT	:	Department of Environmental Affairs and Tourism (see DEA)
DAFF	:	Department of Agriculture, Forestry and Fisheries
DPLG	:	Department of Local Government
DPME	:	Department of Monitoring and Evaluation
DT	:	Dashboard Tool
DWAF	:	Department of Water Affairs and Forestry (see DWS)
DWAFEC	:	Department of Water Affairs, Forestry & Environmental Conservation (DWS)
DWS	:	Department of Water and Sanitation
EA	:	Environment Agency (United Kingdom)
ECA	:	Environment Conservation Act, Act 73 of 1998
ECE	:	Environmental Compliance and Enforcement
EIA	:	Environmental Impact Assessment
EIP	:	Environmental Implementation Plan
EMI	:	Environmental Management Inspector
EMP	:	Environmental Management Plan

FAII	:	Fish Assemblage Integrity Index
FSE	:	Fuzzy Synthetic Evaluation
GDARD	:	Gauteng Department of Agriculture and Rural Development
GNR	:	Government Notice Regulation
GWM&ES	:	Government Wide Monitoring and Evaluation System
GWP	:	Global Water Partnership
FISCRWG	:	Federal Inter-Agency Stream Corridor Restoration Working Group
HET	:	Higher Education Training
HQA	:	Habitat Quality Assessment
IGRFA	:	Inter- Government Relations Framework Act, Act 13 of 2005
IHI	:	Index of Habitat Integrity
INECE	:	International Network for Environmental Compliance and Enforcement
IUA	:	Integrated Unit of Assessment
IUCN	:	International Union for Conservation of Nature
IWRM	:	Integrated Water Resources Management
km	:	Kilometres
LST	:	Legislation Search Tool
M&E	:	Monitoring and Evaluation
MA	:	Management Assistant
MPAT	:	Management Performance Assessment Tool
NEMA	:	National Environmental Management Act, Act 107 of 1998
NEM:BA 2004	:	National Environmental Management: Biodiversity Act, Act 10 of
NEM:PAA 2003	:	National Environmental Management: Protected Areas Act, Act 57 of
NEM:WA	:	National Environmental Management: Waste Act, Act 59 of 2008
NFEPA	:	National Freshwater Ecosystems Priority Areas
NGO	:	Non-Governmental Organisation
NSSD	:	National Strategy on Sustainable Development
NWA	:	National Water Act, Act 36 of 1998
NWRI	:	National Water Resources Institute

NWRS	:	National Water Resources Strategy
OECA	:	Office of Enforcement and Compliance Assurance (US-EPA)
PAJA	:	Promotion of Administrative Justice Act, Act 3 of 2000
PAIA	:	Public Access to Information Act, Act 2 of 2000
PES	:	Present Ecological State
RDM	:	Resource Directed Measures
REC	:	Recommended Ecological Category
RHP	:	River Health Programme
RIVPACS	:	River Invertebrate Prediction and Classification Scheme
RO	:	Regional Office (DWS)
RoD	:	Record of Decision
RH	:	River Health
RHS	:	River Habitat Survey
RQO	:	Resource Quality Objective
RU	:	Resource Units
SACNSP	:	South African Council for Natural Scientific Professions
SAEO	:	South African Environment Outlook
SANBI	:	South African National Biodiversity Institute
SASS	:	South African Scoring System
SEMA	:	Strategic Environmental Management Acts
SEMF	:	Strategic Environmental Management Frameworks
SETA	:	Skills Education Training Authority
SIC	:	Site Inspection Checklist
SIF	:	Site Inspection Form
SOER	:	State of Environment Report
SOP	:	Standard Operating Procedure
TA	:	Technical Assistant
UN	:	United Nations
UNCED	:	United Nations Conference on Environment and Development
UNDP	:	United Nations Development Programme
USDA	:	United States Department of Agriculture

US-EPA	:	United States Environment Protection Agency
VAI	:	Vegetation Assessment Index
WRC	:	Water Research Commission
WRI	:	Water Resource Institution
WUA	:	Water Users Association

GLOSSARY

Active channel: is the part of the channel that receives water flow most often. It is usually marked by noticeable banks on either side of the channel (Freeman and Rowntree, 2005). Regular storm events such as 1:2 or 1:5 year events occur within the active channel. This is also referred to as the instream channel.

Adjacent properties: include next-door properties located both up and downstream, and surrounding the property in question. It is not limited to a common boundary, e.g. it may be across the road, servitude or river.

Catchment: "is the land surface that contributes water and sediment materials to a river channel." (Freeman and Rountree, 2005:8)

Channel is a term used collectively to refer to the course of a river or stream including, the bed and banks. It can be individually referred as in-stream and banks. (EA, 1998).

Criteria: a standard of judging; a principle or fact by which a correct assessment may be formed.

Ecology: "the branch of biology dealing with the relationships and interactions between organisms and the (natural) environment; the set of relationships existing between organisms and their environment" (Webster's College Dictionary, 1995)

Ecosystem: "A set of interacting organisms and the solar driven system that comprise of primary producers, and consumers and decomposers" (Falkenmark, 2003:9).

EcoStatus: "the totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services" (DWAF, 2008:xii)

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water, regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other non-material benefits. (Millennium ecosystem assessment).

Enforcement: refers to the "actions that the governments and others use to achieve compliance within the regulated community" (Craigie *et al., 2005:45)*.

Environment: "the aggregate of surrounding things, conditions, or influences; surroundings, milieu; the air, water, minerals, organisms and all external factors surrounding and affecting a given organism at any time; the social and cultural forces that shape the life of a person or population" (Webster's College Dictionary, 1995).

Flood zone: the area between the regular flow of the active channel and the maximum height of major floods e.g. the 1:100 or 1:200 year flood plain. Also referred to as the macro-channel.

Fuzzy synthetic logic: is a method of computing or analysis using "degrees of truth" rather than the usual "true or false" (1 or 0) logic on which modern computing and analysis is based. It is applied where truths are not easily translated into absolute terms of true or false. (Programming glossary; 2015)

Governance: 'is the system of values, policies and institutions by which a society manages its economic, political and social affairs through interactions within and among the state, civil society and private sector. (UNDP, 2007)"

Justiciable right: Justiciability concerns the limits on legal issues over which a court can exercise its judicial authority. Therefore a justiciable right is a right can be decided by a court.

Indicators: are the measurements or statistical parameters that help us to present a meaningful picture of what is happening within the environment, (UNEP, 2004). An indicator can be an organism, attribute or parameter that defines a particular characteristic.

Integrated Water Resources Management (IWRM): "is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. (GWP, 2000:22)"

Non-compliance: "refers to any breach of an environmental legislative obligation or permit condition, irrespective of whether such a breach constitutes a criminal offence or not." (DEA, 2013a)

Regulation: is “the means by which any activity, person, organism or institution is guided to behave in a regular fashion, or according to rule. (Picciotto *et al.,* 2002)”

Rehabilitation: is the remedying of some ecosystem functions and processes in a degraded state or site

Remediation: is defined as improving the ecological condition of the river, while not aiming for an endpoint which resembles its original condition, Breen and Walsh (1999), i.e. maintain status quo and prevent further degradation.

Restoration: is defined as *“the process of returning an ecosystem as closely as possible to pre-disturbance conditions and functions”* (FISCRWG, 1998:1-3) i.e. to return to pristine.

River functions: are the biological, geochemical and physical processes that take place or components that occur within a riverine ecosystem.

Watercourse: is defined in the National Water Act, Act 36 of 1998, as:

a) A river or spring;

b) A natural channel in which water flows regularly or intermittently;

c) A wetland, lake or dam into which, or from which, water flows; and

d) Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes where relevant, its bed and banks.

1 INTRODUCTION

1.1 Motivation

Water resources are under pressure; "growth in population, increased economic activity and improved standards of living lead to increased competition for and conflicts over the limited freshwater resource" (GWP, 2000:9). In response to the general world water resource challenges, concerns to stop environmental degradation (Falkenmark, 2003) and building on various initiatives such as the Stockholm Declaration of the United Nations Conference on the Human Environment, 1972 (Stockholm Declaration) and the Brundlandt Report with the concept of "sustainable development", a consultative process was undertaken to address water resources management from a global perspective. The outcome of the process culminated in the International Conference on Water and the Environment, in Dublin in 1992, with the "Dublin Principles". The principles[1] aim "to promote changes in those concepts and practices which are considered fundamental to improved water resources management" (GWP, 2000:13). Furthermore, the Dublin Principles contributed significantly to the Agenda 21 Recommendations (Chapter 18 on freshwater resources) that were adopted at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Relevant to this research, Agenda 21 Chapter 18 states that "integrated water resource management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilisation." The challenge, however, is for water resources management to ensure sustainable management of the multiple services offered by water systems whilst avoiding their over-exploitation and degradation (Millennium Development Goal 7). This requires both proactive and reactive management methods to ensure the sustainable use as well as the rehabilitation of degraded water resources.

[1] The Dublin principles are:

1. Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
3. Women play a central part in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognized as an economic good.

In line with these international trends (Brundlandt Report, World Conservation Strategy, Agenda 21, etc.), South Africa started to develop its own Environmental Policy. This policy (DWAFEC, 1980:12) recognised that water was of primary importance in the total habitat of man and that there is limited availability of water resources for all the demands of development and utilisation in South Africa. The policy further proposed that all the activities and measures for the prevention, control and combating of water pollution must be effectively co-ordinated and optimised, and the necessary steps should be taken to identify, protect, conserve and ensure the multipurpose utilisation of the freshwater ecosystems (DWAFEC, 1980:12). From this policy grew the Environment Conservation Act, Act 100 of 1982 and amended as Act 73 of 1989 (ECA), and later the environmental right contained in Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996 (the Constitution).

1.2 Context

The Constitution provides two rights regarding water. Firstly in terms of water as a resource of the environment, Section 24 states that:

"Everyone has the right-

> *(a) to an environment that is not harmful to their health or well-being; and*
>
> *(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that-*
>
> > *(i) prevent pollution and ecological degradation;*
> >
> > *(ii) promote conservation; and*
> >
> > *(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."*

Secondly, as a right to life, Section 27(1)(b*)* states that *"everyone has the right to have access to sufficient food and water."*

The provision of water services contemplated in Section 27 is dependent on the availability (quantity and quality) of water resources from the environment, as contemplated in Section 24.

South Africa has implemented a complex regulatory framework of legislative and other measures for the sustainable management of water resources in the country, in order to enable the progressive realisation of these rights (Section 24 and Section 27 of the Constitution). This regulatory framework encompasses three components:

i. An Enabling Environment – this includes the legislative measures, such as the National Environmental Management Act, Act 107 of 1998 (NEMA) and the National Water Act, Act 36 of 1998 (NWA), national principles, policies, regulations and resource management strategies;

ii. Institutional Roles – this includes the various administrative organisations tasked with implementing the legislative measures and developing and implementing the management instruments, such as the National, Provincial or Regional Departments of Environment or Water Affairs respectively; and,

iii. Management measures – this includes the "operational instruments of effective regulation" (GWP, 2000:30), such as plans, procedures, methodologies, management objectives, strategies, and tools for their implementation.

South Africa's National Water Act, Act 36 of 1998 (NWA), is widely regarded as one of the most progressive pieces of environmental legislation in the world (Postel and Richter, 2003:253). However, Van Wyk *et al.,* (2006) caution that the objectives of the NWA are ambitious and unprecedented, and it is not surprising that the objectives of equity, efficiency and sustainability in the allocation and use of the country's water resources remain elusive. The 2006 State of the Environment Report (DEA, 2006) confirms this elusiveness, as it noted that 82% of the country's main river ecosystems were threatened, 50% of the wetlands had already been destroyed, and water demand was expected to rise by 52% over the next 30 years.

Water resources management requires a two-pronged approach. The first being the formal regulatory aspect and proactive management of water resources in order to prevent the over-exploitation and degradation of water resources, i.e. obtaining permits, licences or authorisations for activities that will impact on the water resources. The second approach is that of the compliance and enforcement of such permits, licences and authorisations. Compliance and enforcement is not limited to the administrative aspect of the permits, licences or authorisations, but includes ensuring that the impacts to the water resources as a result of non-compliances are identified, addressed and rehabilitated or mitigated appropriately

in order to remediate degradation and over-exploitation, and thereby contribute towards the achievement of the objectives of Section 24 of the Constitution.

Markowitz and Michalak (2004) argue that while there are many environmental indicators that report on the pressures on the environment; the indicators of policy responsiveness to the environmental problems, and especially those in relation to enforcement and non-compliance actions, have not been well developed. In other words, the indicators do not measure improvement in the environment as a result of the compliance and enforcement actions (Stahl, (2002); Markowitz and Michalak (2004); Mazur, (2010)).

1.3 Problem statement

The overall study addresses the following research question:

Does the South African water resources management regulatory governance framework achieve its constitutional responsibilities in respect of Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996? If not, to identify how to make enforcement-driven rehabilitation of water resources more appropriate to achieving its constitutional responsibilities.

1.4 Aims of the study

Specific aims of the study are to:

1. Review the concepts of the environmental right, sustainability, Integrated Water Resources Management (IWRM), riverine function, good governance, and enforcement-driven rehabilitation;
2. Conduct a critical evaluation of the water resources management regulatory framework and identify operational challenges to implementation of the regulatory framework;
3. Propose recommendations to address the operational challenges; and,
4. Use applied research to identify or develop pragmatic (practical, user-friendly) tools to assist enforcement officials to set appropriate rehabilitation objectives in the compliance and enforcement process.

1.5 Research methodology

The first part of the thesis focuses on the policy context of the water resources management regulatory governance framework. The research comprises an analytical literature review of the concepts of the environmental right, sustainability, Integrated Water Resources Management (IWRM), riverine function, good governance, and enforcement-driven rehabilitation. Within the setting of these concepts, the research outlines and discusses the current South African water resources regulatory framework. Using indicators of good governance, the research conducts a critical evaluation of the regulatory framework and identifies, discusses and makes recommendations on the operational challenges limiting implementation of the compliance and enforcement framework. The next part of thesis focuses on the operational challenges and how to resolve or address these challenges. From the outcomes of the policy evaluation, the research uses applied science and fuzzy synthetic logic to develop tools to assist enforcement officials improve the effectiveness of enforcement-driven rehabilitation of watercourses. In this process of tool development, a comparative study is undertaken of existing river assessment tools and methodologies to determine their appropriateness for utilisation in the enforcement-driven context.

Sections of this research were conducted through Water Research Commission (WRC) funding (TT 594/14) *Tools to determine enforcement-driven rehabilitation objectives on urban river reaches*. The candidate was the project manager and principal researcher. The project was monitored by the WRC through a reference committee of peers and scientists.

1.6 Structure of the thesis

This study commences in Chapter 2 with a discussion of the theoretical foundations of key concepts of the thesis before presenting the current South African water resources management regulatory framework (the framework) in Chapter 3. This is followed by a critical evaluation of the regulatory framework in Chapter 4 in order to determine the challenges facing implementation of the policy framework. In Chapter 5 the operational issues of compliance and enforcement are then reviewed and illustrated with a case study of the Bryanston Bicycle Park. A discussion on the operational challenges of water resource based compliance and enforcement leads to the development of tools to assist and guide

enforcement officials to be more effective through enforcement-driven rehabilitation in Chapter 6. A comparative analysis (Chapter 6) is conducted of existing river assessment methodologies, and the details of each assessment are included in Appendix A. The thesis-developed tools are tested through an iterative process illustrated through several case studies presented in Chapter 7. Lastly, in Chapter 8, conclusions are drawn and recommendations made regarding the resolution of the operational and policy challenges within the South African water resources management regulatory framework.

1.7 Contribution to knowledge

This research contributes to the body of knowledge in two ways:

1. The framework for review of the knowledge. In the absence of a formal policy review, this research conducts a critical evaluation of the regulatory framework governing water resources management from a compliance and enforcement perspective and questions its effectiveness in contributing towards the achievement of the environmental right (Section 24 of the Constitution).

2. There are many existing river assessment methodologies and tools to prioritise rehabilitation however few of these have applicability to enforcement-driven rehabilitation or to the current system of South African enforcement procedures and processes. Using applied research and fuzzy synthetic logic, the knowledge from existing tools is adapted to the South African enforcement context in the development of enforcement specific tools.

2 THEORETICAL FOUNDATIONS

2.1 Introduction

This research addresses the challenges in the enforcement of the South African water resources management regulatory framework and in the South African approach to enforcement-driven rehabilitation, in particular for urban[2] river reaches. This requires a multi-disciplinary approach that requires the understanding of key concepts from a number of different disciplines which have a direct or indirect relevance and/or influence to identifying and addressing the abovementioned deficiencies. These key concepts are the environmental right, sustainability, Integrated Water Resources Management (IWRM), enforcement, rehabilitation and good governance.

In the sub-sections below, the following questions relevant to these key concepts are addressed:

- What is the meaning of environmental right encapsulated in Section 24 of the South African Constitution?
- What is the difference between the concepts of sustainability and sustainable development?
- What is IWRM and how is it relevant to rehabilitation?
- Why measure riverine function instead of river health to determine the state of urban rivers?
- What is good governance from a compliance and enforcement perspective?
- What is enforcement-driven rehabilitation?

2.2 Environmental Right

According to Section 24 (the environmental right) of the Constitution of the Republic of South Africa, Act 108 of 1996 (the Constitution), "*everyone has the right- [own emphasis]*

[2] This research has a core focus on urban areas as they are more affected by unauthorised activities. Non-urban areas i.e., agricultural land, is prone to more legislation as well as additional impacts. Quinn *et al.* (2003) specifically looked at rehabilitation of South African rural rivers.

*(a) To an **environment** that is not harmful to their **health** or **well-being**; and*

*(b) To have the environment **protected**, for the benefit of present and future generations, through reasonable legislative and other measures that –*

*(i) Prevent **pollution** and ecological degradation;*

(ii) Promote conservation; and

(iii) Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

Thompson (2006:136) makes two noteworthy observations of this right. Firstly, Thompson highlights that this right contains both an individual right and a justiciable right to a healthy environment. In other words, the conduct of an organ of state, a private individual or an organisation that violates this right may be challenged. Importantly, and relevant to this research, the right also imposes a duty on the State to implement both legislative and other steps to protect the environment; and if the State fails in this, it can be forced to comply.

Secondly, Thompson explains that the right is negatively phrased, i.e. a right that is "not harmful", instead of a positive right to a healthy environment. This implies that the right enshrines a certain minimum standard. The question then arises as to what is the minimum environmental standard that is not harmful to citizens' health or well-being? With regard to water resources, resource quality objectives represent such a minimum standard. Resource quality objectives are a set of narrative and/or numerical management objectives defined for any particular resource, where the management class sets the boundaries for the volume, distribution and quality of the reserve of the resource and informs the determination of the allocable portion of a water resource for that is available for use.

Ultimately, the right places "a duty on the State to protect the environment" Thompson (2006:137). This duty is realised through legislation and administrative measures, i.e. the regulatory framework. Therefore, should the State not implement, or not implement effectively and sufficiently, the regulatory framework, then the right to have the environment protected may be jeopardised. It is therefore the duty of the State to

monitor, regulate and enforce compliance of those activities that are likely to cause serious damage or significant degradation of the environment and the water resources. To enact progressive legislation is insufficient, the legislation needs to be implemented and the desired outcomes achieved, for the State to achieve its duty regarding the environmental right.

The component parts of Section 24 are further defined as follows:

Environment as defined in the National Environmental Management Act, Act 107 of 1998 (NEMA), "*means the surroundings within which humans exist and that are made up of—*

> *(i) the land,* ***water*** *and atmosphere of the earth* [own emphasis];
>
> *(ii) micro-organisms, plant and animal life;*
>
> *(iii) any part or combination of (i) and (ii) and the interrelationships among and between them; and*
>
> *(iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence* ***human health*** *and* ***well-being*** [own emphasis].

This confirms that water is a component of the environment. Thus, the management of water resources is also subject to legislation governing the environment. This is elaborated in Chapter 3.

The National Water Act, Act 36 of 1998 (NWA), defines ***protection*** in relation to a water resource, means -

> *(a) maintenance of the quality of the water resource to the extent that the water resource may be used in an ecologically sustainable way;*
>
> *(b) prevention of the degradation of the water resource; and*
>
> *(c) the* ***rehabilitation*** *of the water resource* [own emphasis].

Rehabilitation has been identified in the legislation as a key contributor to the protection and~~,~~ thereby, the management of water resources. As water is a

component of the environment, rehabilitation of the water resources is a key contributor to achieving the environmental right.

Health is defined by the WHO (1948) as being "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." The Webster Dictionary defines ***well-being*** as being "healthy, happy and prosperous". This elicits a circular reference as health and wellbeing both refer to each other; one cannot be achieved without the other. In terms of the definition of "well-being", the condition of being "happy" is determined from the spiritual and/or psychological state of the individual. Certain aspects of the environment may trigger that spiritual or psychological state based on their scenic beauty and aesthetic appeal, for example a visit to the Augrabies Falls or Thukela falls which are protected for their natural and scenic beauty.

In the World Conservation Strategy (IUCN, 1980), **conservation** is defined as "the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is the positive, embracing preservation, maintenance, sustainable utilisation, **restoration**, and enhancement of the natural environment" [own emphasis].

These definitions confirm unambiguously that rehabilitation and restoration are critical components in the environmental right, and in the sustainable conservation and management of the environment. Therefore the state that we need to benchmark against includes principles and implementation promoting rehabilitation.

2.3 Sustainability versus Sustainable Development

The concept of "sustainable development" was first proposed in the World Conservation Strategy in 1980, in an effort to integrate environment and development concerns under an umbrella concept (Mebratu, 1998:501). Although the term "sustainable development" was not actually used in the text of the conservation strategy, it did define development as: "the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life." Development, by its definition, is anthropocentric, i.e. survival of human beings is the core objective. Although the

concept of sustainable development was formulated in the World Conservation Strategy, the term "sustainable development" grew in popularity from the Brundtland report of 1987, where it was formally defined as: "The ability of humanity to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs".

Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional changes are made consistent with future as well as present needs (UN, 1987)[3]. By its definition, sustainable development is also anthropocentric; it is focused inwardly on the survival of human beings, rather than on the survival of ecosystem functions that produce the resources to sustain all life. This is supported by Parker and Doak (2012:34) who see sustainable development as "a process of change, i.e. of development, and of being anthropocentric i.e. human needs come first." Parker and Doak (2012:37) further argue that "sustainable" and "development" are partnered together to reflect this process of change and improvement. The process of change implies that there is a need for further economic and physical development in order to provide for future needs. Since the initial definition, there has been much discussion, interpretation and discourse regarding the concept of sustainable development, for example Roberts (2004), Bernie and Boyle (2002), Urquhart and Atkinson (2000), Weiss (1992), and Sands (2003), amongst others. In context to this research, Kotze (2005a) classifies sustainable development as being an abstract and general term, whose meaning may vary depending on the context in which it is used. The term is however limited to the "development" of resources and does not include other aspects such as utilisation, management or impacts on the resources, which are implied in the definition of protection.

Kotze (2005a) proposed that sustainable development is a mechanism that can be utilised to achieve sustainability; where sustainability refers to "the ability to maintain a

[3] According to the Institute for International Urban Development, the term "Sustainable Development" was born out of global dissatisfaction with large-scale development projects such as hydroelectric dams or logging schemes that increased GDP but at the expense of local communities and natural resources. The term aimed to include facilitating coordination between social, environmental and economic considerations in these development projects.

desired condition over time without eroding natural, social and financial resource bases" (Nel 2004 cited in Kotze, 2005a). Parker and Doak (2012:36) interpret sustainability to be "where stewardship and protection of the physical environment are placed at the centre, in order to support humans", i.e. move towards eco-centric rather than anthropocentric. This suggests firstly, that ecological functions are maintained in order to conserve resources for future generations. Secondly, it is suggested that all aspects of the utilisation of resources must be considered, i.e. it is not only limited to development, but rather encompasses the utilisation of, management of, and impacts on resources as well. Furthermore, the managing or mitigation of impacts on the resources is a key requirement of sustainability in order to maintain the desired state of the resources. Sustainability by its definition, requires an integrated and holistic approach to environmental governance, resource management, implementation and enforcement, as well as the monitoring of actual impacts on the environment. Therefore the term "sustainability" is broader and more inclusive than the term "sustainable development" when considering anthropogenic interaction with and dependence on the environment for survival.

In the context of South African legislation, Section 24 of the Constitution and the Section 2 principles of NEMA include "sustainable development", where "sustainable development means the integration of social, economic and environmental factors into planning, implementation and decision making so as to ensure that development serves present and future generations" (NEMA, s1). However the principles of the NWA include "sustainability". No definition of sustainability or sustainable development is included in the NWA.

The National Strategy for Sustainable Development (NSSD), developed by the Department of Environmental Affairs, however has the following to say on the two concepts (DEA, 2011):

"Sustainability (or a sustainable society) is seen as the overall goal of the NSSD 1. Sustainability in this context implies ecological sustainability. In the first instance, it recognises that the maintenance of healthy ecosystems and natural resources are preconditions for human wellbeing. In the second instance, it recognises that there are limits to the goods and services that can be provided. In other words, ecological sustainability acknowledges that human beings are part of nature and not a separate entity" DEA, 2011:8).

"Sustainable development is the process that is followed to achieve the goal of sustainability. Sustainable development implies the selection and implementation of a development option, which allows for appropriate and justifiable social and economic goals to be achieved, based on the meeting of basic needs and equity, without compromising the natural system on which it is based" (DEA, 2011:8)."

These definitions provided in the NSSD (DEA, 2011), for sustainability or a sustainable society are reflected in the ecosystems' ability to include humans in the biosphere as a measure of sustainability, hence an ecosystem approach or what humans will require together with other species to be sustainable. Whilst sustainable development is only a reflection of meeting the developmental needs as well as the social, economic and environmental needs of society.

2.4 Integrated Water Resources Management (IWRM)

Falkenmark (2003) explains that the process of integrating water resource management is to strike a balance between the use of water resources for livelihoods, and the conservation of the resources to sustain their functions for future generations, i.e. the principle of sustainability. The Integrated Water Resources Management (IWRM) framework is composed of the components of sustainability, and of economic, social and environmental equity. For example, equity does not mean equal parts, but equal consideration. IWRM is implemented through the three elements of resource management, i.e. the enabling environment which includes the legislation and policies, the institutional structures, and the management mechanisms such as operating systems and procedures. The "integrating" encompasses two categories, namely that of the natural system, and that of the human system. Primary features of the natural system are the availability and state or quality of the water resource, while features of the human system are resource use and production, and related degradation and pollution. This integration needs to occur within each of these systems as well as between these systems. The South African water resources management governance structures need to manage the delicate cyclical balance between these human and natural cycles. The governance framework needs to balance the impacts of human utilisation on the water resources and the resultant capacity of the impacted and degraded water resources to provide ecosystem services and functions in order to support human utilisation. Balancing this cycle is

the basis of achieving sustainability of the country's water resources. As per the legislative definitions at the start of this chapter, the process of balancing this cycle is not limited to proactive management measures only, but also involves the rehabilitation of degradation and impacts on the environment and ecological systems as a result of resource development and utilisation.

2.5 Riverine Function versus River Health

2.5.1 Riverine Functions

Ecosystem functions include the biological, geochemical and physical processes that take place or components that occur within an ecosystem. These functions include production, regulation, carrier, habitat provisioning and information/cultural functions (Posthumus, *et al.,* 2010). The products of these functions are referred to as ecosystem services. Aylward *et al.* (2005) defines ecosystem services as being the benefits people obtain from ecosystems. Therefore maintaining or rehabilitating riverine function and integrity is important to us because of the "goods and services" provided to us by these functions. These ecosystem services (regulatory, provisioning and cultural/aesthetic) are underpinned by having an effective "ecological infrastructure" in place to facilitate the various ecosystem services. Table 2-1 provides a summary of the functions and their goods and services for riverine ecosystems.

The particular riverine functions that are considered in this research are described below:

2.5.1.1 Flood attenuation (Regulation)

Flood attenuation refers to the ability of the river or reach of river to temporarily store flood water, which reduces peak flows. Good attenuation adds to the lag time of a flood event by increasing the time between the middle of the rainfall event and the runoff peak (FISCRWG, 1998). A reduction in the ability to attenuate flood flows will decrease the time between the middle of the storm event and the peak runoff, which results in an increase in discharge, velocity, energy and erosive power, and a reduction in silt deposition and sediment trapping (FISCRWG, 1998). Temporary storage for flood water is provided by undeveloped floodplains, unmodified river channels and river banks. Riparian vegetation assists to slow flood flows thereby

providing some attenuation. In summary “flood attenuation protects landscapes from flood damage (Dosskey *et al. (*1997), Postel and Carpenter (1997), and Field *et al.* (2006), in Soman *et al.*, 2007:3), moderates the velocity of flood waters, reduces high flows and floods, and decreases downstream flooding through flood water moderation and/or uptake” (Forman in FISCRWG 1998:2-86).

2.5.1.2 Sediment Trapping (Regulation)

During both regular flow and flooding, the natural river acts as a sediment trap. “Dissolved substances such as nitrogen, phosphorus, silt and other nutrients, entering a vegetated stream corridor are Restricted or ‘trapped’ from entering the channel by friction, root absorption, clay, and soil organic matters” (FISCRWG, 1998:2-86).

Nutrients and toxic chemicals may attach to sediment particles on land that get washed into surface waters where pollutants may settle with the sediment or become soluble in the water column. For example, the Klip River wetlands in Johannesburg have trapped tonnes of heavy metal toxicants from the surrounding mine dump runoff. However, the rapidly eroding channel and resultant drying out of the wetland is in danger of releasing these pollutants back into the Klip River and to the Vaal River – the source of drinking water for Johannesburg.

In summary, sediment trapping provides for the storing and recycling of organic matter and nutrients (Barling and Moore (1994), in Soman *et al.*, 2007:3), and the removal of nutrients such as nitrogen, phosphorous and sediment from surface and subsurface flow (Lowrance *et al.* (1985), Hill (1996), and USDA-WRCS (1999), in Soman *et al.*, 2007:3).

2.5.1.3 Habitat Provision (Provisioning service)

“Habitat provision” is defined according to Thirion (2008) as any combination of velocity, depth, substrate (bedrock, cobbles, vegetation, sand, gravel, mud), physicochemical characteristics (such as chemical composition, turbidity, oxygen concentration, temperature) and biological features (food source and predators) that will provide the organism with its requirements for each specific life stage at a particular time and locality.

Table 2-1 Riverine functions and services (Adapted from Soman *et al.,* 2007)

Category of Function	Riverine function	Goods & Services	Description	Literature
Production	**Subsistence**	Food	Conversion of solar energy into edible plants and animals.	de Groot (1992); Wilson et al., (2005)
		Water supply	Filtering, retention, and storage of fresh water. Infiltration of surface water that helps maintain baseflow. Water supply and ground water recharge.	Fischer and Fischenich (2000); Waters (1995); Chase (1995); Hartung and Kress (1977); Peterjohn and Correll (1984).
		Raw materials	Conversion of solar energy into biomass for human construction and other uses. Genetic materials.	de Groot (1992). Wilson et al., (2005)
Regulation	**Flood Attenuation**	Disturbance prevention	Influence of ecosystem structure on dampening environmental disturbances such as, flood attenuation, ice damage control, stream bank stabilization, maintaining channel morphology. Biological control mechanisms.	Postal and Carpenter (1997); Fischer and Fischenich (2000); Platts (1981); Wegner (1999); Williams (1986); de Groot (2002).
		Water Regulation	Role of riparian cover in regulating runoff and stream flow. Infiltration and maintenance of stream flow.	Williams (1986); Lowrance et al., (1984).
Regulation	**Sediment Trapping**	Filtration	Riparian buffers filter sediments, nutrients, pathogens, pesticides, and toxics in runoff. Infiltration of surface water that helps maintain baseflow. Water supply and ground water recharge.	Waters (1995); Chase (1995); Hartung and Kress (1977); Peterjohn and Correll (1984).
		Soil retention	Role of vegetation root matrix and soil biota in soil retention. Reduce soil erosion and sediment control.	Waters (1995); Castelle et al. (1994);
		Soil formation	Weathering of rock, accumulation of organic matter. Maintenance of top soil and soil fertility.	de Groot (1992).
		Nutrient regulation	Storage and recycling of nutrients such as N and P and organic matter. Contribution of organic matter to stream from adjacent vegetation	Barling and Moore (1994); de Groot (1992).

Regulation	**Carbon Storage**	Gas regulation	Role of riparian ecosystem in biogeochemical cycles. Provides clean breathable air.	Wilson et al., 2005.
		Climate regulation	Influence of land cover and biological mediated process on climate. Influence terrestrial and stream temperature, human health, recreation and crop productivity. Thermal refuge for aquatic species.	Collier (1995); Wegner (1999); Woodall (1985); Wilson et al., (2005); de Groot et al., (2002). Cunjak (1996); Waters (1995).
Regulation	**Water Quality**	Water filtration	Riparian buffers filter sediments, nutrients, pathogens, pesticides, and toxics in runoff.	Fischer and Fischenich (2000); Waters (1995); Chase (1995); Hartung and Kress (1977); Peterjohn and Correll (1984).
		Waste treatment	Role of riparian vegetation & biota in removal or breakdown of xenic nutrients and compounds. Storage and recycling of human waste	Castelle et al. (1994); de Groot (1992).
Habitat Provisioning	**Habitat Provision**	Pollination	Role of biota in pollination.	de Groot (1992).
		Refuge function	Suitable living space for wild animals and plants. Woody debris in the stream provides habitat and shelter for aquatic organisms. Terrestrial riparian ecosystem provides habitats for amphibians, mammals and birds. Habitat for natural communities, rare threatened and endangered species. Provide travel corridors for migration and dispersal.	Chase (1995); Verry et al., (2000); Allan (1995); Wenger (1991), (2002); Kaufman (1992); Keller et al., (1993); Naiman and Rogers (1997); Hammond (2002).
		Nursery functions	Suitable reproduction habitat for aquatic organisms and amphibians.	Semlitsch (1998); de Groot (1992).
Information / Cultural	**Aesthetic/ Recreational / Cultural**	Aesthetic Information	Attractive landscape features. Clear and clean water enhances sensory and recreational qualities	de Groot (1992). Wilson et al., (2005)
		Recreation	Water quality for recreation, boating, swimming	de Groot (1992); Wilson et al., (2005)
		Science and Education	Variety in nature with scientific and educational value.	de Groot (1992); Wilson et al., (2005)

"The biological diversity and species abundance in streams depends on the diversity of available habitats; naturally functioning stable stream systems promote the diversity and availability of habitats" (FISCRWG, 1998:2-59). However there is no fixed reference for aquatic habitat, as different stream structures provide for different habitats.

In summary, "the function of habitat provision includes the provision of shade, shelter, breeding areas and food for fish and other aquatic organisms; wildlife habitat (Soman *et al.*, 2007:3), habitat and nursery functions for fish and wildlife" (Castelle *et al.* (1994) and Bren (1993) in Soman *et al.*, 2007:3), and habitat connectivity.

2.5.1.4 Carbon Storage (Regulation)

"As a heat-trapping gas, carbon dioxide is a key component of nature's thermostat. If the carbon cycle removes too much CO_2 from the atmosphere, the earth will cool; if the cycle generates too much, the earth will get warmer" (Miller, 1998:113). The earth has developed a natural process for regulating the CO_2 levels in the atmosphere; this is based on carbon storage. Carbon storage takes many forms such as trapping CO_2 in sedimentary rocks such as limestone, in plants such as those found in rainforests and riverine vegetation, and the ocean floor. Carbon storage provides for the storing and recycling of organic matter and nutrients (Barling and Moore (1994) in Soman *et al.*, 2007:3). However, human interventions such as mining, the burning of forests and fossil fuels, noxious industries, urban development and encroachment into riverine and wetland areas disturb these natural processes and release greater volumes of CO_2 into the atmosphere. "While stored, this carbon is not released into the atmosphere as CO_2, unless geomorphological processes expose them to air, e.g. excavation and erosion. Similarly, where carbon is dissolved in water, as the water warms e.g. by more exposure to sunlight, more dissolved CO_2 returns to the atmosphere." (Miller, 1998:113).

2.5.1.5 Water Quality (Regulation)

The riverine zone and its components provide an important service of improving water quality by filtering and trapping pollutants. Pollutants can be reduced through sediment trapping, prolonged exposure to sunlight, carbon trapping and so forth. Furthermore the river channel provides a dilution effect on effluent

discharges. Natural river structures such as rapids, riffles, and falls provide aeration of the water. The water quality can be negatively affected by changes in temperature, reduced oxygen availability, altered pH, effluent discharges, canalizing, dumping and waste, high silt loads, amongst others. These changes in water quality composition affect the ecosystems and biota living in the riverine zone, as well as the usability of the water such as for drinking, irrigation and recreation.

2.5.1.6 Subsistence (Provisioning)

Riverine zones may provide socio-economic resources such as food, water supply, fuel-wood, reeds for weaving, and medicinal plants that are used by humans for subsistence. The degradation (especially by encroachment of development and/or clearing) of riverine zones and water quality reduces the ability to produce these resources and services.

2.5.1.7 Cultural, Aesthetic and Recreational (Information / Cultural)

Rivers "visually diversify a rural or urban landscape, enhancing landscapes aesthetically, expanding recreational opportunities (Dosskey *et al. (*1997), Postal and Carpenter (1997), and Field *et al. (*2006) in Soman *et al.*, 2007:3), and provide scientific and educational opportunities" (USDA-NRCS (1999) in Soman *et al.*, 2007:3). The river and riparian vegetation is also used for cultural and religious rituals such as baptisms and wedding traditions. Usually an increase in the aesthetic and recreational use of water courses results in a decrease in ecological functions. For example, the clearing of riparian vegetation provides increased access for fishing and similarly the construction of impoundments results in the increased provision of access for sailing, canoeing, fishing swimming, model boating, and so forth, but results in a decrease in habitat provision and potential deterioration in water quality.

In summary, not all riparian areas would be able to perform these functions to the same extent. Whilst some may be good for flood attenuation, others may play more important carbon storage functions. The protection of the riverine function requires that a suitable buffer be maintained between land use activities in the terrestrial areas and the possible impacts within the aquatic river channel itself. The South African Department of Water and Sanitation promotes maintaining at

least a 30m buffer from the water's edge. Maintaining riparian zones – including their naturally dense vegetation - also allows for riverine functions to be maintained. It is important that a riverine area's capacity to provide the functions, listed in Table 2-2, not be reduced. Many of these areas are best managed as natural areas, rather than being converted to other land uses. Where these [riverine functions] are impacted, the affected areas should ideally be rehabilitated.

Table 2-2 Summary of riverine functions

River component	Riverine Function *(Category)*	Detail
Flood zone (Banks)	Flood attenuation *(Regulation)*	Flood water storage, slowing down, reducing severity of floods
	Sediment trapping *(Regulation)*	Trap and retain sediment from runoff water
	Habitat provision *(Habitat)*	Reproduction, shelter, food, migration corridors
	Carbon storage *(Regulation)*	Trap carbon as organic soil and peat
	Cultural / Aesthetic/ Recreational use *(Information & Cultural)*	Fishing, picnic, walking, cycling, not birding
	Subsistence *(Provisioning)*	Firewood collection, reeds for weaving, baptisms
Active Channel (In-stream)	Flood attenuation *(Regulation)*	Flood water storage, slowing down, reducing severity
	Sediment trapping *(Regulation)*	Trap and retain sediment from runoff water
	Water Quality *(Regulation)*	Phosphate, nitrate, toxicant assimilation
	Aquatic habitat provision *(Provisioning)*	Reproduction, shelter, food, migration corridors
	Cultural / Aesthetic/ recreational use *(Information & Cultural)*	Fishing, swimming, canoeing, sailing
	Subsistence *(Provisioning)*	Firewood collection, reeds for weaving

2.5.2 River Health

The common process to determine the degradation, and thereby identify the necessary rehabilitation activities to rehabilitate the water resources and associated ecosystem integrity, is through the process of measuring the health of the river. River health is used to describe the ecological condition of a river. "The

condition or health of the river may be influenced by a number of factors including its ecological status, water quality, hydrology, geomorphology and physical habitat" (Maddock, 1999:374). Furthermore, "an organism is healthy when it performs all its vital functions normally and properly, when it is able to recover from normal stresses, and when it requires minimal outside care. An environment is healthy when the supply of goods and services required by both human and non-human residents is sustained" (Karr, 1999:222). In support of this notion, Rapport (1989) in Norris and Thoms (1999:198) suggests three approaches that might differentiate "healthy" from "sick" ecosystems; these include:

(i) the absence of distress defined by measured characteristics or indicators e.g. biological monitoring;
(ii) the ability of an ecosystem to handle stress, or bounce back – its resilience (Holling, 1973); and
(iii) the identification of risk factors such as industrial or sewage effluents.

Karr (1999:221) explains that "biological monitoring is essential to identify the biological responses to human actions." By using the results of the biological monitoring one can describe the condition or health of rivers and their adjacent landscapes and thereby diagnose the causes of degradation. Using this information, Karr goes on to explain that one can then develop rehabilitation plans, estimate the ecological risks associated with land use plans in a catchment, or select among alternative development options to minimize the river degradation.

Bio-monitoring is reliant on biological indicators. However Norris and Thoms (1999) warn that most indicators are highly specific measurements of single chemicals or biota and offer little integration. Furthermore, interpretation is based largely on experimental tests on the effects that they have on biota and results from these are used to set guidelines to protect rivers. Such monitoring [physical and chemical indicators] are distinctly "bottom-up" and may explain cause of damage to river health and biotic integrity rather than ecosystem condition (Karr, 1991; Chapman, 1992).

The South African River Health Programme (RHP) primarily makes use of biological indicators, for example fish communities, riparian vegetation, and aquatic invertebrate, to assess the condition or health of river systems. The rationale for using biological monitoring is that the integrity of biota inhabiting river ecosystems provides a direct, holistic and integrated measure of the integrity or health of the river as a whole which is reported as the Present Ecological State

(PES). The aim of the RHP is to assess and report on the ecological state of aquatic ecosystems (RHP, 2008). This approach does not assess and report on the full spectrum of functions, goods and services provided by the water resource and ecosystems, but is limited rather to only the biological components.

According to Rapport (1989) and Chapman (1992) cited in Norris and Thoms (1999:201) "ecosystems need not be pristine (few are now because of large-scale changes such as the ozone hole, acid rain, global air pollution), but still can be judged healthy." They explain furthermore that the riverine functions themselves should rather be assessed in determining impacts on rivers, as the changes to physical catchment conditions and flow regimes can markedly alter the functioning of river channels and thus the available habitat for the biological components. Despite the impacts and degradation, the environment will always adapt, as stated by Norris and Thoms (1999:202). "It may be quite possible to have degraded channels that have quite a healthy biota associated with them". Therefore this research proposes that the river function is assessed as a screening procedure, followed by a river health assessment, rather than river health alone, when assessing the impacts of activities on river reaches.

Clapcott and Young (2008) highlight that there have been several recent studies that have demonstrated the relevance and applicability of measuring river function in river health assessment such as Fellows et al. (2006), Udy *et al*. (2006), Young *et al*. (2004). They summarise that indicators of function measure the rates of ecological interactions, e.g. what is happening in the river, whereas the traditional measures of ecosystem structure measure the river health, e.g. what lives there. Similarly Matthews (cited in Young *et al.*, 2004) differentiates function indicators as measures of the rate, or relative importance, of a particular process happening in an ecosystem, while structural indicators focus on patterns of abiotic resources or biological community composition. Young *et al*. (2004:2) illustrate this differentiation by the analogy of pastures on a farm; "The health of pasture on a farm (or a lawn) could be measured by looking at the species of grass growing there, the nutrient concentrations in the soil, and perhaps even the types of worms in the soil. All of these are examples of structural measurements. However, another good indicator of pasture health is the rate at which it grows – a functional measurement. Two contrasting sites may have the same types of grass, worms and nutrient concentrations but pasture growth may be much faster at one site than the other because of a difference in some causal factor such as rainfall or temperature. This difference between sites would be missed if only structural

features were measured in each pasture." Therefore function-based indicators provide direct measurements of the various categories of functions that river ecosystems perform and thus provide an alternative, but complementary, view of ecosystem health (Bunn (1995) Gessner and Chauvet (2002), and Brooks et al. (2002), cited in Young *et al*., 2004). In other words a change in ecosystem function would result in a change in ecosystem structure (diversity or number) and would be a more holistic indicator of the state of the water resource.

This research employs assessment of riverine functions as a screening measure of disturbance to river systems. This process does not replace biological assessment, but rather an initial or preceding step in determining rehabilitation objectives. Re-establishing the ecosystem structures or restoring a particular physical or biological process or ecosystem are not the only objectives that rehabilitation seek to achieve. According to FISCRWG (1998:2-78) "rehabilitation aims to re-establish valued functions." A focus on riverine functions provides the rehabilitation effort its best chance to recreate a self-sustaining system. FISCRWG (1998:2-78) argues that "this property of sustainability in rehabilitation is what separates a functionally sound stream that freely provides its many benefits and services to people, the natural environment and its resident ecosystems, from a degraded watercourse that cannot sustain its valued functions and may remain a costly, long-term maintenance burden."

2.6 Enforcement-driven Rehabilitation

"Regulation, in general form, refers to the means by which any activity, person, organism or institution is guided to behave in a regular fashion, or according to rule" (Picciotto, 2002:1). The process of achieving sustainability and the environmental right is housed in the regulatory framework that governs natural resource management, i.e. the legislative framework, management measures and institutional structures that implement the latter. The regulatory framework "promotes" a particular behaviour by the audience.

According to Craigie *et al.*, (2005:42) the word "compliance" has been defined as "obedience to a request or command". Craigie *et al.,* (2005:42) go on to explain that in legal and regulatory policy, the state of "compliance" describes an ideal situation in which all members of a legal community adhere to the legal standards and requirements applicable to that community's activities, and that from a legal

perspective, governance and regulation are largely meaningless without compliance, or at least a general trend towards compliance.

Overseeing compliance is an aspect of enforcement. "Enforcement" refers to the "actions that the governments and others use to achieve compliance within the regulated community" (Craigie *et al., 2005:45)* and to correct or halt situations where such compliance is not present. "Enforcement may take place through 'compulsion and coercion, or by conciliation and compromise' and the strategy, or mix of strategies, which is ultimately adopted will frequently be determined by the regulatory context" (Craigie *et al.*, 2005:45). Ultimately, enforcement action is reactive management, as opposed to proactive management. In the context of this thesis, enforcement actions may take different forms (Craigie *et al.,* 2005), such as:

- Administrative measures which include issuing directives or suspending an environmental authorisation;
- Criminal measures such as issuing a fine or imprisonment; and
- Civil measures such as issuing a court order to an offender to halt and/or remediate harm to the environment.

Enforcement measures should not be limited to rectifying the administrative status in the regulatory framework, but also to remedying or rehabilitating the impact on the environment. Craigie (2005:51) concurs in that "the actions taken should ensure that harm to the environment is halted and/or rehabilitated."

2.6.1 What is rehabilitation?

Ecosystems are individual ecological units that consist of biotic and abiotic factors. Every ecosystem that exists within a river system consists of a combination of all the factors that make up the river environment; these include living organisms (e.g. insects, fish, birds, animals, vegetation, diatoms), and biophysical components or attributes such as temperature, pH and clarity (water quality component), water flow and rainfall (hydrology component), and materials that make up the banks and bottom of the river bed (geomorphology component) (Freeman and Rowntree, 2005). Human activities such as land use change and water resource development can alter physical, chemical and biological processes (functions) of river ecosystems thus modifying their biological communities (impacting on the health) (Karr cited in Norris & Thoms, 1999:203). For example,

field research by Boon (cited in Maddock, 1999) showed that changes in water quantity, water quality and the physical structure of the channel, almost without fail led to changes in the composition of the biotic community occurring in the river, usually with a resultant reduction in the biological diversity of the aquatic ecosystem. Therefore, to maintain ecosystem function, goods and services, rehabilitation of such impacts is required. This is especially important in the enforcement context. Activities that may impact on the environment (and its ecosystems and functions), the environmental right and sustainability are regulated[4], in order to minimise and mitigate such impacts. Where activities have triggered non-compliance, it is even more important to rectify the resultant ecological impact.

DWAF (1999:4) highlight that if a water resource is over-utilised or allowed to degrade too far, for example by taking too much water out of the system, putting too much waste into the system, altering the natural shape and structure, modified too greatly by erosion, sedimentation or habitat degradation, then the water ecosystem will lose its resilience and begin to break down. DWAF (1999:4) go on to caution that once the ecological integrity of the water resource has been damaged, then the capability of the resource to meet people's demands for utilisation will be reduced, or possibly even lost altogether. However if the utilisation of water resources remains at a level within the ecological integrity limits of the resource, where the limits are determined to protect the ecological resilience, then that level of utilisation can be sustained indefinitely. According to DWAF (1999:4) many water resources in South Africa have already been modified by utilisation and development, and no longer remain in their natural ecological state. "A water resource does not have to be in a pristine or untouched state to have ecological integrity; even modified aquatic ecosystems have the resilience which makes them renewable resources, so long as we manage them in such a way that we either maintain or rehabilitate a certain level of ecological function and integrity" (DWAF, 1999:4).

According to Pimm (1994), ecosystems have some capacity for resilience, in other words the ability to resist change or to recover from it. There is some balance of nature or stability and this balance is affected by the loss of diversity. This is referred to as dynamic equilibrium. Disturbances of sufficient magnitude or duration can significantly affect an ecosystem and may even force an ecosystem

[4] The water resources regulatory framework is discussed in Chapter 3.

to reach a threshold beyond which a different regime of processes and structures predominates (Folke, *et al.,* 2004). These disturbances usually directly affect the riverine functions with the resultant impact on river health. The Federal Inter-Agency Stream Restoration Working Group (FISCRWG) (1998:2-86) explains that "the maintenance of dynamic equilibrium requires that a series of self-correcting mechanisms be active in the riverine corridor. These mechanisms allow the riverine functions to control external stress or disturbances within a certain range of response thereby maintaining a self-sustaining condition." This is similar to an elastic band that may be stretched and will return to its original shape, however stretching the elastic band past its threshold may cause the elastic band to snap. Similarly, stream systems can tolerate disturbances and then return to a functional state once the impact has been removed or rehabilitated. This new equilibrium condition however, may not be the same that existed prior to the initial occurrence of the disturbance; for example a deep fast flowing river channel versus a shallow, sediment laden river channel. In addition, disturbances can often stress the system beyond its natural ability to recover. In these instances, **rehabilitation** is needed to remove the cause of the disturbance or stress, and to repair damages to the structure and functions of the riverine corridor.

2.6.2 Drivers of rehabilitation

Brierley and Fryirs (2005) point out that river recovery is not simply the reverse of river degradation, but rather suggest that river recovery would be the post-human disturbance trajectory of change towards an improved condition. When conducting riverine rehabilitation it is important to set clear objectives, determine who the drivers for the rehabilitation activities are, and what their underlying objective for the rehabilitation is. Riverine rehabilitation can be categorised as initiative-driven or enforcement-driven.

Initiative-driven rehabilitation links to the concept of "Duty of Care", for example, where a land owner or community group has decided to proactively rehabilitate their own property or a particular reach of river. This includes municipal responsibility – where a municipality has identified a particular area in their jurisdiction that has suffered riverine zone damage, usually from flooding. Examples are the 2009 floods in Soweto, Johannesburg, or 2009 floods in Drakenstein Municipality in the Western Cape, and where the respective municipalities initiated projects under municipal or NGO budgets to proactively rehabilitate the damaged river reaches. The rehabilitation is driven by the

landowner, the community group or the municipality, and could cover a reach of river several erven or kilometres long.

On the other hand, **enforcement-driven rehabilitation** is driven by a regulatory body of an Organ of State, e.g. where the compliance and enforcement unit of a particular statutory institution has issued an Administrative Notice (e.g. a Compliance Notice, Directive or Control Measure) to a landowner or person in control of the land, instructing them to rehabilitate a reach of river in order to remedy an illegal or non-compliant activity and its resultant impact or disturbance. The rehabilitation activities are usually aimed at site specific activities, e.g. on a specific erf. For the purposes of this research, the driver of rehabilitation is enforcement-driven Rehabilitation. The key differences between initiative-driven and enforcement-driven rehabilitation are captured in Table 2-3. Rivers in different geographic regions of the country differ due to geological structure, altitude, rainfall, biotic structure. "Normal, or expected, conditions constituting integrity vary geographically because each river's biota evolve in the context of local and regional constraints and opportunities (Karr, 1999:224). Karr (1999) concludes that understanding this baseline must be the foundation for assessing human-induced change. Norris and Thoms (1999:200) argue that "site specific reference characteristics need to be identified and this is very time consuming and specialist dependent." In enforcement, only the specific site can be considered in the enforcement process, and therefore directed activities are limited generally to the specific site or activity and not the entire stream.

Table 2-3 A comparison of the main characteristics of initiative-driven versus enforcement-driven rehabilitation.

Characteristics	**Initiative-driven rehabilitation**	**Enforcement-driven rehabilitation**
Activation Process	Proactive (Strategic approach contributing to set objectives)	Reactive (disaster management or illegal activity)
Size	Sub-catchment, several kilometres (km) of river	Site specific and resultant impacts; short reach
Stakeholders Involved	Government Departments, NGOs, CBOs, funding agencies, municipality, land owner	Land owner (person in control of the land), Government Departments
Funding	Donors, government	Land owner responsibility /

	funding	Developer
Rehabilitative Objectives	Clearly set out, comprehensive, detailed	*Ad hoc*, site specific, not comprehensive
Timeframe	Long process	Short timeframes, in order to prevent further impacts/damage
Potential Authorising Processes	Full EIA, NWA s21 Water Use Licence	Rectification, NEMA S24G, General Authorisation
Rehabilitation Drivers	Public concern / Conservation driven	Illegal or non-compliant legislative requirements and Government Department driven

Norris and Toms (1999) caution that this poses a flaw, as it is not the whole stream but sites within streams that are the units being compared and most indicators, especially biota, from a site upstream will be unlikely to match those from a site downstream of the same stream, or another similar stream. For enforcement purposes, an initial screening assessment of river functions or the degradation or disturbance to the functions, may be more easily defined than to determine symptoms and the indicators of poor health, especially considering that in South Africa most enforcement officials are not ecological scientists.

2.6.3 Objectives of rehabilitation

In order to propose appropriate rehabilitation processes and activities, it is necessary to understand the different types of rehabilitation objectives, rehabilitation drivers, and the applicable scale to which they apply in order to ensure the appropriate process is followed. When carrying out rehabilitation activities, apart from the individual objectives such as improving water quality or re-establishing riparian zone vegetation, there is an overall aim that the rehabilitation activities are trying to achieve. This overall aim or desired state will be captured in the goal of the rehabilitation plan, and it sets out the intention for carrying out the rehabilitation activities. Rogers and Biggs (1999) stipulate that clear definitions of desired conditions, given surrounding land uses, are required for effective management and assessment for rehabilitation. These objectives fall into one of three categories, that of restoration, rehabilitation, or remediation. While these terms are often used interchangeably in various countries around the world to describe the physical rehabilitation activities, it is important to identify

which one is the intention of the overall rehabilitation objectives in order to avoid disappointment or set unrealistic objectives. For example, “often, pre-European (pre-colonial era) disturbance conditions are set as restoration goals (e.g. Chapman, 1992; Scrimgeour & Wicklum, 1996), but those conditions may not be attainable; furthermore this target denies the place of humans in the landscape” (Norris and Thoms, 1999:201). Simply put, each objective deviates from the pristine state, and when setting the objective for rehabilitation, a clear understanding of “how far from” the pristine state the rehabilitated river reach will ultimately be. These rehabilitation categories are defined as follows:

2.6.3.1 Restoration

The Federal Inter-Agency Stream Restoration Working Group (FISCRWG, 1998:1-3) defines ecological restoration as “the process of returning an ecosystem as closely as possible to pre-disturbance conditions and functions”. It stresses that it is implicit in this definition that stream ecosystems are dynamic and that it is consequently not possible to recreate a system exactly. Rather, the stream restoration process is aimed at re-establishing the “general structure, function and dynamic, but self-sustaining behaviour of the ecosystem”. In addition, Rutherford, Jerie and Marsh (2000:13) proposed that the objectives of ideal restoration would typically involve the sequential achievement of the following objectives:

(a) Restoration of the natural range of water quality;
(b) Restoration of the natural sediment and flow regime (seasonal, annual and decadal fluctuations);
(c) Restoration of the natural channel geometry and stability;
(d) Restoration of the natural riparian plant community; and
(e) Restoration of indigenous aquatic plants and animals if they do not colonise on their own.

In summary, the objective of restoration is to restore the river reach to as close to pristine as possible. Restoration is not a reasonable objective in urban contexts due to human influence in the catchment.

2.6.3.2 Rehabilitation

In its most simple form, rehabilitation can be considered as a series of actions which make the landscape useful to human and natural systems again after a disturbance, and usually involves “the recovery of some ecosystem functions and processes in a degraded habitat” (Dunster and Dunster in FISCRWG, 1996:1-3). The objective of rehabilitation, as a specific goal, would be to address and

improve specific or selected biological components and riverine functions that were lost/impacted upon by a specific activity.

2.6.3.3 Remediation

The term “remediation” is appropriate in cases where it is not possible to rehabilitate elements of natural function, due to a river system being irretrievably degraded, or where a system has been fundamentally altered in character but has over time adjusted and achieved a new state of dynamic equilibrium or stability. The aim of remediation is to improve the ecological condition of the river, while not aiming for an endpoint which resembles its original condition. Rutherfurd *et al.* (2000:15) suggest the action of remediation would be “to establish a new ecosystem on the basis that the stream has changed so much from the original condition that it [the original condition] is no longer relevant, and therefore a new condition is intended.” The objective of remediation would be to stabilise the impacts on the river and prevent further degradation thereby creating a new or different structure and functions.

When setting rehabilitation objectives within the urban context, it must be remembered that, firstly, the river is already in an altered state, in other words it is not pristine, given that the river’s catchment is affected by urban land use activities. Secondly, rivers are dynamic and continually adapt to disturbance such as altered land use within the catchment, changes in proportions of pervious and impervious ground cover in the catchment, as well as environmental fluxes, such as flooding and drought. Ebersole *et al.,* in Norris and Thoms (1999), argue that restoration is fundamentally about allowing stream systems to re-express their capacities. In order to achieve this, they go on to explain, historical patterns of habitat development and developmental constraints should be identified; constraints should be relieved; sensitive, critical, or refuge habitats should be classified; the development diversity that remains should be protected; and the biotic responses to habitat development should be monitored. Their approach attempts to match the potential of the environment to produce habitat with that which could be realized given constraints of human use. However, Roux (2002) points out that trade-offs are inevitably required between protecting rivers (achieving biodiversity conservation) and achieving economic development. He observes that it is usually difficult to determine what the original condition of the river was, and therefore rehabilitation rather than restoration would be the norm. Furthermore, restoration would possibly require the re-instatement of all the elements of the river, including flow regime, sediment, and biota, which is not

usually possible in an urban context. Furthermore, all rivers cannot be maintained in natural or even in good states. Quinn (2003:4) cautions that "at all times the focus of rehabilitation should be the re-establishment of an appropriate ecosystem structure and functions, which must be self-sustaining." Therefore, as suggested by Gonzalez del Tánago, (2004), restoration or rehabilitation alternatives can be defined more succinctly if the main degradation causes are correctly identified and the human pressures that are limiting natural riverine function are known and assessed. It is pertinent that during enforcement activities, when conducting site inspections and initial investigations, the causes of degradation and resultant impacts on riverine functions be timeously identified. Therefore, enforcement-driven rehabilitation is as important a component of the regulatory framework to achieve the environmental right as are initiative driven activities. Likewise, it is important that the regulatory framework that supports enforcement-driven rehabilitation be as robust as the framework that governs proactive resource management.

Note: In this thesis the term "rehabilitation" is used as a general term to describe remedial activities and should not be interpreted as a preferred objective unless specifically stated otherwise.

2.7 Good Governance

The responsibility of achieving the environmental right is both a public and government responsibility. The public are compelled through the regulatory framework to act responsibly with regard to activities and their impacts on the environment. In a similar vein the right places a duty on the State to implement the regulatory framework; the regulatory framework itself should be structured appropriately and more importantly, implemented appropriately in order to achieve the environmental right. The effective and appropriate implementation of the regulatory framework is referred to as "Good Governance".

The United Nations Development Programme (UNDP) (2007) defines governance as being the system of values, policies and institutions by which a society or country manages its economic, political, environmental, and social affairs through interactions within and amongst the role-players e.g. the state, civil society and the private sector. In other words it is the combination of laws, policies and regulations as well as the institutional roles and responsibilities, and interactions with and between role-players and stakeholders within a given geographic area.

"Good Governance" is thus the conduct of the role-players in carrying out the governance functions. "Good governance is fundamentally about improving the quality of 'governance', where the quality of governance is usually assessed by means of various indicators including the effectiveness, accountability and transparency of government" (Kotze (2005b) in Paterson and Kotze, 2005:120).

The concept of good governance has been clarified by the work of the former Commission on Human Rights (CHR). In its resolution 2000/64, the Commission identified key attributes of good governance as including: transparency, responsibility, accountability, participation, and responsiveness. According to the Good Governance Guide (Exiner, 2012), these attributes are detailed below. Furthermore, three additional attributes are added, those of: effective and efficient, rule of law, and equitable and inclusive.

- Transparency: People should be able to follow and understand the decision-making process. This means that they will be able to clearly see how and why a decision was made – what information, advice and consultation was considered, and which legislative requirements (when relevant) were followed.
- Responsibility: The concept centres on the responsibility of governments and governing bodies to meet the needs of the masses as opposed to select groups in society.
- Accountability: Government has an obligation to report, explain and be answerable for the consequences of decisions it has made on behalf of the people it represents.
- Participation: Anyone affected by or interested in a decision should have the opportunity to participate in the process for making that decision.
- Responsiveness (to the needs of the people): Government should always try to serve the needs of the entire community while balancing competing interests in a timely, appropriate and responsive manner.
- Effective and efficient: Government should implement decisions and follow processes that make the best use of the available people, resources and time to ensure the best possible results for their community.
- Rule of law: This means that decisions are consistent with relevant legislation or common law and are within the powers of the spheres of government.

- Equitable and inclusive: A community's wellbeing results from all of its members feeling that their interests have been considered by government in the decision-making process. This means that all groups, particularly the most vulnerable, should have opportunities to participate in the process. In terms of resource management, this includes considerations of the requirements of natural systems which don't physically have a voice, but the management instruments put in place to include it for example environmental flow requirements.

Kotze (2005b), (in Paterson and Kotze, 2005:121) sets the tone for this thesis with the statement that "Good environmental governance requires the current South African environmental regime to be effectively implemented and enforced." Using these attributes of good governance, Chapter 4 presents a critical review of the South African regulatory framework with regard to enforcement-driven rehabilitation of water resources.

2.8 Synthesis of conceptual foundations

This Chapter has introduced some key concepts that form the theoretical foundations for this thesis. These concepts have been presented through the following questions:

- What is the environmental right?
- Sustainability versus sustainable development?
- What is IWRM and how is it relevant to rehabilitation?
- Riverine function versus river health to determine the state of rivers?
- What is enforcement-driven rehabilitation?
- What is good governance from a compliance and enforcement perspective?

In order to achieve the environmental right, minimum standards for ecological function need to be identified, implemented, monitored and adhered to in order to ensure the sustainability of the ecosystem functions to support the environment both for now and the future.

Monitoring and achieving these standards requires a regulatory framework such as integrated water resources management (IWRM), in order to ensure that all components, i.e. legislative, institutional and management measures are in place

to ensure compliance of the minimum standards. The regulatory framework will also ensure all the elements i.e. environment, economic and social are considered, and contribute towards sustainable resources management. Where non-compliance occurs, remedial action such as rehabilitation is needed. Enforcement-driven rehabilitation is as important as proactive management and achievement of the minimum standards. Therefore rehabilitation is a critical management measures to achieve the environmental right. The regulatory framework is implemented by various institutions of the different spheres of government. Within itself, this regulatory framework needs to comply with good governance, and thereby provide a robust framework to manage and rehabilitate the environment in order to support the achievement of section 24 of the Constitution, the environmental right.

Building on this theoretical foundation, and in the context of this research, the following questions are raised:

i. What is the enforcement-driven rehabilitation regulatory framework?
ii. Is it good environmental governance? and ultimately,
iii. Is the environmental right, Section 24 of the Constitution, being achieved?

3 THE SOUTH AFRICAN WATER RESOURCES REGULATORY FRAMEWORK

3.1 Introduction

According to Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996 (the Constitution), "*the State has a duty to protect the environment through reasonable legislative and other measures."* These legislative and other measures form the regulatory framework that aims to sustainably protect the environment, and ensure that the environment is not harmful to one's health or well-being.

The legislative and other measures are not exhaustive, and may include principles, policies, strategies, objectives, laws, regulations, organisations and institutions to implement such means, as well as their goals, operational plans, procedures, methods, tools, mechanisms, norms and practices (Thompson, 2006).

In order to achieve sustainability of natural resources needed to support human development now and for future generations, an integrated approach to resource management is required, i.e. understanding, managing and mitigating the interconnected activity-impact cycle of utilising natural resources. In the context of water resources, this is called Integrated Water Resources Management (IWRM). "IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000:22). The concept of IWRM is also applicable to the management of other natural resources however it has only been formerly adopted in the water resources sector. The IWRM approach relies on an effective resources management regulatory framework. This regulatory framework, and in accordance with the provisions of Section 24 of the Constitution include:

- The enabling environment (the legislative means) – this includes the national principles, policies, legislation, and regulations.
- The institutional structures (the implementers) – this includes the various administrative organisations tasked with implementing the legislation and measures.

- The management instruments (other measures) – this includes the "operational instruments of effective regulation" (GWP, 2000:30), plans, procedures, methods, strategies, compliance and enforcement mechanisms including licences, directives and compliance notices.

As already highlighted in the previous chapter, water is a component of the environment therefore it is governed by the legislation that governs the environment. However, water resources are also a critical asset, and therefore are also governed by their own resource management specific legislation. Depending on the geographic location of activities affecting water resources, other legislation may also apply, for example the Conservation of Agricultural Resources Act, Act 43 of 1983 (CARA) applies to land zoned agriculture and outside of demarcated urban areas. Likewise, additional governance legislation applicable to regulating the State may also apply to the regulatory framework, for example the Promotion of Administrative Justice Act, Act 3 of 2000 (PAJA) and the Inter-Governmental Relations Framework Act, Act 13 of 2005 (IGRFA). (Table 6-1 in Chapter 6 provides a summary of applicable legislation and sections of statutes that apply to watercourses.)

The overarching legislation governing the environment is the Constitution of the Republic of South Africa, Act 108 of 1996 (the Constitution). The umbrella legislation regulating the environment is the National Environmental Management Act, Act 107 of 1998 (NEMA). Although listed as a specific Act under the NEMA, the National Water Act, Act 36 of 1998 (NWA) is a national statute and does not fall in hierarchy under the NEMA, but rather as it's equal, i.e. the NEMA does not supersede the NWA. Other environmental legislation such as the National Environmental Management: Protected Areas Act, Act 57 of 2003 (NEM:PAA) and the National Environmental Management: Biodiversity Act, Act 10 of 2004 (NEM:BA) are also strategic environmental management Acts.

This chapter aims to answer the following question: what is the water resources management regulatory framework of South Africa? This sets out the foundation of the regulatory framework which later chapters evaluate and discuss further.

3.2 Constitution of the Republic of South Africa, Act 108 of 1996

Post-1994 South African legislation has been guided by the Constitution of the Republic of South Africa. Act 108 of 1996 (the Constitution). "The Constitution

lays down the all-important principle of constitutional supremacy and Section 2 states that the 'Constitution is the supreme law of the Republic; law or conduct inconsistent with it is invalid, and the obligations imposed by it must be fulfilled.' The Constitution therefore places a particular mandate on the State and grants the courts the powers to ensure that this mandate is complied with" (Feris in Paterson and Kotze, 2005:133).

The Bill of Rights contained in the Constitution sets out the rights of the citizens of the State, as well as the duties of the State to provide those rights. In particular, Section 24 of the Constitution provides the environmental right.

Section 24 states that:

> *"Everyone has the right-*
> *(a) to an environment that is not harmful to their health or well-being; and*
> *(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that-*
> *(i) prevent pollution and ecological degradation;*
> *(ii) promote conservation; and*
> *(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."*

Thompson (2006:137) makes an important observation in his interpretation of this environmental right, that "the right to an environment that is not harmful to a person's health and well-being does not demand differentiation between State and private conduct." In other words the right is anthropocentric and the aim is to protect the individual against an environment that is harmful to their health or well-being, where the harm may be from any source or conduct, and whether private or public. The duty that is placed on the State is to ensure that a regulatory framework is implemented (composed of both legislative and other measures), that both private and public persons should comply with. Therefore it is as much the responsibility of the State to ensure the implementation and achievement of the regulatory framework, as it is of its own compliance with the regulatory framework. Feris (in Paterson and Kotze, 2005:133) agree with this interpretation, "Section 24 paragraph (b) also provides protection against any infringement by the State that negates environmental protection or that is in any way harmful to the environment."

"The Constitutional Court has taken the view that as a minimum, these rights can at least be 'negatively protected from improper invasion'. Case law suggests that the level or[sic] protection goes further than negative protection, and that the State can be obliged to ensure that it fulfils its positive duty to give effect to the right." (Feris in Paterson and Kotze, 2005:136). This suggests that environmental compliance and enforcement is not merely limited to stopping illegal activities and halting activities causing environmental degradation, but includes the rehabilitation of such environmental degradation in order to meet the minimum standards posed in the environmental right as well.

However, not all the rights in the Bill of rights are equal. Socio-political rights, such as the right to vote are considered as a first generation right[5]. The environmental right is considered a second or third generation right. However, water is recognised as a key component to life. Therefore, water should be a primary right, as a right to life. Feris (2008:49) supports this by "the insertion of an environment right into the Constitution elevates the importance of the environment; it places it on a par with other constitutionally-protected rights such as equality, dignity and the right to life." Water is necessary for electricity generation, irrigation of crops, watering of livestock, and for drinking, all of which contribute towards dignity, equality and ultimately life.

In South Africa, priority is given to first generation rights and then progressive realisation of the secondary and tertiary rights based on available resources. "Progressive realisation" suggests that although the right cannot be realised or provided for immediately, the basic needs of all in the society would effectively be met (Government of the Republic of South Africa v Grootboom ZACC19, 4 October 2000) provided that the legislative and other measures are being implemented. However, this still implies that the State has to take *reasonable* steps to achieve this right. The question posed is, what is "reasonable", especially as Feris (2008:35) points out that there cannot always by a uniform standard for a healthy environment. In response, this thesis proposes as a reasonable minimum

[55] Feris (2008; Footnote) explains that the "generation" reference with regard to rights was a result of the aftermath of the Second World War where legal instruments embodied the notion of universal human rights. The first set of rights recognized in the Universal Declaration of Human Rights (1948) and later in the United Nations Covenant on Civil and Political Rights (1966) were the so-called first generation rights, namely civil and political rights. More recently the so-called second and third generation rights, which are socio-economic and environmental rights, were recognized in the United Nations Covenant on Economic, Social and Cultural Rights.

standard, a functioning environment in order to support ecosystem goods and services, which supports human life and sustainable development.

Noteworthy in relation to rights, Section 27(1)(b) of the Constitution also relates to water in that "*everyone has the right to have access to sufficient food and water."* Section 27 relates to access to potable water services and sanitation, while Section 24 relates to the environment in general, of which water as a resources is a component. As Section 27 of the Constitution identifies water as a right to life; water resources, as contemplated in Section 24, are held in trust for the country and managed by the Government, through the Department of Water and Sanitation and the National Water Act, Act 36 of 1998 (NWA) in part to provide water for the services contemplated in Section 27. The provision of access to water and sanitation services and the Water Services Act, Act 108 of 1997 which gives effect to Section 27 of the Constitution, is not discussed further in this research as this thesis focuses on the enforcement aspects of management of water resources.

The two key statutes that provide the regulatory framework to enable the Section 24 environmental right with regard to water resources, are the National Environmental Management Act, Act 107 of 1998 (NEMA) and the National Water Act, Act 36 of 1998 (NWA). These two statutes are discussed in more detail.

3.3 Environment

3.3.1 Environment: Enabling Environment

Under the Constitution, the lead environmental legislation of the country is the National Environmental Management Act, Act 107 of 1998 (NEMA). The previous legislation, the Environment Conservation Act, Act 73 of 1989 (as amended) (ECA), set many important global concepts in place, such as environmental management, impact assessments and sustainable development. Although the ECA is in most part repealed by the NEMA, it still provides a good reference for comparison in sections of this research.

3.3.1.1 Environmental Policy

In line with international trends (Brundtland Report, World Conservation Strategy, etc.), South Africa started to develop its Environmental Policy in the late 70's. In

1980 a White Paper on a National Policy regarding Environmental Conservation was published by the Department of Water Affairs, Forestry and Environmental Conservation (DWAFEC). The proposed policy set out the foundations for sustainable development, "that a golden mean between dynamic development and the vital demands of environmental conservation should constantly be sought. The aim therefore, is that man and nature should co-exist in productive harmony to satisfy the social, economic and other expectations of the present and future population" (DWAFEC, 1980:6). The White Paper went on to outline several policy directives that needed to be addressed in future environment orientated activities. These directives included:

- Environmental impact studies – to evaluate new development projects in light of environmental considerations;
- Environmental educations – to promote awareness and improve attitudes towards the environment; and,
- Individual environmental aspects, which included:
    - Soil conservation
    - Noise pollution
    - Cultural-historic aspects
    - Air pollution
    - Nature Conservation
    - Marine pollution
    - Radiation pollution
    - Solid waste and littering; and,
    - **Water pollution** [own emphasis].

The White Paper (DWAFEC, 1980:12) observed that "the control of water supplies, water usage, water pollution, nature conservation within water areas and State land covered by water, is at present dealt with by at least five Government departments, the provincial administrations, local authorities and statutory bodies." Furthermore, at that time there were several overlapping Acts and provincial ordinances involved as well. In light of this myriad of institutions and governing statutes, the proposed policy recognised the "primary importance of water as part of the total habitat of man and the limited availability of water resources for all types of development and utilisation in South Africa" (DWAFEC, 1980:12). The White Paper proposed that all the activities and measures for the prevention, control and combating of water pollution must be effectively co-ordinated and optimised, and the necessary steps should be taken to identify, protect, conserve

and ensure the multipurpose utilisation of the fresh water ecosystems (DWAFEC, 1980:12). These sentiments are still contained in the objectives of the National Water Act, Act 36 of 1998 (discussed further in this chapter). The objective of coordinating and optimising activities and measures for prevention, control and combating of water pollution, was proposed by apportioning overall responsibility for environmental conservation and promotion in its entirety to the Department of Water Affairs, Forestry and Environmental Conservation. This Department and its powers were later broken up into smaller Departments. The principles that were proposed in the White Paper were eventually promulgated in the Environment Conservation Act, Act 73 of 1989

3.3.1.2 Environment Conservation Act, Act 73 of 1989 (As Amended)

The first formal South African environmental management legislation was the Environment Conservation Act, Act 100 of 1982, and amended as Act 73 of 1989 (ECA). There are still some provisions of this Act in effect such as the Section 31A Directive. However, the current and primary environmental legislation is the National Environmental Management Act, Act 107 of 1998 (NEMA). One of the significant differences between the ECA and the NEMA lies in how the statutes define "environment" and what it encompasses.

The ECA section (1) defined "environment" as meaning "the aggregate of surrounding objects, conditions and influences that influence the life and habits of man or any other organism or collection of organisms." In contrast, the definition of "environment" in NEMA section (1), includes "the surroundings within which humans exist and that are made up of –

(i) The land, water and atmosphere of the earth;

(ii) Micro-organisms, plant and animal life;

(iii) Any part or combination of (i) and (ii) and the interrelationship among and between them; and,

(iv) The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing."

Uys (2006) argues that the ECA definition is more accommodating as it includes non-natural resources, such as health and human resources within its definition, while the NEMA definition is restricted specifically to natural elements only. This

is a relevant observation, as the concept of “sustainable development” which the NEMA promotes is anthropocentric, and thus the definition of environment should include the human interaction within it. It is the concept of “sustainability” that is eco-centric. However, the principles contained in Section 2 of NEMA are more encompassing of the cultural, heritage, social, human and economic aspects considered in the ECA.

Also of particular relevance from the ECA, is the *Section 31A Directive where the environment is damaged, endangered or detrimentally affected*. Any sphere of Government, mandated with environmental management, can issue an ECA s.31A Directive, i.e. it can be issued by municipalities.

> *Section 31A* [own emphasis] *(1) If, in the opinion of the Minister or the competent authority, local authority or government institution concerned, any person performs any activity or fails to perform any activity as a result of which the environment is or may be* ***seriously damaged, endangered*** *or* ***detrimentally affected****, the Minister, competent authority, local authority or government institution, as the case may be, may in writing direct such person -*
>
> *(a) to cease such activity; or*
>
> *(b) to take such steps as the Minister, competent authority, local authority or government institution, as the case may be, may deem fit, within a period specified in the direction, with a view to eliminating, reducing or preventing the damage, danger or detrimental effect.*
>
> *(2) The Minister or the competent authority, local authority or government institution concerned may direct the person referred to in subsection (1) to perform any activity or function at the expense of such person with a view to* ***rehabilitating any damage caused to the environment*** *as a result of the activity or failure referred to in subsection (1), to the satisfaction of the Minister, competent authority, local authority or government institution, as the case may be.*
>
> *(3) If the person referred to in subsection (2) fails to perform the activity or function, the Minister, competent authority, local authority or government institution, depending on who or which issued the direction, may perform such activity or function as if he or it were that person and may authorize any person to take all steps required for that purpose.*

(4) Any expenditure incurred by the Minister, a competent authority, a local authority or a government institution in the performance of any function by virtue of the provisions of subsection (3), may be recovered from the person concerned.

In terms of general national environmental management legislation (i.e. excluding specific legislation (SEMAs) e.g. NEM:Waste Act or municipal By-laws), the ECA s.31A Directive is the only enforcement mechanism currently available to municipalities. The Section 31A Directive makes provisions that the Organ of State that issued the directive may carry out the activities of the directive, if the person (causing the contravention) does not do so themselves, and then reclaim the costs from the person. However, in terms of public financial administration, this is problematic, as the Organs of State would need to motivate for the budget to conduct these works each year, and the cost and extent of works may vary from case to case and year to year. Furthermore, should expenditure not be met, the funds would need to be returned to the Treasury. This funding would need to be ring-fenced, but without a specific associated business plan.

3.3.1.3 National Environmental Management Act, Act 107 of 1998

There are four particular Chapters of the National Environmental Management Act, Act 107 of 1998 (NEMA) that are critical to the regulatory framework governing water resources, namely those of Chapter 1 Principles, Chapter 5 Integrated Environmental Management, Chapter 7 Compliance and Enforcement, and Chapter 10 General and Transitional Provisions.

The NEMA provides management measures for environmental resource utilisation, and leaves the specific resource directed management aspect to the Specific Environmental Management Acts under its ambit. For example, the Biodiversity Act (Act 10 of 2004) includes the management of specific species, the Protected Areas Act (Act 57 of 2003) addresses the management of specifically protected areas, the National Water Act (Act 36 of 1998) addresses water resource management, the Waste Act (Act 59 of 2008) manages waste and the Air Quality Act (Act 39 of 2004) addresses measures for the specific management of air quality. Being the “umbrella” legislation means that the enforcement mechanisms of the NEMA can be used to enforce the provisions of the SEMA

legislation. With regard to the NWA, there is no hierarchy between the NEMA and NWA.

NEMA Chapter 1: Principles

Section 2 of the NEMA identifies the principles to be applied in environmental management throughout the country. Section 2(3) of the principles requires *"development must be socially, environmentally and economically sustainable*." Section 2(4) goes on to list the factors to be considered in sustainable development.

NEMA Section 2(4) [own emphasis]:

(a) *Sustainable development requires the consideration of all relevant factors including the following:*

(i) That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and ***remedied****;*

(ii) That pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and ***remedied****;*

(iii) That the disturbance of landscapes and sites that constitute the nation's cultural heritage is avoided, or where it cannot be altogether avoided, is minimised and ***remedied****;*

(iv) That waste is avoided, or where it is cannot be altogether avoided, minimised and reused or recycled where possible and otherwise disposed of in a responsible manner;

(v) That the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;

(vi) That the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised;

(vii) That a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and,

(viii) That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where

they cannot be altogether prevented, are minimised and ***remedied***

Remediation, a form of rehabilitation, is clearly included in the principles of the NEMA. The principles encompass the whole life cycle of a project i.e. from inception to completion and operation, or design to decommissioning; for which the impacts must be identified, mitigated and rehabilitated. The principles continue with, *inter alia,* integrated environmental management, equitable access to environmental resources, community wellbeing and empowerment, right of workers to refuse work that is harmful to their health or the environment, etc. Of relevance to this research are the following principles [own emphasis]:

2(4)(g) Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge.

2(4)(k) Decisions must be taken in an open and transparent manner, and access to information must be provided in accordance with the law.

2(4)(l) There must be intergovernmental coordination and harmonisation of policies, legislation and actions relating to the environment.

2(4)(m) Actual or potential conflicts of interest between Organs of State should be resolved through conflict resolution procedures.

2(4)(o) The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and ***the environment must be protected*** *as the people's common heritage.*

2(4)(p) The costs of ***remedying pollution, environmental degradation and consequent adverse health effects*** *and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.*

2(4)(r) Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, ***wetlands,*** *and* ***similar systems*** *require specific attention in management and planning procedures,*

especially where they are subject to significant human resource usage and development pressure.

Bray (in Paterson and Kotze, 2005) summaries Section 2 as "Those in authority have to protect the environment and promote sustainable development as a matter of public interest, in a manner that is procedurally fair." Having so many principles is perhaps ambitious, as the regulatory framework needs to implement these measures as part of their implementation and reporting, in order to ensure that the objectives of the Act are being met.

These principles read together with Section 24 of the Constitution, suggest that the environmental right is not limited to promotion of sustainable development, but includes rehabilitation of degraded environments, especially NEMA principle 2(4)(a) that provides *where harm to the environment cannot be avoided it must be* ***mitigated and remedied*** and section 2(4)(p) *the costs of remedying pollution, environmental degradation and consequent adverse health effects must be paid.*

NEMA Chapter 5: Integrated Environmental Management

Chapter 5 of the NEMA outlines the concept of Integrated Environmental Management and focuses on the principle that if activities have the potential to impact negatively on the environment, then such activities need to be assessed and authorised as a function of that assessment. The formal Environmental Authorisation process, which is guided by NEMA Sections 23 and 24, is very thorough and prescriptive for applicants in terms of the requirements for specialist studies, identifying and mitigating impacts. For example [own emphasis]:

- *Section 23(2)(b) The general objective of integrated environmental management is to* ***identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities****, with a view to minimising negative impacts, maximising benefits, and promoting compliance with the principles of environmental management set out in Section 2 of NEMA;*
- *Section 23(2)(c) The general objective of integrated environmental management is to ensure that* ***the effects of activities on the***

environment receive adequate consideration *before actions are taken in connection with them;*

- *Section 24 (1) in order to give effect to the general objectives of integrated environmental management laid down in this Chapter, the potential* ***consequences for or impacts on the environment*** *of listed activities or specified activities must be* ***considered, investigated, assessed and reported on*** *to the competent authority…;*
- *Section 24(1A)(f) every applicant must comply with the requirements prescribed in terms of this Act in relation to the* ***undertaking of any specialist report where applicable****;*
- *Section 24(4)(a) Procedures for the investigation, assessment and communication of the potential consequences or impacts of activities on the environment must ensure, with respect to every application for an environmental authorisation-*
  - *(i) Coordination and cooperation between organs of State in the consideration of assessments where an activity falls under the jurisdiction of more than one organ of state;*
  - *(ii) That the findings and recommendations flowing from an investigation, the general objectives of integrated environmental management laid down in this Act and the principles of environmental management set out in section 2 are taken into account in any decision made by an Organ of State in relation to any proposed policy, programme, process, plan or project;*
  - *(iii) That a description of the environment likely to be significantly affected by the proposed activity is contained in such application;*
  - *(iv)* ***Investigation of the potential consequences for or impacts on the environment of the activity and assessment of the significance of those potential consequences or impacts****; and*
  - *(v) Public information and participation procedures which provide all interested and affected parties, including all Organs of State in all spheres of government that may have jurisdiction over any aspect of the activity, with a reasonable opportunity to participate in those information and participation procedures;*
- *Section 24(4)(b)(v) procedures for the investigation, assessment and communication of the potential consequences or impacts of activities on the environment must include, with respect to every application for an*

environmental authorisation and where applicable investigation and ***formulation of arrangements for the monitoring and management of consequences for or impacts on the environment, and the assessment of the effectiveness of such arrangements after their implementation****.*

In terms of the list of activities requiring authorisation prior to conducting the activities, the Minister may gazette regulations outlining the "listed activities". However, there have been several sets of "listed activities" gazetted as indicated in Table 3-1. One of the challenges for enforcement of the NEMA is keeping up to date with changes between what is or is not "listed" as well as the changes of thresholds of listed activities. In relation to enforcement, it is important to determine the exact date that the potentially non-compliant or illegal activity was carried out, in order to determine which set of "listed activities" was applicable at the time, if any, and therefore which enforcement mechanisms are available. It is important to note that a Compliance Notice in terms of section 31L of NEMA cannot be issued for non-compliance with the provisions of repealed legislation, unless the replacement legislation very specifically states that the activities in the replacement legislation are to be considered an extension of the repealed legislation. For example if an activity was repealed e.g. GNR 385 in 2010, then a compliance notice may not be issued in relation to an activity as defined in GNR 544 in 2013, as the GNR544 does not specifically state that its activities are an extension of GNR385.[6]

Table 3-1 Regular updating of the NEMA listed activities.

Validity period	**5 September 1997 – 2 July 2006**	**3 July 2006 - 1 August 2010**	**2 August 2010 – December 2014**	**8 December 2014 - Ongoing**
Legislation *in terms of*	Environment Conservation Act, Act 73 of 1989, ECA, section 21	National Environmental Management Act, Act 107 of 1998, NEMA, section 24	National Environmental Management Act, Act 107 of 1998, NEMA, section 24	National Environmental Management Act, Act 107 of 1998, NEMA, section 24
Regulations	GN R1182 of 5 September	GN R386 of 21 April 2006	GN R544 of 2 August 2010	GN R983 of 4 December

[6] Section 12(1) Interpretation Act, Act 33 of 1957 "[w]here a law repeals and re-enacts with or without modifications, any provision of a former law, references in any law to the provisions so repealed shall, unless the contrary intention appears, be construed as references to the provision so re-enacted." The GN 544, 545 and 546 do not include any "contrary intentions".

	1997 (Listed activities)	(Requires Basic Assessment)	(Requires Basic Assessment)	2014 (Requires Basic Assessment)
	GN R1183 of 5 September 1997 (Application process)	GN R385 of 21 April 2006 (Application process)	GN R545 of 2 August 2010 (requires an Environmental Impact Assessment)	GN R984 of 4 December 2014 (Requires an Environmental Impact Assessment)
	GN R670 of 10 May 1998 (Amended listed activities)	GN R387 of 21 April 2006 (Requires an Environmental Impact Assessment)	GN R546 of 2 August (Geographic specific listed activities)	GNR 985 of 4 December 2014 (Geographic specific listed activities)

The NEMA listed activities requiring authorisation prior to commencement are quite specific and detailed, unlike the National Water Act, Act 36 of 1998 (NWA) activities requiring water licences. The NWA identifies a general action that will have an impact on water resources. This allows for the merits of the context specific application to be considered, as well as any extraordinary circumstances. The NEMA listed activities on the other hand are so detailed that they risk creating gaps or excluding cases because of their explicit detail.

In addition to formal authorising procedures, NEMA Section 24G makes provision for granting of an environmental authorisation in order to rectify an illegal activity. As the s24G process is a formal Environmental Authorising process, it too is fairly prescriptive in terms of the detail to be included as part of the application [own emphasis]:

- Section 24G(1): *On application by a person who has committed an offence in terms of section 24F(2)(a), the Minister or MEC concerned, as the case may be, may direct the applicant to compile a report containing:*
    - *(i) An **assessment of the nature, extent, duration and significance of the consequences for or impacts on the environment of the activity, including the cumulative effects**;*
    - *(ii) A **description of mitigation measures** undertaken or to be undertaken in respect of the consequences for or impacts on the environment of the activity;*

(iii) A description of the public participation process followed during the course of compiling the report, including all comments received from interested and affected parties and an indication of how issues raised have been addressed;

(iv) ***An environmental management programme****; and*

(b) ***provide such other information or undertake such further studies*** *as the Minister or MEC, as the case may be, may deem necessary.*

- Section 24G(2): *The Minister or MEC concerned must consider any reports or information submitted in terms of subsection (1) and thereafter may-*

  (a) ***Direct the person to cease the activity, either wholly or in part, and to rehabilitate the environment*** *within such time and subject to such conditions as the Minister or MEC may deem necessary; or*

  (b) Issue an environmental authorisation to such person subject to such conditions as the Minister or MEC may deem necessary.

However, it is not compulsory to apply for s24G authorisation nor can it be directed in enforcement action, as a person cannot be instructed to make an application since it is a person's right to choose to apply. Furthermore, the s24G process only addresses illegal activities, e.g. activities that are listed and should have attained environmental authorisation prior to commencement. The s24G process is not applicable to non-compliance of activities with existing authorisations. Furthermore, the regulations do not prescribe timeframes for the s24G Environmental Authorisation process, while many of these activities require immediate remediation of impacts on the environment.

NEMA Chapter 7: Compliance and Enforcement

Chapter 7 of the NEMA outlines the process and measures for compliance and enforcement. These enforcement measures are administrative notices that direct the transgressor to conduct specified activities, commonly called "directives" or where it is NEMA specific "compliance notices". Where an activity has commenced prior to authorisation, or where there is non-compliance with conditions of authorisation, the applicable sphere of government may issue an administrative notice. For Local Municipalities this Directive is in terms of Section 31A of the ECA; and for Provincial and National spheres of the Department of

Environmental Affairs it may be a Directive or Compliance Notice in terms of Sections 28(4) or 31L of the NEMA respectively.

Section 28(4) of NEMA places a general duty of care on all persons, including juristic persons (such as companies and closed corporations). It provides that any person [own emphasis]:

> *"who causes, **has caused** or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and **rectify such pollution or degradation** of the environment."*

The measures required in terms of the above section include but are not limited to the following [own emphasis]:

- *investigate, assess and evaluate the impact on the environment;*
- *inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;*
- *cease, modify or control any act, activity or process causing the pollution or degradation;*
- *contain or prevent the movement of pollutants or the causant of degradation;*
- *eliminate any source of the pollution or degradation; or*
- ***remedy** the effects of the pollution or degradation.*

This means that any activity, not only the listed activities, should not cause significant pollution or degradation to the environment, or where there has been significant pollution or degradation to implement reasonable measures to remediate it. A NEMA Section 28(4) directive can also be issued retrospectively for activities that have caused pollution or environmental degradation, however this would be limited to the period since the commencement of the Act. Section 28 is still reasonably prescriptive in identifying, evaluating and assessing the impacts of the specific activities on the environment, and remedying the effects thereof.

Furthermore

> *Section 28 (4) provides that the Director-General of the Department of Environmental Affairs or a provincial head of the relevant environmental affairs department, may, after consultation with any other Organ of State concerned and after having given adequate opportunity to affected persons to inform him or her of their relevant interests, direct any person who fails to take the measures required under subsection (1) to-*
>
> *(a) investigate, evaluate and assess the impact of specific activities and report thereon;*
>
> *(b) commence taking specific reasonable measures before a given date;*
>
> *(c) diligently continue with those measures; and*
>
> *(d) complete them before a specified reasonable date.*
>
> *If urgent action is necessary for the protection of the environment, the Director-General or a provincial head of department may issue such a directive, and consult and give such opportunity to inform as soon thereafter as is reasonable.*

Previously, non-compliance with a Section 28(4) directive was not a criminal offence, and therefore this mechanism was not frequently issued. However, in the 2009 NEMA Amendments this was remedied, and non-compliance with a Section 28(4) directive is now a criminal offence and subject to the same punitive damages as other enforcement mechanisms of the NEMA.

On the other hand, Section 31L of NEMA provides that where there are reasonable grounds for believing that a person has not complied with any term or condition of a permit or authorisation or with a provision of the law for which an Environmental Management Inspector (EMI) has been designated (e.g. to NEMA and the SEMAs), such an EMI may issue a compliance notice. According to NEMA Section 31L, the compliance notice must:

> *set out any steps the person must take and the period within which those steps must be taken*.

There is a prescribed form for the drafting of a compliance notice[7], and it must include reference to the fact that such notice may be objected to and how such

[7] Regulations Relating To Qualification Criteria, Training And Identification Of, And Forms To Be Used By, Environmental Management Inspectors, Published under Government Notice R494 in Government Gazette 28869 of 2 June 2006.

objection procedure works. However in comparison to the detailed and prescriptive requirements of the Section 24 authorising sections and the s28(4) directive, the key compliance measure is not very informative. The s31L does not require an impact assessment, mitigation measures or remedial work as compulsory activities. It is left to the enforcement official to determine what steps the person must take, i.e. what studies, if any, should be done and what rehabilitation, if any, should be implemented.

A person who receives a compliance notice must comply with that notice within the time period stated. Failure to comply with a compliance notice is a criminal offence carrying a maximum penalty of R5 million and/or 10 years (see section 31N).

The NEMA s.31L Compliance Notice is limited to specifically identified 'listed activities' published in the Government Gazette. There have been several sets of 'listed activities' in the past 5 years, therefore it is imperative to keep up to date with what activities, thresholds and descriptions thereof, are considered as 'listed activities' requiring authorization prior to commencement.

Discussion on enforcement mechanisms

Whereas both the NEMA s.28 Directive and the ECA s.31A Directive can be issued in relation to impacts to the environment without being linked to specific identified 'listed activities' like the NEMA s.31L Compliance Notice, Molteno *et al.,* (2010) highlight that these two Directives are however dissimilar.

> NEMA section 28(1) identifies that *every person who causes, has caused or may cause <u>significant pollution or degradation of the environment</u> must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*

The relevant authority must provide adequate opportunity to the person and inform them of their responsibilities to take reasonable measures to prevent significant pollution or degradation of the environment; only then if the person fails to take the *reasonable measures*, may the competent authority issue the Directive.

Furthermore, this Section requires the person to take *reasonable measures to prevent degradation of the environment;* however there is neither a definition of *reasonable measures* nor of *serious damage, endangered or detrimentally affected* in the legislation. Currently, the NEMA s.28 Directive does not make provision for the relevant authority to direct the activity to cease. The only relevant authorities that may issue a NEMA s.28 Directive are the National or Provincial Departments of Environmental Affairs. The NEMA s.28 makes provision for issuing of the Directive in urgent circumstances if needs be, and foregoing the pre-directive stage, although consultation and opportunity to inform the person is still required as soon thereafter as is reasonable.

While ECA section 31A identifies (1) *if, in the opinion of the Minister or the competent authority, local authority or government institution concerned, any person performs any activity or fails to perform any activity as a result of which the environment is or may be seriously damaged, endangered or detrimentally affected, the Minister, competent authority, local authority or government institution, as the case may be, may in writing direct such person –...*

The ECA s31A identifies that not only the performing of an activity causing an impact, but the failure to perform an activity to prevent an impact that will result in serious damage also warrants compliance measures. The ECA s.31A Directive does make provision for the competent authority to direct such activity to cease. The competent authority may be the National and/or Provincial Department of Environmental Affairs, as well as municipalities, and other *government institutions*, which could include the Departments of Water and Sanitation, Agriculture, or Forestry where relevant, i.e. where activities within their mandate may cause serious damage to the environment. The ECA s.31A makes no provision for urgency, and a pre-directive is thus required to be issued providing the person is granted opportunity to respond to the notice of the intention to issue a Directive.

Note that the ECA s.31A Directive is where the *environment is damaged, endangered or detrimentally affected*, whereas the NEMA s.28 Directive is where there is *significant pollution or degradation of the environment.* This raises the pertinent question as to how does an inspector prove or determine **significant** pollution or **serious** damage? In respect to urban rivers, the river corridor is

already, in the majority of cases in South Africa, in a degraded state, so how does one determine that a specific activity/ies has *significantly* degraded the river corridor further or detrimentally affected the river more than it already has been altered by its nature of being an urban river? The specialist studies which identify the *significant pollution or degradation* of the activity/ies, are a condition of the Directive, which is only supposed to be issued once significant pollution has been identified. Is this not a case of "putting the cart before the horse"? This situation therefore requires some form of scientific substantiation in order to help the inspectors support their case and defend their actions to issue a directive or compliance notice that then requests the specialist studies to be conducted.

In order to accommodate emergency incidents, the NEMA Section 30 makes provision for the control of emergency incidents, where an *"incident" means:*

> *an unexpected sudden occurrence including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment whether immediate or delayed.*

Subsection 30(6) in particular includes enforcement mechanisms to ensure the obligations identified with an incident are carried out.

> ***Section 30****(6) A relevant authority may direct the responsible person to undertake specific measures within a specific time to fulfil his or her obligations under subsections (4) and (5): Provided that the relevant authority must when considering any such measure or time period have regard to the following:*
>
> *(a) the principles set out in section 2;*
>
> *(b) the severity of any impact on the environment as a result of the incident and the costs of the measures being considered;*
>
> *(c) any measures already taken or proposed by the person on whom measures are to be imposed, if applicable;*
>
> *(d) the desirability of the State fulfilling its role as custodian holding the environment in public trust for the people;*
>
> *(e) any other relevant factors.*

The NEMA Section 30 emergency incidents are similar to the NWA Section 20 emergency incidents.

NEMA Chapter 10: General and transitional provisions

According to Chapter 10 section 48, the NEMA *is binding on the State except in so far as any criminal liability is concerned.* In Chapter 2 Thompson (2006:137) observes that there is a positive duty on the State to protect the environment; furthermore, that "the right to an environment that is not harmful to a person's health and well-being does not demand differentiation between State and private conduct." At the beginning of this Chapter, Feris (in Paterson and Kotze, 2005:133) noted that Section 24 paragraph *(b)* "also provides protection against any infringement by the State that negates environmental protection or that is in any way harmful to the environment." This places a responsibility on the State not only to implement a regulatory framework to protect the environment, but to ensure that its own actions comply both with the environmental right, as well as the regulatory framework. Therefore this clause is in contradiction with the premise of Section 24 of the Constitution. Although the implication of this Section in NEMA is for the protection of the country's tax-paying citizens, it is used as a means for Organs of State to avoid their accountability to comply with the legislation. Noteworthy, this clause has recently been repealed by Section 24 of Act 30/2013 with effect from 18 December 2013. This still raises the question of accountability. The Department of Environmental Affairs monitors other persons with regard to the regulatory framework, but it is not defined as to who monitors the Department in terms of implementing the regulatory framework, and ensuring achievement of the environmental right? The Department of Environmental Affairs monitors the conduct of persons, public and private, in compliance with the environmental regulatory framework however Section 48 has in the past prevented the State taking criminal action against itself, where its own Organs are the transgressors.

3.3.1.4 Other Strategic Environmental Management Acts (SEMAs)

The Department of Environmental Affairs is also responsible for the implementation and enforcement of the National Environmental Management: Protected Areas Act, National Environmental Management: Biodiversity Act and National Environmental Management: Waste Act. The provisions of NEMA, as discussed, may be used to enforce these Statutes as they are Specific Environmental Management Acts of the NEMA. However, they do also contain their own additional enforcement mechanisms. These additional mechanisms that

may be relevant to enforce river rehabilitation on urban rivers are mentioned below. The enforcement mechanisms of the NEMA can be used to enforce the SEMA legislation; whichever mechanisms are more punitive usually take the lead.

NEM: Protected Areas Act, Act 57 of 2003 (NEMPAA)

The NEM:PAA is administered by all three spheres of government (national, provincial and local) based on the type of protected area affected, i.e. National park is administered by the National Department, whereas Nature Reserves are administered by either the Provincial Department or the Local Municipality, whoever owns them. Section 9 of the Act identifies the different *kinds of protected areas:*

(a) special nature reserves, national parks, nature reserves (including wilderness areas) and protected environments;

(b) world heritage sites;

(c) marine protected areas;

(d) specially protected forest areas, forest nature reserves and forest wilderness areas declared in terms of the National Forest Act, 1998 (Act No. 84 of 1998); and

(e) mountain catchment areas declared in terms of the Mountain Catchment Areas Act, 1970 (Act No. 63 of 1970).

The NEM:PAA provides no additional relevant enforcement mechanisms.

NEM: Biodiversity Act, Act 10 of 2004 (NEM:BA)

The NEM:BA is regulated and enforced by the National and Provincial Departments of Environmental Affairs, formerly within the Directorates of Nature Conservation, now referred to as Biodiversity and Conservation Directorates.

The NEM:BA makes provision for two additional enforcement mechanisms, a Section 69(2) Directive for contravention in relation to a permit for alien species; and a Section 73(3) Directive for contravention in relation to a permit for invasive species.

NEM: Waste Act, Act 59 of 2008 (NEMWA)

The NEM:WA is regulated and enforced by the National and Provincial Department of Environmental Affairs and municipalities. The additional enforcement mechanisms included in the NEM:WA are only available to the

National and Provincial Departments. The additional mechanisms include the Section 37(1) site assessment Directive to determine contamination and section 38(2) and 38(3) remediation orders for contaminated land.

Mountain Catchment Areas Act, Act 63 of 1970 (MCAA)

The Mountain Catchment Areas Act, Act 63 of 1970 (MCAA) *as amended* is administered by the Provincial Protected Area Agency, as per the NEM: Protected Areas Act. The Act in itself has not been repealed. It is not a Specific Environmental Management Act of the NEMA, but the principles of the Act and its required activities are incorporated in the NEM:PAA, and the Environmental Management Inspector's (EMI) can enforce the NEM:PAA. The management functions can be delegated to any Department of State. A Mountain Catchment Area advisory committee may be established. In order to regulate and conserve the land within a defined Mountain Catchment, the Minister may issue a directive in terms of Section 3 of the Act:

The implementation and regulation of the Act is carried out through the Department of Environmental Affairs and not through the Department of Water and Sanitation, although mountain catchments are the source of the country's water resources, and the NWA rather than the NEMA is mandated with the protection of the country's water resources.

3.3.2 Environment: Institutional Roles

3.3.2.1 Department of Environmental Affairs

The National Department of Environmental Affairs is responsible for application and implementation of national policy and the regulatory framework, for management of waste and hazardous substances, for trans-provincial activities requiring environmental impact authorisations (activities across provincial boundaries), and the environmental regulation of parastatal organisations. The guiding legislation for the Department of Environmental Affairs, is the National Environmental Management Act, Act 107 of 1998 (NEMA), which is an umbrella legislation for several Specific Environmental Management Acts (SEMAs). The Department of Environmental Affairs' institutional arrangements align with political boundaries and spheres of government. The NEMA assigns core competencies across the spheres of government in accordance with Constitutional assigned

competencies; enforcement functions are carried out at both the provincial and national levels.

Within the national sphere of government, the enforcement function of the NEMA and NEM:WA is located within the Branch: Environmental Quality and Protection, in the Directorate of Regulatory Services, as illustrated in

Figure 3.1, while the enforcement function of the NEM:PAA and NEM:BA is located separately within the Branch Biodiversity and Conservation, as illustrated in

Figure 3.2. The NEMA and NEM:WA deal with more land use related issues, called “brown issues” while the NEM:PAA and NEM:BA deal with more biodiversity, species and conservation related issues and are referred to as “green issues”.

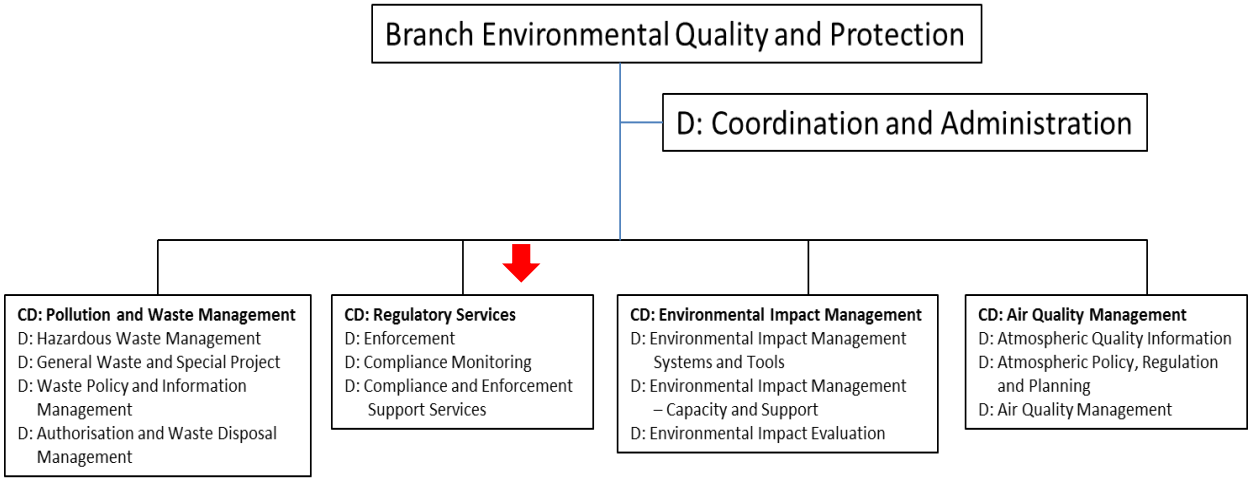


Figure 3.1 Organogram of the National Department of Environmental Affairs, illustrating the enforcement function within the Directorate: Regulatory Services.

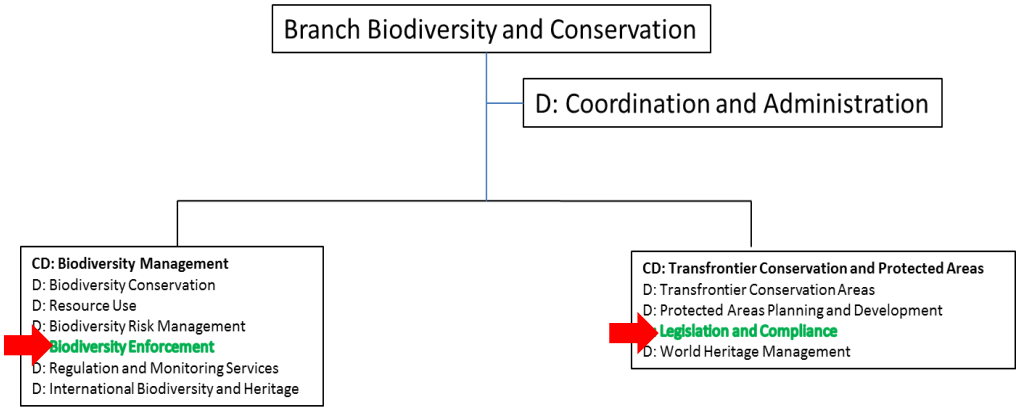


Figure 3.2 Organogram of the National Department of Environmental Affairs, illustrating the enforcement functions within the Brand: Biodiversity and Conservation.

3.3.2.2 Provincial Department of Environmental Affairs

The Provincial Departments of Environmental Affairs are responsible for the day-to-day management, protection, conservation, sustainable utilisation and regulation of environmental resources according to provincial administrative boundaries. The provincial departments are responsible for general environmental impact authorisations, development guidelines within the relevant provinces to guide land use activities and minimize impacts to the environment, and regulatory function associated with these. Each provincial department is arranged individually, and the enforcement function is not necessarily consolidated into a specific directorate.

Enforcement activities, in terms of the NEMA and its SEMA's, are carried out by the Environmental Management Inspectors, located in the National and Provincial Departments of Environmental Affairs.**Environmental Management Inspectorate (EMI)**

The enforcement functions identified in the NEMA are tasked to the Environmental Management Inspectorate (EMI).

> *NEMA Section 31(G)(1) provides that an EMI - may investigate any act or omission in respect of which there is a reasonable suspicion that it might constitute –*
>
> *(i) an offence in terms of such law;*

(ii) a breach of such law; or

(iii) a breach of a term of condition of a permit, authorization or other instrument issued in terms of such law.

In terms of the various subsections of Section 31 of NEMA, and subject to the grading of an EMI and their designated powers and functions, compliant with a warrant where necessary, EMIs have the following powers:

- The power to enter and inspect to ascertain compliance;
- The power to enter premises for purpose of interrogation;
- The power to question witnesses, suspects and to take statements;
- The power to obtain documents;
- The power to collect physical evidence;
- The power to search and seize;
- The power to set up a roadblock, to stop and immobilize vehicles;
- The power to arrest;
- The power to issue a Section 56 CPA notice for an admission of guilt fine; and
- The power to issue a compliance notice.

In terms of competency, it is important to note that a person must complete the EMI training course (a specific academic qualification), and that their job function should requires the skills set of an EMI, before a person can be considered for designation as an EMI. This applies to all government organs, including National Park Rangers, Chief Directors, Head of Departments and Director and Deputy Director Generals, requiring EMI powers or authority to sign Compliance Notices.

EMI's can be, and are, located throughout all three spheres of government, in order to comply with the provisions and assigned jurisdictions of NEMA and the various SEMA's, i.e. EMI powers used to enforce NEM:BA, NEM:PAA and NEM:WA, NWA. Currently, however, only enforcement by EMI's is conducted by the National and Provincial Departments of Environment and not at Local Government level. However, EMI's may only operate in their area (geographic and legislative) of delegation. In terms of Sections 31B and 31C of the NEMA, EMI's are designated by the Minister where mandates or functions require national jurisdiction or where functions are performed by the National Department. At the provincial level, the MEC designates EMI's within his/her area of jurisdiction and competence, i.e. only designated in terms of the duties performed by the MEC or

provincial government. For example, an EMI designated by the MEC for Environmental Affairs in Mpumalanga Province, may not utilise the powers of an EMI within the Eastern Cape Province, unless duly designated by the MEC of Environment Affairs in the Eastern Cape. Similarly, an EMI designated in terms of the Waste Act in the Drakenstein Municipality (Western Cape) may not enforce the Protected Areas Act in Mpumalanga Province.

The EMI's are graded 1 to 5. A grade 5 EMI is conferred on park rangers, whereas grade 1 is usually head of departments and chief directors who are responsible for signing compliance notices. Grade 5 EMI's usually only tackle green issues.

3.3.2.4 South African National Biodiversity Institute (SANBI)

Although not involved in enforcement activities, the Institute, established through the NEM:BAA does develop management measures such as the Bio-assessment report, state of the environment report and other scientific assessments.

3.3.2.5 Local Government: Municipalities

The Constitution established local government as a distinctive sphere of government, interdependent, and interrelated with the national and provincial spheres of government. These are obliged to ensure sustainable, effective and efficient municipal services, promote social and economic development, and encourage a safe and healthy environment by working with communities in creating environments and human settlements in which all people are uplifted and can live dignified lives, (preamble, Municipal Structures Act, Act 117 of 1998 *as amended*).

There are three types of Municipalities, as per section 155(1) of the Constitution, these include:

(a) Category A: a municipality that has exclusive municipal executive and legislative authority in its area (Metropolitan);
(b) Category B: a municipality that shares municipal executive and legislative authority in its area with a category C municipality in whose area it falls (Local); and

(c) Category C: a municipality that has municipal executive and legislative authority in an area that includes more than one municipality (District).

Despite the three types of municipalities, municipalities of the same category may vary in terms of function, capacity and resources, as a result of geographic location and historic inheritance. "The term asymmetry refers to the idea that the functions and powers of one municipality need not be exactly the same as the functions and powers of another municipality, but there is room for differentiation, according to different municipalities capacity (DPLG, 2003:6)" and geographic requirements or constraints.

Municipalities play a vital component in promoting development, enabling effective service delivery and performing as a viable financial and administrative entity. According to the Demarcations Act, 2006, all land in South Africa is administered by a municipality, so actual land development is managed and monitored at the local sphere of government, however resource protection, and enforcement, is administered by the national and provincial spheres. In order to promote sustainable development and resource utilisation, it is important that municipalities are incorporated into the enforcement process, within their mandates and jurisdiction, to promote a harmonized approach to resource utilisation and sustainable development on the ground.

In terms of enforcement mechanisms, municipalities can issue ECA section 31A Directives to prevent or remedy degradation of the environment (as discussed earlier in this chapter). Furthermore, Municipalities have their own specific By-laws for the protection of the environment within their jurisdiction.

3.3.2.6 By-Law enforcement

Municipal By-Laws refer to a variety of topics that fall under the Local Government sphere of competence, as identified in the Constitution. In relation to this research, these include *inter alia*:

- By-laws relating to water services;
- By-laws to limit or restrict the use of water;
- Stormwater Management By-laws;
- Treated Effluent By-laws;

- Wastewater and industrial effluent By-laws; and
- Environmental Health By-laws.

The number of By-laws and the details of By-laws vary according to- and are drafted for- each Local Municipality specifically. It is therefore difficult to compile the Municipal By-laws into one set of regulations/ 'listed activities'. The By-laws are enforced by the municipal police.

Municipalities are also responsible for the implementation and regulation of various sections of other legislation, such as the NEM: Waste Act and the Disaster Management Act (Act 57 of 2002) and also for the National Health Act (Act 61 of 2003).

3.3.3 Environment: Management measures

Unlike the National Water Act, which makes provision for the determination of management classes for the sustainable management of water resources, the NEMA does not make specific provision for resource specific management measures. The NEM:BA makes provision for the various spheres of government to develop critical biodiversity or conservation plans as well as compiling ecosystem specific bio-assessment reports. The NEMA Section 11 makes provision that all National departments listed in NEMA schedule 1 exercising functions that may affect the environment, must compile and submit an Environmental Implementation Plan (EIP), and National Departments listed in schedule 2 exercising functions which manage the environment, must compile and submit an Environmental Management Plan (EMP). The EIP and EMP, or consolidated plan, must be submitted every four years to the DEA for approval. The purpose of the EIP is to (NEMA Section 12):

(a) Co-ordinate and harmonise the environmental policies, plans, programmes and decisions of the various national departments that exercise functions that may affect the environment or are entrusted with powers and duties aimed at the achievement, promotion and protection of a sustainable environment, and of provincial and local spheres of government, in order to –

(i) minimise the duplication of procedures and functions; and

(ii) promote consistency in the exercise of functions that may affect the environment;

(b) give effect to the principle of co-operative government in Chapter 3 of the Constitution;

(c) secure the protection of the environment across the country as a whole;

(d) prevent unreasonable actions by provinces in respect of the environment that are prejudicial to the economic or health interest of other provinces or the country as a whole; and

(e) enable the Minister to monitor the achievement, promotion, and protection of a sustainable environment.

The content of an EMP includes (NEMA section 14):

(a) a description of the functions exercised by the relevant department in respect of the enviornment;

(b) a description of environmental norms and standards, including norms and standards contemplated in section 146(2)(b)(i) of the Constitution, set or applied by the relevant department;

(c) a description of the policies, plans and programmes of the relevant department that are designed to ensure compliance with its policies by other organs of state and persons;

(d) a description of priorities regarding compliance with the relevant department's policies by other organs of state and persons;

(e) a description of the extent of compliance with the relevant department's policies by other organs of state and persons;

(f) a description of arrangements for co-operation with other national departments and spheres of government, including any existing or proposed memoranda of understanding entered into, or delegation or assignment of powers to other organs of state, with a bearing on enviornmental management;

(g) proposals for the promotion of the objectives and plans for the implementation of the procedures and regulations referred to in Chapter 5 of this Act.

These management measures refer more to cooperative governance than actual environmental resource management objectives.

In terms of integrated environmental management, the environmental impact assessment process results in a Record of Decision (ROD) or Authorisation. These may include conditions of authorisation. Offences occur when a person does not comply with the conditions of the authorisation, or fails to obtain such an authorisation prior to commencing with a listed activity. The primary compliance and enforcement administrative mechanisms are the directives and compliance notices, as already discussed. Other mechanisms include interdicts, civil and criminal offences.

3.4 Water

Although water is a component of the environment and falls within the ambit of the National Environmental Management Act, Act 107 of 1998 (NEMA), water is also a key resource of the State. Water resources management, and the sustainable utilisation thereof, is overseen by the National Water Act, Act 36 of 1998 (NWA).

3.4.1 Water: Enabling Environment

The White Paper for National Water Policy which sets out the principles of water resources management and the National Water Act, Act 36of 1998 (NWA) promote two key fundamental principles, namely, those of equity and sustainability.

3.4.1.1 White Paper on a National Water Policy for South Africa (1997)

Prior to the gazetting of the NWA, a discussion document on Water Law Principles (1996) was published which proposed 27 core principles to be enacted in the NWA. As proposed in the Water Law Principles, the purpose of the NWA is to ensure that water resources are managed to promote the sustainable use of water in the public interest, to protect aquatic ecosystems and their biological diversity, and to allocate water in a way that will promote environmental values which include the human right to an environment that is not harmful and sustainable environmental development. As suggested earlier in this research, rehabilitation is an active component of the protection and management of water resources, and therefore rehabilitation objectives should equally also aspire to these principles of water resources management.

The water law principles applicable to this research include [own emphasis]: (DWAF, 1996)

- *A1: In a relatively arid country such as South Africa, it is necessary to recognise the unity of the water cycle and the interdependence of its elements, where evaporation, clouds and rainfall are linked to underground water, rivers, lakes, wetlands, estuaries and the sea.*
- *C1: The objective of managing the quantity, quality and reliability of the nation's water resources is to achieve optimum long term social and economic benefit for society from their use, recognising that water allocation may have to change over time.*
- *C3: The* ***quantity, quality and reliability of water required to maintain the ecological functions*** *on which humans depend should be reserved so that the human use of water does not individually or cumulatively compromise the long term sustainability of aquatic and associated ecosystems.*
- *D1: The national government is the custodian of the nation's water resources, as an indivisible national asset, and has ultimate responsibility for, and authority over, water resource management, the equitable allocation and usage of water, the transfer of water between catchments and international water matters.*
- *D2: The development, apportionment and management of water resources should be carried out using the criteria of public interest, sustainability, equity and efficiency of use in a manner which reflects the value of water to society while ensuring that basic domestic needs, the requirements of the environment and international obligations are met.*
- *D3: In as far as it is physically possible, water resources should be developed, apportioned and managed in such a manner as to enable all user sectors to gain equitable access to the desired quantity, quality and reliability of water, using conservation and other measures to manage demand where this is required.*
- *D4: Water quality and quantity are interdependent and should be managed in an integrated manner, which is consistent with broader environmental management approaches.*
- *D5: Water quality management options should include the use of* ***economic incentives and penalties to reduce pollution****; and the possibility of irretrievable environmental degradation as a result of pollution should be prevented.*

- *D6: Water resource development and supply activities should be managed in a manner which is consistent with broader environmental management approaches.*
- *D7: Since many land uses have a significant impact upon the water cycle, the regulation of land use should, where appropriate, be used as an instrument to manage water resources.*
- *D10: The development and management of water resources should be carried out in a manner which limits to an acceptable level the danger to life and property due to natural or other man-made disasters.*

Unlike the NEMA principles, the water policy principles notably do not mention rehabilitation or remedial actions, especially where there has been degradation of water resources, for example principles C3 and D5. The two main principles are equity and sustainability. In terms of equity there is extensive focus on redress of access to water from South Africa's political past. However, the state of the rivers and ecological health was also not pristine when South Africa transitioned into a Democratic State. The management of the water resources should not just be looking forward, but also remediating the impacts from the past (proactive rehabilitation). The policy does acknowledge the impact of pollution and environmental degradation in that it should be prevented but does not acknowledge remediating the degradation or impacts where it has happened in the past or may happen in the future. The policy does however utilise the term "sustainability" not "sustainable development".

3.4.1.2 National Water Act, Act 36 of 1998 (NWA)

The NWA provides a framework to protect water resources against over exploitation and to ensure that there is water to sustain the environment, for social and economic development, and water for the future, (DWAF 2003), as per the constitutional mandate. When referring to water resources, the Act Section 1, defines water resources as including *a watercourse, surface water, estuary, or aquifer,* where a watercourse is defined as meaning:

(a) a river or spring;

(b) a natural channel in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The principles of the Act strive for sustainability, equity and efficiency. In order to ensure management of water resources is sustainable and equitable for the benefit of all, the NWA aims to protect, use, develop, conserve, manage and control water resources as a whole. Rivers, dams, wetlands, the surrounding land, groundwater, as well as human activities that influence them, need to be managed as one integrated cycle or process. The utilisation – degradation – and cumulative impact spiral needs to manage in an integrated manner in order to ensure the sustainability of the country's water resources. The Act includes the principle of sustainability and is not limited to sustainable development, therefore the principles of the Act include sustainable utilisation and management of impacts on resources as well. Furthermore, the principles of the Act do not include "rehabilitation" of water resources where degradation or pollution has occurred either historically or since promulgation of the Act.

NWA Authorising requirements

Section 21 of the Act outlines the specific activities affecting water resources or watercourses that require authorisation. There are three types of authorisation, namely, those of water use licences and permits, existing lawful use, and general authorisations. In terms of regulating the use of a water resource the NWA identifies specific activities as requiring authorisation prior to utilisation. Table 3-2 outlines the activities requiring water use licences or permits. Enforcement is usually carried out where non-compliance with the conditions of a licence or permit occurs, or the illegal conducting of activities requiring a licence or permit. As part of the enforcement process, rehabilitation of the non-compliant activity and its impacts are required.

Table 3-2 Listed activities of the National Water Act, Act 36 of 1998, requiring a licence.

Section	**Activity**
21. For the purposes of this Act, water use includes -	*(a)* taking water from a water resource;
	(b) storing water;
	(c) impeding or diverting the flow of water in a watercourse;
	(d) engaging in a stream flow reduction activity contemplated in section 36;
	(e) engaging in a controlled activity identified as such in section 37(1)

	or declared under section 38(1);
	(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
	(g) disposing of waste in a manner which may detrimentally impact on a water resource;
	(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
	(i) altering the bed, banks, course or characteristics of a watercourse;
	(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
	(k) using water for recreational purposes.
36. (1) The following are stream flow reduction activities:	(a) the use of land for afforestation which has been or is being established for commercial purposes; and
	(b) an activity which has been declared as such under subsection (2).
37. (1) The following are controlled activities:	(a) irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterwork;
	(b) an activity aimed at the modification of atmospheric precipitation;
	(c) a power generation activity which alters the flow regime of a water resource;
	(d) intentional recharging of an aquifer with any waste or water containing waste; and
	(e) an activity which has been declared as such under section 38.
38 (1)	The Minister may, by notice in the Gazette, in general or specifically, declare an activity to be a controlled activity.
39 General Authorisations	Although the general authorisations indicates certain activities that can be carried out without formal licences, the conditions must be adhered to. It is recommended that water users obtain formal confirmation from DWS that the proposed water use does in fact falls within the ambit of the general authorisations.

As part of the authorising process, the impacts of listed activity/ies are considered within the overall catchment scale, as well as within the principles of sustainability, equity and efficiency. Therefore, when setting objectives for enforced rehabilitation, consideration of the illegal activity/ies and its impacts on the receiving environment, at local and catchment scale, should also be considered.

Section 41 outlines the process of application for the water use licence. The NWA application process is relatively flexible in that it is guided by the Department of Water and Sanitation (DWS) rather than the legislation, which provides for more flexibility on a case by case basis. The Act rather provides guidance to the decision makers with regard to criteria to be considered when reviewing an application. Of interest, despite one of the principles of the Act being to *protect aquatic and associated ecosystems and their biodiversity*, the criteria for reviewing applications, as per Section 27 of the Act, do not specifically identify the environment and its ecosystems or potential impacts the water use activity may have on them. In addition, criterion *(g)* refers to the class and resource objective of the water resource; when considering this criterion, it is anticipated that the current and future class as a result of the impacting activity is also to be considered. Similarly, criterion *(j)* mentions the Reserve in terms of water quality, but does not specify if this includes the future potential quality as a result of the activity on the Reserve (both Basic Human Need and Ecological Reserve). It is interesting to note in NWA section 41(2)(b) that the responsible authority may carry out its own investigation into the likely effect of the proposed activity on the water resource.

Unlike the NEMA section 24G, the NWA does not include any formal processes for the retrospective authorising of activities. Although a SEMA of the NEMA, this section of NEMA may not be applied to the NWA.

NWA Compliance and enforcement

There are three compliance and enforcement mechanisms in the NWA, including: Section 19 for the prevention and remedying effects of pollution; Section 20 for control of emergency incidents; and Section 53 for non-compliance to a licence or permit. The provisions of these Sections are as follows.

Section 19 *(1) An owner of land, a person in control of land or a person who occupies or uses the land on which* – [own emphasis]

> *(a) any activity or process is or was performed or undertaken; or*
>
> *(b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource,*
>
> *must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.*

(2) The measures referred to in subsection (1) may include measures to -

(a) cease, modify or control any act or process causing the pollution;

(b) comply with any prescribed waste standard or management practice;

(c) contain or prevent the movement of pollutants;

(d) eliminate any source of the pollution;

(e) ***remedy*** *the effects of the pollution; and*

(f) ***remedy*** *the effects of any disturbance to the bed and banks of a watercourse.*

(3) A catchment management agency may direct any person who fails to take the measures required under subsection (1) to -

(a) commence taking specific measures before a given date;

(b) diligently continue with those measures; and

(c) complete them before a given date.

While the legislation does specifically identify remedial action as a reasonable measure to be taken, it is up to the enforcement official to indicate what this remedial action should be.

Unlike the environmental legislation of ECA and NEMA where "seriously damaged, endangered or detrimentally affected" and "signification pollution or degradation" are not defined, the NWA defines pollution, in Section 1, as:

"*the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it -*

(a) less fit for any beneficial purpose for which it may reasonably be expected to be used; or

(b) harmful or potentially harmful -

(aa) to the welfare, health or safety of human beings;

(bb) to any aquatic or non-aquatic organisms;

(cc) to the resource quality; or

(dd) to property;

The NWA acknowledges "pollution" of a water resource whereas the NEMA acknowledges "serious pollution" this suggests that the NWA regards any change to the status quo, given the definition of pollution, as being problematic and requiring addressing, whereas the NEMA requires a significant impact first.

Furthermore, it is important to note that harmful in the NWA definition is not limited to the harm to human beings, but includes harm to the aquatic and non-aquatic organisms, the resource quality and to property. Furthermore, the pollution itself

may be an alteration to the physical or biological properties of a water resource and not only the chemical properties. Therefore it includes the impacts to the ecological function, goods and services of the water resource as well.

Alternatively, **Section 20***(1) In this section, "incident" includes any incident or accident in which a substance* – [own emphasis]

(a) pollutes or has the potential to pollute a water resource; or

(b) has, or is likely to have, a ***detrimental effect*** *on a water resource.*

20(2) In this section, "responsible person" includes any person who -

(a) is responsible for the incident;

(b) owns the substance involved in the incident; or

(c) was in control of the substance involved in the incident at the time of the incident.

20(4) A responsible person must – [own emphasis]

(a) take all reasonable measures to contain and ***minimise the effects*** *of the incident;*

(b) undertake ***clean-up*** *procedures;*

*(c****) remedy*** *the effects of the incident; and*

(d) take such measures as the catchment management agency may either verbally or in writing direct within the time specified by such institution.

Both of these Sections, while not prescriptive in terms of identifying the extent of the impacts of incidents or pollution, do include clauses for *remedying the effect of the pollution.* There is no limit placed on the extent of the effect. This implies that the extent is not only limited to the pollution activity itself, but the impacts to the ecological integrity and function of the water resource as a result of the pollution as well. It is not specified in the legislation, however in determining the remedial action relevant specialist studies that should be included, bearing in mind that cumulative and delayed impacts are still "effects" of the incident or pollution and therefore a holistic approach will be required. Similarly these Sections do not include requirements for monitoring or measuring the progress or success of the remedial activities. There is no follow up assessment after the remediation to measure the improved state or health of the water resource as a result of the remedial activities.

Where non-compliance has occurred, in other words where activities requiring authorisation have commenced without such authorisation, or where there is non-

compliance to licence or permit conditions, a Section 53(1) directive may be issued to rectify such contraventions.

Section 53 [own emphasis]

> *(1) A responsible authority may, by notice in writing to a person who contravenes -*
>
> *(a) any provision of this Chapter;*
>
> *(b) a requirement set or directive given by the responsible authority under this Chapter; or*
>
> *(c) a condition which applies to any authority to use water, direct that person, or the owner of the property in relation to which the contravention occurs, to take **any action specified in the notice to rectify the contravention**, within the time (being not less than two working days) specified in the notice or any other longer time allowed by the responsible authority.*
>
> *(2) If the action is not taken within the time specified in the notice, or any longer time allowed, the responsible authority may -*
>
> *(a) carry out any works and take any other action necessary to rectify the contravention and recover its reasonable costs from the person on whom the notice was served; or*
>
> *(b) apply to a competent court for appropriate relief.*

Any action specified implies that the enforcement officer issuing the notice will provide guidance as to the remedial objectives and activities. The Section does not specifically require that the actions needed are to be remedial to the impacts as a result of the non-compliance, but rather identifies the actions as being needed to bring the specific activity into compliance.

NWA State Bound

Section 156 states that "*This Act* [NWA] *binds all organs of state*." Therefore compliance and enforcement measures may be taken against any institution, including Government itself, for non-compliance of the legislation. This upholds the premise of Section 24 of the Constitution, in that the responsibility includes Organs of State to comply with the applicable legislation.

3.4.1.3 National Water Resources Strategy 2004 (NWRS I)

The purpose of the National Water Resources Strategy (NWRS) (2004) is to:

- Facilitate the proper management of the nation's water resources;
- Provide a framework for the protection, use, development, conservation, management and control of water resources for the country as a whole;
- Provide a framework within which water will be managed at regional or catchment level, in defined water management areas;
- Provide information about all aspects of water resources management; and
- Identify water-related development opportunities and constraints.

The formal Compliance and Enforcement Directorate only commenced in 2010. It is thus not surprising that the 2004 NWRS does not include a strategy for compliance and enforcement. The strategies are focused on resource protection and utilisation from a proactive approach.

3.4.1.4 National Water Resources Strategy 2013 (NWRS 2)

The National Water Resources Strategy 2 (NWRS 2) covers the period 2013-2017. The core water strategies of the NWRS 2 include:

i. Implementation of equity policy – a pro-poor focus based on various factors such as the need to develop infrastructure;
ii. Putting water at centre of integrated development planning and decision-making;
iii. Ensuring water for equitable growth and development;
iv. Contributing to a just and equitable South Africa;
v. Protecting water ecosystems;
vi. Implementing water use efficiency, conservation and water demand management;
vii. Optimising and stretching our water resources;

viii. Achieving effective water governance and development water management (DWM);

ix. Embedding sustainable business principles and practices

x. Implementing a water sector investment framework

xi. Engaging the private and water use sectors.

None of the strategies specifically target compliance and enforcement or rehabilitation of degraded water resources.

3.4.2 Water: Institutional Roles

The Minister of Water and Sanitation is responsible for the overall effective management of water, and custodian of the country's water resources, in terms of the National Water Act, Act 36 of 1998 (the NWA). The Act identifies several tiers of water management institutions in order to achieve its objectives, i.e. National Department of Water and Sanitation, Catchment Management Agencies and Water User Associations. However, watercourses and water resources are not bound by political or municipal boundaries. In order to manage these resources holistically, the water resources are managed per catchment. Therefore, the alignment of the institutions involved in the various aspects of water resources management do not align to the standard National, Provincial and Local Government sphered approach, or to political boundaries. The NWA defines a *Water Management Institution to mean a catchment management agency, a water user association, a body responsible for international water management or any person who fulfills the functions of a water management institution in terms of the NWA.* Figure 3.3 illustrates the structures of the water management institutions in South Africa. These include: Catchment Management Agencies (CMA) whose functions are carried out by the DWS Regional Office (RO) until the CMA is Gazetted, and Water User Associations (WUA). As the various water management institutions are established and take up their functions and powers, it is anticipated that the role of the National Department will change from overall resource manager, to rather focusing on national policy, regulatory framework for water resource management, and overseeing the effective functioning of the water management institutions.

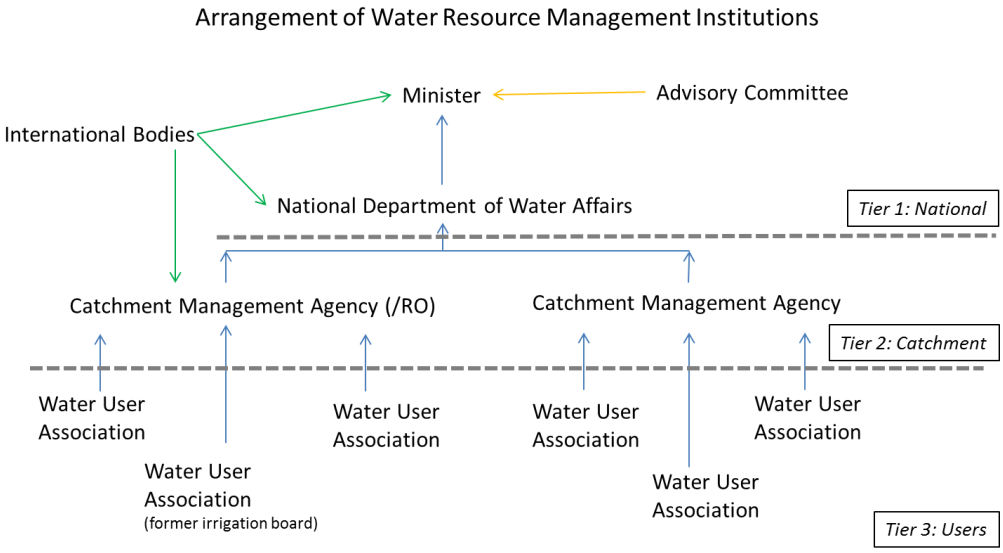


Figure 3.3 Arrangements of the water management institutions in South Africa across the different tiers of water resources management.

3.4.2.1 National Department of Water and Sanitation

Previously the Department was called the Department of Water Affairs. It is now referred to as the Department of Water and Sanitation. In terms of implementation of the water resource management framework, the National Department is still ultimately responsible for the issuing of water use licences, as well as overseeing dams with a safety risk, and determining the ecological reserve requirements per catchment. The Minister delegated powers and functions to the Director-General and the National Department of Water and Sanitation to administer the NWA.

Currently, in terms of enforcement activities, the National Department has the power to issue Directive notices in terms of sections 19(3) for prevention and remedying effects of pollution, 20(4)(d) for control of emergency incidents and 53(1) for rectification of contraventions. The enforcement function of the Department is located within the Branch Policy and Regulation, specifically the Directorate of Regulation. Figure 3.4 illustrates the extensive operational organogram of the Department of Water and Sanitation[8]. The Regulatory Directorate is highlighted.

[8] Structure at time of writing.

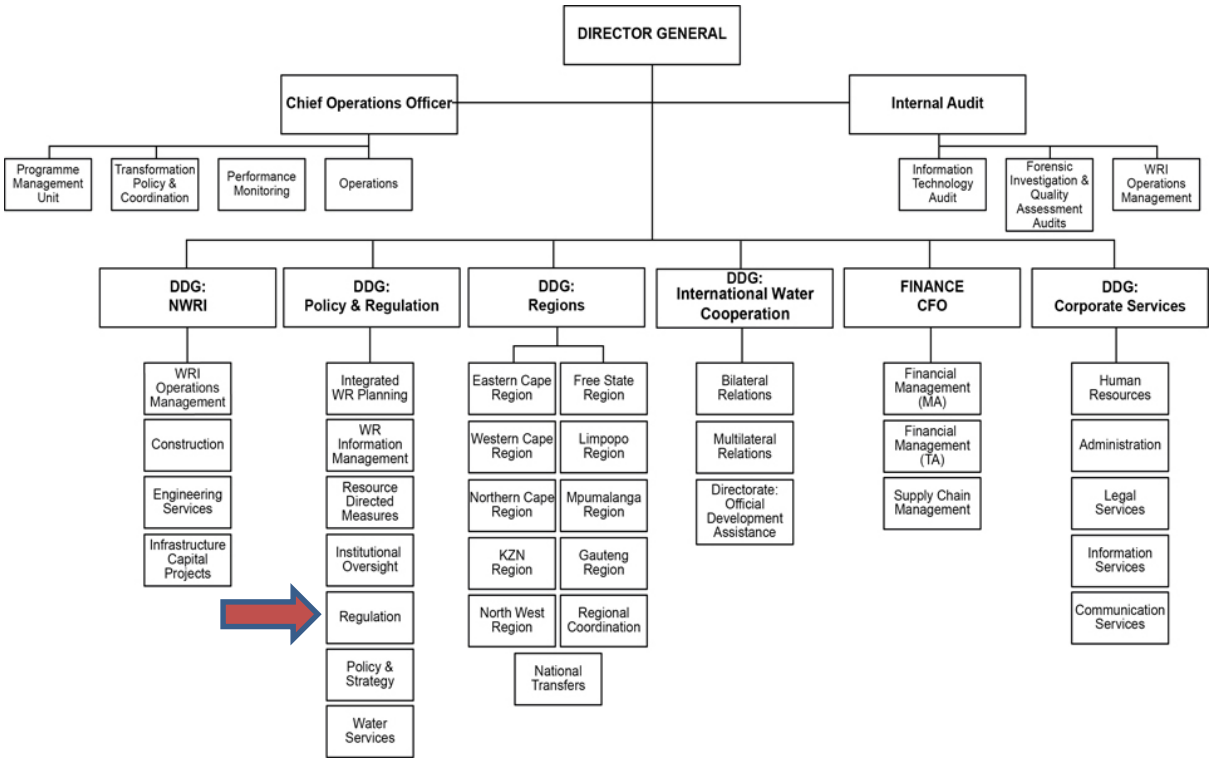


Figure 3.4 Operational organogram of the Department of Water and Sanitation.

Abbreviations:
CFO : Chief Financial Officer
DDG : Deputy Director General
KZN : KwaZulu-Natal
MA : Management Assistant
TA : Technical Assistant
WR : Water Resources
WRI : Water Resource Institution

3.4.2.2 Regional Offices of Department of Water and Sanitation

Regional Offices have been established to assist with the implementation and regulation of the NWA. The Regional Office acts as the proto-CMA for specified water management areas until such time as a CMA is established in the specified catchments. Many of the functions and powers of the Minister have been delegated to the Regional Directors in the Regional Offices in order to implement and operationalize the water resources management framework. The Regional Offices are responsible for the monitoring and regulation of water resources within their jurisdiction. The Regional Offices powers include Sections 19(3) Directive for

prevention and remedying effects of pollution, 20(4)(d) Directive for control of emergency incidents and 53 (1) Directive for rectification of contraventions to issue directives, and Sections 34 and 35 requiring registration of existing lawful water use and requiring application for verification of that use. In terms of Section 40(1) the Regional Office also considers the applications for some water use licences.

In order for a person to carry out their responsibilities of enforcement, suitable persons will require various powers to be delegated or conferred to them. In terms of water resources these include being designated as a ***Peace Officer*** and/or a ***Water Control Officer***. Importantly, people working in compliance and enforcement lines of work will also ultimately need to be designated as *Environmental Management Inspectors (EMI)* in terms of the National Environmental Management Act, Act 107 of 1998 (NEMA) and will then be able to utilise the NEMA powers designated to them within the area designated.

Peace Officer

The **Criminal Procedures Act, Act 51 of 1977 (CPA)** defines a peace officer as including *any magistrate, justice, police official, correctional official as defined in Section 1 of the Correctional Services Act (act 8 of 1959), and, in relation to an area, offence, class of offence or power referred to in a notice issued under section 334(1) of this Act, any person who is a peace officer under that Section.*

It should be noted that a person can only use the powers conferred on them as per their designation notice, and may only use those powers or exercise those duties within the area or jurisdiction as per their notice. To use powers outside of one's designation and jurisdiction may jeopardise the constitutional rights of the offender, the Peace Officer's case, and may lead to criminal action against the Peace Officer in their individual capacity. One of the powers conferred on a Peace Officer is the power to issue a J534 fine. Similarly, a Peace Officer may issue a notice to appear in court in terms of CPA Section 56(1).
It needs to be noted that unless otherwise expressly agreed to by the Department of Treasury, all fines, admission of guilt fines, and fines levied by the courts, are paid into the Treasury and not the Department taking action. Also, unless directed by the courts, rehabilitation works are not carried out where a fine has been paid. Therefore, issuing a fine can be counter-productive to rehabilitating the impacts or effects of detrimental harm to water resources, and ultimately counter-productive

to Section 24 of the Constitution; i.e. if the impact or activity to a water resource is significant or severe, it is better to rather opt for the rehabilitation or remediation rather than an admission of guilt fine. The Departments don't usually budget for carrying out works where the perpetrator has not complied with Directives.

Water Control Officer

According to Section 124(1) of the NWA, *the Minister or a water management institution may, in writing, appoint any suitable person as an authorised person to perform the functions contemplated in section 125(1),(2) and (3).* An authorised person mentioned above, is referred to as a Water Control Officer.

The authorised person must be provided with a certificate of appointment signed either by the Minister or the water management institution, which clearly outlines the authorised person's functions. This certificate must be carried by the authorised person at all times. For ease of use, this is usually captured on an identity card of the authorised person, with the listed functions and relevant statutes on the back. The powers and duties of a Water Control Officer are outlined in **Box 1**.

A Water Control Officer, like most other enforcement inspectors, has the power to enter a property to conduct a routine inspection, e.g. for regular monitoring purposes and without suspicion of non-compliance. However, should the Officer discover a non-compliance or any other offence in terms of his/her mandated legislation, the objective of the inspection changes into an investigation. The main objective of an investigation is to gather sufficient evidence and information in order to make an informed decision regarding further appropriate enforcement action and determine appropriate objectives for rehabilitating the impacts of the contravention. When a routine inspection changes into an investigation, the landowner and/or occupier of the land must be notified of the change in objective and be notified of his/her rights, and to request consent from the landowner/ occupier to continue with the investigation.

Box 1: Powers and Duties of a Water Control Officer, in terms of Section 125 of the National Water Act, Act 36 of 19988.

(1) An authorised person may, at any reasonable time and without prior notice, enter or cross a property with the necessary persons, vehicles, equipment and material in order to carry out routine inspections of the use of water under any authorisation.

(2) An Authorised person may enter a property with the necessary persons, vehicles, equipment and material –

(a) After giving reasonable notice to the owner or occupier of the property, which notice must state the purpose of the proposed entry; and

(b) After obtaining the consent of the owner or occupier of that property, in order to –

(i) Clean, repair, maintain, remove or demolish any government water work operated by any water management institution;

(ii) Undertake any work necessary for cleaning, clearing, stabilising and repairing the water resource and protecting the resource quality;

(iii) Establish the suitability of any water resource or site for constructing a water work;

(iv) Undertake any work necessary to comply with an obligation imposed on any person under this Act, where that person has failed to fulfil that obligation;

(v) Erect any structure and to install and operate any equipment on a temporary basis for monitoring and gathering information on water resources; or

(vi) Bring heavy equipment on to a property or occupy a property for any length of time.

(3) An authorised person may, at any reasonable time and without prior notice, on the authority of a warrant, enter a property with the necessary persons, vehicles, equipment and material, and perform any action necessary to –

(a) Investigate whether this Act, any condition attached to any authorised water use by or under this Act or any notice or directive is being contravened;

(b) Investigate whether any information supplied in connection with the use of water is accurate; or

(c) Carry out any of the activities referred to in subsection (2) where the consent of the owner or occupier of that property has been withheld.

(4) A warrant referred to in subsection (3) must be issued by a judge or a magistrate who has jurisdiction in the area where the property in question is situated, and must only be issued if it appears from information obtained under oath that –

(a) There are reasonable grounds for believing that this Act, any condition attached to any authorised water use by or under this Act or any notice or directive, is being contravened;

(b) There are reasonable grounds for believing that any information supplied in connection with the use of water is inaccurate; or

(c) It is necessary to carry out an activity mentioned in subsection (2) and access to that property has been denied.

(5) If a warrant is likely to be issued if applied for but the delay involved in obtaining the warrant is likely to defeat the object of an inspection in terms of subsection (3)(a) or (b), an authorised person may enter a property without a warrant.

(6) An authorised person entering a property in terms of this Section must, at the request of any person on that property, identify himself or herself and present a certificate of appointment contemplated in Section 124(2).

(7) *Notwithstanding any provision of this Section an authorised person may not under any circumstances, enter a dwelling without the consent of the occupier or without a warrant authorising entry.*

If the landowner/occupier of land does not consent to continuing with the investigation, a warrant will be required to be obtained from a judge or magistrate who has jurisdiction in the area where the property is situated, prior to continuing with the investigation on site. If an Officer is not designated to carry out functions and duties of investigation, then the officer must request assistance from a duly

designated Officer or police official. Alternatively, if contraventions of another statute are discovered, for which the Officer is not designated to enforce, then the contravention must be reported to a suitably designated person in terms of that legislation. For this reason, it is important to keep in good communication with other law enforcement officials, e.g. EMI's (in terms of NEMA) and Extension officers (in terms of CARA). When a routine inspection changes into an investigation, each sample and piece of evidence needs to be collected according to approved sample/evidence collecting Standard Operating Procedures (SOP), to ensure its legality and admissibility in court.

3.4.2.3 Catchment Management Agencies

Catchment Management Agencies (CMAs) form the second tier of water management institutions, after the Department of Water and Sanitation. These are statutory bodies responsible for the management of water resources based on specific catchment areas. A CMA has a governing board, appointed by the Minister, comprised of stakeholders from throughout the catchment area. The CMA is responsible for developing a catchment management strategy (CMS) regarding the management of water resources (balancing user needs, environmental requirements, international requirements, and available resources) within the catchment.

CMA's are intended to carry out resource management at a catchment level, i.e. transposing national policy and framework into tangible management mechanisms. CMA's provide an interface between water users, government that regulates and actual management requirements of the resources. The CMA is responsible to ensure community participation in the resource management, ensure sustainable water use within the catchment, co-ordinate activities utilising/impacting on water resources in order to achieve Integrated Water Resources Management (IWRM), and practice co-operative governance.

According to *Section 80* subject to Chapter 2 and Section 79, upon the establishment of a Catchment Management Agency, the initial functions of a CMA are –

(a) to investigate and advise interested persons on the protection, use, development, conservation, management and control of the water resources in its water management area;

(b) to develop a catchment management strategy;

(c) to co-ordinate the related activities of water users and of the water management institutions within its water management area;

(d) to promote the co-ordination of its implementation with the implementation of any applicable development plan established in terms of the Water Services Act, 1997 (act 108 of 1997); and

(e) to promote community participation in the protection, use, development, conservation, management and control of the water resources in its water management area.

Remedial action is not specifically included as a function of CMA's. CMA's have the powers to issue directives in terms of Sections 19(3) for prevention and remedying effects of pollution and 20(4)(d) for control of emergency incidents, and 53 (1) Directive for rectification of contraventions to issue directives, and Sections 34 and 35 requiring registration of existing lawful water use and requiring application for verification of that use.

Until recently only the Breede-Overberg CMA and Inkomati CMA have been established and gazetted, and are formally operating. These CMA's have been extended in area in May 2014 to form the Breede-Gouritz CMA and the Inkomati-Usutu CMA respectively. These two CMA's have only recently in January 2015 been delegated more powers and functions. Therefore, enforcement functions that rested with the Regional Offices and National Department, have now been delegated to the functioning CMA's.

3.4.2.4 Water User Associations

Water User Associations (WUA's) form the third tier of the water resources management institutions. These operate in a localised part of a catchment. The WUA's will, when established, incorporate the Irrigation Boards established in terms of the Water Act, Act 54 of 1956. WUA's are established by the Minister, in terms of the NWA and are statutory bodies governed by a management committee. According to the NWA Chapter 8 preamble, a WUA's *primary purpose*

is the co-operative association of individual water users undertaking water-related activities for their mutual benefit. This enables users within a localised area to group their resources to enable them to more effectively and efficiently carry out water-related activities. WUA's may be represented on the governing board of the relevant CMA, where they are included in the decision making process together with other water users or sector needs within the catchment. In reciprocity, the WUAs offer the CMA a localised institutional structure in which to implement the Catchment Management Strategy and manage the catchment at the grassroots level.

Water User Associations have no powers of enforcement, but can carry out monitoring activities.

3.4.2.5 Water Tribunal

The Water Tribunal is a function of the NWA, by providing an independent body to which the public may appeal decisions or actions of the Responsible Authority. According to the NWA*, the Water Tribunal is an independent body which –*

(a) Has jurisdiction in all the provinces of the Republic; and

(b) May conduct hearings anywhere in the Republic.

The members of the Tribunal must have knowledge in law, engineering, water resource management or related fields of knowledge.

The following decisions can be appealed to the Water Tribunal *inter alia*:

Section 148*(1) There is an appeal to the Water Tribunal –*

(a) Against a directive issued by a catchment management agency under Section 19(3) or 20(4)(d), by the recipient thereof;

(b) Against a claim by a catchment management agency for the recovery of costs under Section 19(5) or 20(7) by the person affected thereby;

(c) Against the apportionment by a catchment management agency of a liability for costs under Section 19(8) or 20(9), by a person affected thereby;

(h) Against the amendment of a condition of a licence by a responsible authority on review under Section 49(2), by any person affected thereby;

(j) Against a directive issued by a responsible authority under Section 53(1), by the recipient thereof;

(k) Against a claim by a water management institution for the recovery of costs under Section 53(2)(a), by the person against whom the claim is made;

(l) Against a decision by a responsible authority on the suspension, withdrawal or reinstatement of an entitlement under section 54, or on the surrender of a licence under Section 55, by the person entitled to use water or by the licensee; and

(m) Against a declaration made by, directive given by or costs claimed by the Minister in respect of a dam with a safety risk under Section 118(3) or (4).

However, it must be noted that:

An appeal under the above Section 148, subsection (1) of the NWA –

(a) Does not suspend a directive given under Section 19(3), 20(4)(d or 53(1); and

(b) Suspends any other relevant decision, direction, requirement, limitation, prohibition or allocation pending the disposal of the appeal, unless the Minister directs otherwise.

The Act does not make provision for the suspension or altering of Directives. Therefore the following recommendations are not statutory but advised in good faith of responsible water resource management:

- If the Water Tribunal decides against a Directive, the Directive must be withdrawn by the enforcement official that issued the Directive, in writing.
- If the Water Tribunal upholds the Directive, the enforcement official may consider altering the Directive's timeframes to account for the time of the appeal, or other changes the Tribunal deems necessary.
- Where new information/requirements are made, a new Directive must be issued. This however requires the existing directive to be withdrawn and a new Directive with all the relevant information to be issued.

3.4.3 Water: Management Measures

As discussed, the Water Law Principles of 1996 have clearly set out the direction for the management of the country's water resources. In particular the objectives of sustainability and equity are observed threaded through the Principles, the National Water Policy of 1997 and the National Water Act (Act 36 of 1998). According to DWAF (1999:4), "(we) need to recognise and respect the limits to the

degree of utilisation which can be sustained by a water resource before resilience is lost. Resilience in turn depends on maintaining a certain base level of ecological integrity and function. This level, which we call the Resource Base, is critical to the capability of water resources to sustain utilisation, and must be protected" (DWAF, 1999:4). The concept of water resource protection embraces (DWAF, 1999:5):

- "Protection to ensure sufficient water quantity and water quality (especially in relation to human health), to meet basic human needs;
- Protection of ecosystem structure and function, in order to ensure that utilisation of water resources can be sustained in the long term;
- Meeting the water quality requirements of other water users (Agriculture, industry, recreation) as far as possible, within the constraints of requirements for protection of basic human needs and protection of the resources."

As such the Department of Water and Sanitation developed a water resources protection policy. The implementation of this policy rests on the combined use of various regulatory activities. These regulatory activities are grouped into two prongs, namely that of resource directed measures e.g. protecting the physical resources; and that of resource use regulation e.g. authorising the use of the resources. In the context of compliance and enforcement, the tools of enforcement fall under the regulation of use, however the objective of management or rehabilitation fall in the ambit of resource directed measures, thereby requiring that these two prongs of water resources management are not implemented in isolation.

As already discussed, the measures for regulating the use of water resources, i.e. managing demands and controlling impacts on the water resource in order to keep utilisation within the limits (Resource Quality Objectives) required for protection, includes the following instruments:

i. Water use licences (NWA Sections 21):
ii. Schedule 1 use (NWA Section 22): provides for the use of water resources for domestic use such as watering gardens and vegetable gardens for non-commercial purposes, fire-fighting, etc.
iii. Existing lawful use (NWA Section 32): addresses legal uses of water in place prior to the change in Government in1994 and the new National Water Act (Act 36 of 1998), whereby lawful uses do not need to reapply

for water licences before compulsory licensing is requested, provided they were lawfully granted in terms of the previous Water Act, 1956.

iv. General authorisations (NWA Section 39): provides thresholds below which the Section 21 activities do not require a formal licence but the use of the water resource must still be registered.

Measures for the protection of water resources (Resource Directed Measures (RDM)) include the following instruments:

1. Classification of water resources (NWA Section 13);
2. Setting resource quality objectives (RQOs) (NWA Section 13); and
3. The Reserve (NWA Section 16).

Although the resource directed measures are usually set at a reach or segment scale within a catchment, they are still relevant and applicable when setting enforcement-driven rehabilitation objectives, because ultimately the objective of rehabilitation is to rehabilitate the river to the management class and resource quality objective set for the particular water resource.

3.4.3.1 Classification of water resources

In terms of the NWA, the first stage in the protection of water resources is the development of a system to classify the nation's water resources. The Water Resource Classification System has been defined as a set of guidelines and procedures for determining the different Classes of water resources (DWAF, 2007). The Water Resources Classification System (WRCS) is a key framework into which both the Reserve and the Resource Quality Objectives (RQOs) fit. "A key component of classification is an iterative process of evaluating catchment configuration options (scenarios) with stakeholders where the economic, social and ecological trade-offs will be made, and out of which will emerge the allocation schedule, installed modelling system, Class, Ecological Reserve, RQOs and the Catchment Management Strategy (CMS). This process is referred to as the 'Larger Process', or the Compulsory Licensing Process" (DWA, 2011:4). The participation of stakeholders and the engagement with civil society is required to ensure the appropriateness and the acceptability of the WRCS and, ultimately, of the proposed Management Class (DWA, 2011). The Classification of water resources includes setting the Management Classes (MC) for such resources (refer Table 3-3). These Classes give direction to the setting of RQOs (DWA, 2011:4).

Table 3-3 Summary of water resource management classes produced by the Water resources Classification System (DWAF, 2007)

Management Class	**Description**
Class I	Natural – minimal impact of humans, natural water quality and safe for most uses, of high significance. Other classes are defined in terms of degree of deviation from the Natural Class.
Class II	Moderately used/impacted – slightly altered from natural due to human activity.
Class III	Heavily used/impacted – significantly changed from natural due to human activity but nevertheless ecologically sustainable.
Class IV	Unacceptably degraded resources – due to overexploitation. The Management Class is set higher in order to rehabilitate the resource.

NOTE: A water resource can be classified as a Class IV; however a Class IV may not be set as a management class for any resource.

According to DWA (2010a), the procedure for determining the class of a water resource includes*:*

1. Delineating the units of analysis and describing the status quo of the water resource;
2. Linking the socio-economic and ecological value and conditions of the water resource;
3. Quantifying the ecological water requirements and changes in non-water quality ecosystem goods, service and attributes;
4. Determining an ecologically sustainable base configuration scenario;
5. Evaluating scenarios within the Integrated Water Resources Management (IWRM) process;
6. Evaluating scenarios with the stakeholders; and
7. Gazetting the class configuration.

Each class in the classification system needs to state which types of impacts on the water resource are acceptable and which types of impacts are not acceptable in order to protect the resource. The class also needs to state how much water can be used from the water resource. The classification system must satisfy the water quality requirement of users without significantly altering the natural water

quality characteristics of the water resource. It must also take into account the use of water for particular activities that need to be controlled in order to protect the water resource. The classes allow national government to group water resources, based on Present Ecological Status (PES) from those that are in a very good state (class A) to those that are in a very poor state (class F). Each class represents:

- A different level of protection that is required for the water resource, and
- The extent to which the water can be used.

The classification is used to define the present status of the water resource, as well as to define the state towards which the water resource needs to be managed sustainably (future state). This classification is important on a larger scale when setting objectives for river rehabilitation. This classification will help determine the "desired state" of the river, and thereby inform generally the objectives to which the rehabilitation should be aimed. It is however impossible to achieve the desired state of the overall river when addressing rehabilitation on a case by case, or site specific context. However, it should still, where available, be considered in the process.

"The EcoClassification process (Kleynhans and Louw, 2008), a component of the Ecological Reserve determination process, determines the Present Ecological State (PES) of various biophysical attributes of the resource compared to the natural or close to natural reference condition. The purpose of EcoClassification is to understand the causes and sources of the deviation of the PES of the assessed biophysical attributes from those at the reference condition (DWA, 2011:6). The EcoClassification process considers both the *drivers (e.g. hydrology)* and the *responses (e.g. fish)* components. "Each of these "components" has an attendant suite of methods that are used for the assessment of the state of a resource which may range from Natural to Critically Modified. All of the biophysical components are integrated to provide a single Ecological Status or EcoStatus for the river" (DWA, 2011:6). The EcoClassification determines the current health of the water resource, where category A is pristine and category F is completely degraded. Iversen *et* al., (2000) defined the EcoStatus as: "the totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services.

The steps followed in the EcoClassification process are as follows (DEA, 2010):

- Determine reference conditions for each component.
- Determine the Present Ecological State for each component as well as for the EcoStatus. The EcoStatus refers to the integration of physical changes by the biota and as reflected by biological responses.
- Determine the trend (i.e. moving towards or away from the reference condition) for each component as well as for the EcoStatus.
- Determine causes for the PES and whether these are flow or non-flow related.
- Determine the Ecological Importance and Sensitivity (EIS) of the biota and habitat.
- Considering the PES and the EIS, suggest a realistic and practically attainable Recommended Ecological Category (REC) for each component as well as for the EcoStatus.
- Determine alternative Ecological Categories (ECs) for each component as well as for the EcoStatus for the purpose of providing various scenarios.

The EcoClassification process is an integral part of the Ecological Reserve determination method and of any Environmental Flow Requirement method. Flows and water quality conditions cannot be recommended without information on the predicted resulting state, the Ecological Category.

3.4.3.2 Resource quality objectives

"In order to reflect a new and broader perspective on water resources, the term 'water resource quality' is used, rather than simply water quality" (DWAF, 1999:4).

The NWA section 1 (xix) defines *resource quality* to mean:

> *"the quality of all the aspects of a water resource including -*
>
> *(a) the quantity, pattern, timing, water level and assurance of instream flow;*
>
> *(b) the water quality, including the physical, chemical and biological characteristics of the water;*
>
> *(c) the character and condition of the instream and riparian habitat; and*
>
> *(d) the characteristics, condition and distribution of the aquatic biota."*

“The Resource Quality Objectives (RQOs) for a water resource are a numerical or descriptive statement of the conditions which should be met in the receiving water resource, in terms of resource quality, in order to ensure that the water resource is protected” (DWAF, 1999:5). The RQO’s determine both the Management Class of the Classification System as well as the ecological needs determined in the Reserve, into measureable management goals that give direction to resource managers as to how the resource needs to be managed (DWA, 2011).

The compilation of the RQO’s includes the following critical components (DWAF, 1999:5), in order to address each of the aspects of ecological integrity which are necessary for protection of the Resource Base:

- “Requirements for water quantity, stated as Instream Flow Requirements (IFR) for a river reach or estuary, or water level requirements for standing water or groundwater. These are determined according to the current procedures for assessing IFR;
- Requirements for water quality, which are determined on the basis of current guidelines and procedures as set out in the South African Water Quality Guidelines;
- Requirements for habitat integrity, which encompass the physical structure of instream and riparian habitats, as well as the vegetation aspects, which are determined on the basis of the EcoClassification;
- Objectives for biotic integrity, which reflect the health, community structure and distribution of aquatic biota, which are determined on the basis of EcoClassification.”

Targets or objectives are set for each water resource in terms of the level of protection the water resource requires. These objectives provide statements about:

- What the quantity of the water should be (water level, flow patterns, timing);
- What the water quality should be (physical, chemical and biological);
- What the condition of the instream and riparian (river bank) habitat should be;
- What the condition of the aquatic (water) animal and plant life should be.

As the resource quality objectives determine the level of protection for the resource, these must be published as a notice in the *Government Gazette* and must also state:

- The geographical area to which the objectives apply;
- What should be done to achieve the objectives; and
- The date on which the objective should be achieved.

Once the RQOs have been determined and set (gazetted) for a particular resource, then the objective would serve as a basis for management of that particular water resource. In the context of water resources management, the RQO's serve a variety of purposes, including (DWAF, 1999:6):

- "Objectives represent a definite goal for the desired protection level and resource quality status of a water resource, towards which management can be directed. The goal may have to be approached in steps, as part of a long term programme, and then interim objectives can be used to define the steps and the time frame for achievement.
- Objectives provide a clearly understood line between which activities and impacts are acceptable and which are not acceptable. This includes the impacts of point sources, incident sources, land-use and development, and water abstraction;
- Objectives provide quantifiable, verifiable baselines for measuring success of resource management activities and for reviewing the effectiveness of source-directed control and regulatory activities;
- Objectives provide a stable framework, which can be kept in place for an agreed time period, for both resource managers and the regulated community to undertake decision making and planning" (DWAF, 1999:6).

Similar to the classification, these resource quality objectives are important in the process of determining objectives for river rehabilitation. The objectives provide a guideline for the character of the water resource. Again, achieving the overall objectives on site specific approach may be unrealistic, however, the objectives, where *gazetted*, should still be considered in the process.

Note: The procedure to develop and implement Resource Quality Objectives was only published in March 2011 and therefore very few RQO's have been determined and set.

Determination of the RQO's follows a seven step process (DWA, 2011:vi):

Step 1. Delineate the Integrated Units of Analysis (IUAs) and define the Resource Units (RUs)

Step 2. Establish a vision for the catchment and key elements for the IUA's

Step 3. Prioritise and select primary Resource Units for RQO determination

Step 4. Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change

Step 5. Develop draft RQO's and numerical limits

Step 6. Agree Resource Units, RQO's and Numerical Limits with stakeholders

Step 7. Finalize and Gazette RQO's.

The process is holistic to the whole catchment and not erf specific. In theory, the RQO could be used as an objective for guiding rehabilitation of water resources. In terms of enforcement-driven perspective there are two riders to consider:

1. RQO's are determined in terms of the National Water Act, water policy and water principles. It is the function and mandate of the Department of Water and Sanitation to determine the RQO's. Compliance monitoring and enforcement tends to be led by the Department of Environmental Affairs. In terms of integration and coordination the DEA (provincial DEA's) could use the RQO's to guide the rehabilitation objective in the enforcement notices, however, there would need to be a clear agreement as to who would then monitor~~s~~ achievement of the rehabilitation in terms of the RQO.

2. The RQO is set for a resource, as a whole. It may have specific requirements for sub-components of the resource, e.g. tributaries, branches, reaches, etc. In enforcement, it is usually one erf that is concerned; this does not necessarily include both river banks at that point of the river. While it is important to work towards achieving the RQO as a whole, it is not a feasible objective when setting rehabilitation objectives for a specific erf to set the RQO as the

ultimate objective. Rather the RQO should be used to guide the rehabilitation objectives towards contributing to the RQO.

3.4.3.3 The Reserve

The NWA section 1(vxviii) defines the Reserve to mean:

> *"the quantity and quality of water required -*
>
> *(a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No. 108 of 1997), for people who are now or who will, in the reasonably near future, be -*
>
> *(i) relying upon;*
>
> *(ii) taking water from; or*
>
> *(iii) being supplied from,*
>
> *the relevant water resource; and*
>
> *(b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource."*

"The Reserve is intended to protect the resilience of water resources, in order that basic human needs can be met e.g. human health and safety and domestic water supply, and ecological functions and processes can be sustained" (DWAF, 1999:4). In other words, the Reserve is water that is "set aside" to:

- Provide for basic human needs (water as a right to life); and
- Protect water ecosystems (sustain healthy ecosystems).

The Reserve is the only *right* to water in the National Water Act. It therefore has priority over all other water uses. In other words the quantity of water required for the Reserve must be met before water resources can be allocated to other water users. "The Ecological Reserve is not intended to protect the aquatic ecosystem as an end, but rather as a means to maintain aquatic ecosystems in such a way so that they can continue to provide goods and services required by society. (DWA, 2011:5)"

When conducting rehabilitation, taking Reserve requirements into consideration would be necessary in order to ensure abstractions are compliant with licences and to ensure that the Reserve flows are being met. The determination, implementation and achievement of the Reserve should be a measured policy achievement for the water resources regulatory framework.

3.4.3.4 Norms and Standards

Currently there are no specific norms and standards for water resources management or rehabilitation activities. However, there are several guideline documents that pertain to the management and discharge quality of mine water and effluent from waste water treatment works. These guidelines relate to the proactive management of water resources in respect of the activities but do not address the rehabilitation of impacts to the water resources, its ecosystems and functions, should the activities be non-compliant or illegal.

3.5 Other Applicable Legislation

3.5.1 Conservation of Agricultural Resources Act, Act 43 of 1983 (CARA)

The Conservation of Agricultural Resources Act, Act 43 of 1983 (CARA) is applicable to water resources management in so far as the land in an urban area is zoned agricultural, or the land is located outside the demarcated urban edge of a town.

3.5.1.1 Enabling Environment

Principles

The objectives of the Conservation of Agricultural Resources Act, Act 43 of 1983 (CARA), are to provide for the conservation of the natural agricultural resources of the Republic by means of the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants.

Authorising activities

Similar to the activities requiring licensing in the NWA, and the “listed activities” of the NEMA, Section 6 of the CARA makes provision for control measures. A control measure may contain a prohibition or an obligation rather than a formal licence or authorisation contemplated in the NWA or NEMA. However, any land user who refuses or fails to comply with any control measure which is binding on him, shall be guilty of an offence. Applicable control measures, as per GN R1048

of 25 May 1984, relating to potential impacts on or from riparian areas include *inter alia* -

Control measure 4: Protection of cultivated land against erosion through the action of water;

Control measure 6: The prevention of waterlogging and salination of irrigated land;

Control measure 7: The utilisation and protection of vleis, marshes, water sponges, water courses;

Control measure 8: The regulating of the flow pattern of run-off water;

Control measure 9: The utilisation and protection of veld;

Control measure 13: Restoration or reclamation of eroded land;

Control Measure 14: Restoration and reclamation disturbed or denuded land;

Control measure 15: Declaration of weeds and invader plants;

Control measure 16: Indicators of bush encroachment.

One of the biggest impacts as a result of illegal activities within riparian areas, is the resultant soil erosion and sedimentation, either due to bank destabilising, loss of vegetation, altered flow and sediment patterns, or increased erosive power of the watercourse. The CARA is predominantly focused on the conservation of soil resources, and agricultural impacts to water resources, and is not up to date with modern environmental norms and principles. However it is still an important and applicable statute when addressing objectives for enforced river rehabilitation; in many instances non-compliance with relevant control measures is also a non-compliance in terms of the NEMA and NWA.

Compliance and Enforcement

The CARA enforcement mechanisms include Section 7(1) Directive, and the Directives included in the GN R1048 in relation to control measures. (Where the executive officer refers to Department of Agriculture)

Section 7 Directives

(1) The executive officer may, by means of a direction, order a land user to comply with a particular control measure which is binding on him on or with regard to the land specified in such direction, or if it is, in the opinion of the executive officer, essential in order to achieve the objects of this Act, to perform or not to perform any other specified act on or with regard to such land.

(2) Any such direction may provide that any requirement imposed therein shall be complied with in the manner or within the period specified in the direction.

Directives in terms of non-compliance with specific control measures listed in the GN R1048 include *inter alia* GN R1048 Section 4(2), Section 6(2), Section 13(2), Section 14(2) and Section 16(3) directives:

Section 4(2) *If the executive officer is satisfied that the measures applied by a land user in a particular case in terms of sub-regulation (1) are not sufficient to protect cultivated land effectively against excessive soil loss as a result of erosion through the action of water, he may direct such land user in writing to apply such additional measures as the executive officer may determine.*

Section 6(2) *If the executive officer is satisfied that the measures applied by a land user in a particular case in terms of sub-regulation (1) are not sufficient to protect irrigated land effectively against waterlogging or salination, he may direct such land user in writing to apply such addition measures as the executive officer may determine.*

Section 13(2) *If the executive officer is satisfied that the measures applied by a land user in a particular case in terms of sub-regulation (1) are not sufficient to restore or reclaim land on which excessive soil loss due to erosion occurs or has occurred, he may direct such land user in writing to apply such additional measures as the executive officer may determine.*

Section 14(2) *If the executive officer is satisfied that the measures applied by a land user in a particular case in terms of sub-regulation (1) are not sufficient to restore or reclaim disturbed or denuded land effectively, he may direct such land user in writing to apply such additional measures as the executive officer may determine.*

Section 16(3) *One or more of the following practices shall be followed with regard to communities of indicator plants contemplated in sub-regulation (2) in order to remove the cause of the deterioration of the natural resources and to improve and maintain the production potential of the natural pastoral land:*

(a) uprooting, felling or cutting;

(b) treatment with a weed killer that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;

(c) the application of control measures regarding livestock reduction or removal of animals in terms of regulations 10 and 11;

(e) any other method or strategy that may be applicable and that is specified by the executive officer by means of a directive.

Similar to the Section 7 Directive, persons designated as Executive Officer in terms of section 4(4)(a) of the CARA, may be designated to issue Directives in terms of the GN R1048 dated 1 June 1984.

3.5.1.2 Institutional Roles: Department of Agriculture, Forestry and Fisheries

The agricultural sector is regulated by the National Department of Agriculture, located in the Ministry of Agriculture, Forestry and Fisheries (DAFF). In order to carry out its function within the provinces, provincial Departments of Agriculture are located within the provincial spheres of government. However most of the enforcement functions are carried out by the National Office, in particular, by the Programme: Sustainable Resources Management and Use, which is located in the Branch of Forestry and Natural Resources Management. The programme aims to promote the sustainable management of agricultural land and water resources. It achieves this objective by developing policies, norms and standards for the management and use of land and water resources in the agricultural sector. The Programme comprises two Directorates, that of Water Use and Irrigation Development, and Land Use and Soil Management.

<u>Directorate: Water Use and Irrigation Development</u>

The main purpose of this Directorate is the promotion and regulation of agricultural water management, the establishment and maintenance of water management infrastructure, and the promotion of effective irrigation policies and systems. The Directorate is mandated to manage water resources in the agricultural sector and is responsible for ground water, surface water, as well as soil water. The Directorate functions in terms of the Conservation of Agricultural Resources Act, Act 43 of 1983 (‘CARA’)

Directorate: Land Use and Soil Management

The purpose of this Directorate is to render services pertaining to agricultural land use and soil management. It is mandated to promote and coordinate the conservation of natural resources on agricultural land in terms of the follows legislation:

- The Conservation of Agricultural Resource Act, Act 43 of 1983 ('CARA');
- The Agricultural Pests Act, Act 36 of 1983;
- The Subdivision of Agricultural Land Act, Act 70 of 1970;
- The Fencing Act, Act 31 of 1963

In terms of the CARA, Section 6 Control Measures outline the particular activities for which enforcement can take place, and is of relevance to enforced rehabilitation of rivers. The specific control measures have already been discussed. Section 4 of the CARA, outlines the powers of investigation of an executive officer and an authorised person. Only an executive officer may issue a directive to comply with control measures. An officer of the department is designated as an executive officer by the Minister. Only officials of the National Department are designated as executive officers. Where schemes, such as soil conservation schemes are still being implemented by the provincial offices, there may be a designation of an official within the provincial office as an executive officer.

In terms of section 4(4)(a), a municipality may be designated as an Executive Officer, which in turn empowers them to issue Section 7 Directives. Similarly, the subsection also identifies Irrigation Boards in terms of the Water Act, Act 54 of 1956, for delegation as Executive Officer. The Water Act of 1956 has been repealed in part by the National Water Act, Act 36 of 1998. A number of Irrigation Boards have been converted to the NWA Water User Associations, however many are still to be converted.

3.5.1.3 Management measures

The management measures provided for in terms of the CARA refer to the control measures in terms of Section 6 of the Act. The control measures outline a minimum standard for the control and management of agricultural soils with regard to particular activities.

3.5.2 Promotion of Administrative Justice Act, Act 3 of 2000 (PAJA)

The Promotion of Administrative Justice Act, Act 3 of 2000 (PAJA) requires "*administrative action to be lawful, reasonable and procedurally fair and the right to written reasons for administrative action, as provided for in Section 33 of the Constitution of South Africa 1996.*" Therefore the PAJA requires administrators (which includes an Organ of State or any natural or juristic person taking administrative action) to be accountable for their decision making. The PAJA goes on to define a decision as:

> *"any decision of an administrative nature made, proposed to be made, or required to be made, as the case may be, under an empowering provision, including a decision relating to – inter alia:*
>
> *(a) Making, suspending, revoking or refusing to make an order, award or determination;*
> *(b) giving suspending, revoking or refusing to give a certificate, direction, approval, consent or permission;*
> *(c) issuing, suspending, revoking or refusing to issue a licence, authority or other instrument;*
> *(d) imposing a condition or restriction;*
> *(e) making a declaration, demand or requirement."*

The decision making relating to activities in or along watercourses lies with many different institutions, and at various sphere of government. In terms of the PAJA, all these decision makers are accountable for their decisions. In the context of good governance, administrators should be making coordinated decisions. "With regard to procedural constitutional rights, such as the rights to administrative justice and access to information, these procedural requirements are vital to a constitutional dispensation as these require the State to act in accordance with fair procedures when implementing its constitutional mandate" (Feris in Paterson and Kotze, 2005:145). Feris continues to caution, that by the same token however, procedural requirements can be utilised to ensure that the State acts lawfully when its actions (or lack of action) impact on the environment.

3.5.3 Inter-Governmental Relations Framework Act, Act 13 of 2005 (IGRFA)

In light of the gaps in coordination between institutions, the Inter-Governmental Relations Framework Act, Act 13 of 2005 (IGRFA), establishes a framework for

the national government, provincial governments and local governments to promote and facilitate intergovernmental relations and to provide for mechanisms and procedures to facilitate the settlement of intergovernmental disputes.

Chapter 3 of the IGRFA provides for Organs of State (as defined in the Constitution) to enter into an implementation protocol as an Agreement where the implementation of a policy, the exercise of statutory power, the performance of a statutory function or the provision of a service depends on the participation of Organs of State in different spheres of government. As such, implementation protocol guidelines and guidelines on managing joint programmes were promulgated in terms of Chapter 5 of the IGRFA.

The framework extends the principles of participation and co-ordination between Organs of State in the different spheres of government in terms of the IGRFA, to also include integration, participation and co-ordination of joint programmes within a particular Sphere of Government. The Framework defines joint programmes as "(t)hose programmes that transcend the conventional organisational boundaries in planning, budgeting and implementation resulting in a number of departments /agencies /ministries responsible for one aspect of the programme, although none is responsible for it in its entirety." To this end, this is also applicable to the management of water resources within the environment, and as such, to enforcement and regulation of NWA, CARA, NEMA etc. by the Departments of Environmental Affairs, Department of Water and Sanitation and Department of Agriculture, especially for determining procedures for rehabilitation activities in urban river reaches.

While authorisations can be issued as integrated-authorisations in order to streamline a very tedious and costly process, the actual enforcement process needs to use all enforcement mechanisms available in order to highlight the "significant harm" to the environment, and support cases going to prosecution. Where targeted enforcement operations, such as the Green Scorpions Operation Ferro, and Paper and Pulp, were carried out, there have been good examples of this coordinated enforcement approach and exercising of all applicable enforcement mechanisms. However, for smaller cases and complaints, usually the Department responding to the complaint carries out the enforcement with occasional input from other Departments. Coordination in these smaller cases is necessary, and the tools developed in this research aim to improve both the coordination and accountable decision making by the administrators.

3.6 Concluding remarks

The South African water resources management regulatory framework comprises three statutes, namely that of the Constitution of the Republic South Africa, Act 108 of 1996, the National Environmental Management Act, Act 107 of 1998 (NEMA) and the National Water Act, Act 36 of 1998 (NWA). In particular the NEMA and NWA are tasked with translating the environmental right enshrined in Section 24 of the Constitution into resource management legislation that then enables the practical implementation of sustainable resource utilisation and protection for the achievement of Constitution Section 24. The NEMA applies an anthropocentric approach to its framework structure, whereas the NWA applies an eco-centric approach placing water resources at the centre of its policy. The principles of these statutes clearly identify the role of remedial (rehabilitation) activities as a component of sustainable resource utilisation and management; however this is "lost" in the actual Sections of the legislation. Similarly, the enforcement mechanisms provided by the legislation are appropriate, but the crucial Sections lack guidance in terms of actually identifying the ecological impacts as a result of contraventions and setting appropriate rehabilitation objectives.

4 CRITICAL EVALUATION OF THE SOUTH AFRICAN WATER RESOURCES REGULATORY FRAMEWORK

"South Africa appears sufficiently armed with the necessary environmental compliance and enforcement instruments and agents to facilitate the attainment of a sustainable, healthy and safe environment. There are however, some lacunae in this system" (du Plessis, 2005:41). The question is posed: "A*re the fundamental principles of section 24 of the Constitution being upheld through the enforcement and regulatory framework, with regard to the management of the country's water resources?*" It is not adequate to merely monitor performance of the environmental regulatory governance against the criteria of good governance alone, but rather to measure the outcomes of the environmental regulatory governance. For this purpose, this research conducts a critical evaluation of the environmental regulatory governance currently in place and identifies the challenges it faces.

In order to satisfy this evaluation, the following questions need to be addressed:

1. Are the constitutional responsibilities of section 24 of the Constitution being upheld in the water resources governance and enforcement framework, especially in terms of rehabilitation?

2. What are the challenges of the governance framework and how can they be remedied?

4.1 South African public policy management mechanism

The effective assessment of governance requires the implementation of effective public policy planning, monitoring and evaluation. Cloete (2009) explains that until 2006 there was no coherent systematic monitoring and evaluation of South African public policy. The prevailing international mechanism for policy analysis and management is known as evidence-based policy analysis. There is no definitive link that has been established between the availability of better information and resultant better quality decisions and outcomes, however Bamberger (2008:128, in Cloete, 2009:294) suggests that evidence-based policy analysis and assessment have the potential to improve the quality of policy decisions, actions and consequences.

"Evidence-based policy is an approach to policy analysis and management that helps people make well informed decisions about policies, programmes and

projects by putting the best available evidence at the heart of policy development and implementation (Segone, 2008:27, quoting Davies" (Cloete, 2009:295).

Policy monitoring is defined as being the regular, systematic collection of data of specified indicators to determine the levels of progress and the achievement of goals and objectives. Policy evaluation, on the other hand, is defined as a systematic judgement or assessment of the policy programmes. It can include a systematic assessment of:

- resources;
- organisational processes to convert such resources into policy outputs or products; and
- the extent to which these policy programmes have the intended results in the form of outputs, outcomes or impacts, measured against envisaged goals and objectives.

Cloete (2009:295) highlights that a systematic, evidence-based assessment can only be undertaken if the evidence is available to assess. The evidence is reliant on the monitoring and reporting of activities and outcomes.

In South Africa until 2005, performance evaluations and reporting were limited to individual staff performance evaluations; policy programme monitoring and evaluation was not undertaken, managed or coordinated in the South African Public Service (Cloete, 2009). Where evaluation activities were undertaken, it was sporadic and conducted by the line function departments for purposes of their annual department reports.

In light of the lack of a formal monitoring and evaluation framework, the following considerations *inter alia* motivated a Cabinet decision in 2005 to develop the Government-wide Monitoring and Evaluation System (GWM&ES) (Cloete, 2009:298):

- The need for regular national government report-backs to the International UN Millennium Goals Initiative on the country's progress with halving poverty in SA by 2014 (e.g. UNDP 2005);
- South Africa was the host of the World Summit on Sustainable Development in 2002 but however at that time did not have any national M&E system to assess sustainable development as required by the Rio Convention of 1992 and reiterated at the Johannesburg Summit;

- The undertaking by the South African president to regularly inform citizens about progress with the Government's National Programme of Action (POA);
- The fact that donors are increasingly requiring systematic M&E of projects and programmes that they fund, in order to protect their investments; and
- Institutionalising national M&E systems has proven to be international good governance practice.

According to Cloete (2009:298), the initial GWM&ES proposal was revised and updated in 2007, mainly because the timeframes specified in the original 2005 proposal were too optimistic and because more clarity about how the system should be implemented had by then started to emerge (Presidency, 2007a and 2007b). However, the updated 2007 GWM&ES implementation plan still contained no detailed implementation strategy and no times frames to fully establish the system. Furthermore, Cloete (2009) found that the various aspects of the plan were allocated to different institutions including Treasury, StatsSA, DEA, and the Department of Local Government, amongst others. DEA are responsible for assessing the state of the environment and sustainable development [where water resources are a component of the environment]. Unfortunately, there was no corresponding integrated hierarchical structure and no indication of lines of authority and interlinking processes available to link responsibilities and reporting outcomes. Cloete (2009:298) observed that it seemed the GWM&ES had more of an emerging network nature at the time.

Within the ambit of the proposed GWM&E System, the Presidency, in consultation with StatsSA, developed a National Indicator Initiative. The initial series comprised 72 preliminary generic policy assessment indicators and was published in 2007 in the form of a Framework of Mid-term Development Indicators for SA, covering the following sectors (Presidency 2008):

- Economic growth and transformation;
- Employment;
- Poverty and inequality;
- Household and community assets;
- Health;
- Education;
- Social cohesion;
- Safety and security;

- International relations; and,
- Good governance.

A second version of the framework was published with slight adaptations to the first version, now containing 76 indicators. Noticeable in its absence, the first version list of sectors excludes the environment. However the revised list now contains an environmental indicator referring to greenhouse gas emissions in the good governance category. The DEA has compiled an extensive list of environmental indicators for its State of the Environment Report, but the problem with this situation is that these indicators are not yet integrated into the main set of GWM&ES indicators for the Presidency (Cloete, 2009:301).

It is difficult to compare the GWM&ES in more detail with other systems because it is still a developing system that has not really taken root as it is supposed to do. "The GWM&ES in its 2009 form was nothing more than an emerging M&E framework based on a collection of disparate documents published by different departments, each from its own line function perspective" (Presidency, 2007b cited in Cloete, 2009:303). Furthermore it promotes minimum uniform structures and processes in order to ensure a minimum compatibility of data in the different spheres of government (Presidency, 2007b). Cloete further highlighted that the GWM&ES has not been enforced yet and the original timeframe for its implementation has already been exceeded, and therefore accepts as a departure point, that there are divergent and unequal M&E capacities in government. Cloete (2009:303) continued to observe that the most serious weakness of the emerging GWM&ES framework was that it did not contain any suggestions of the focus or contents of ***what*** needs to be monitored and evaluated, i.e. the framework only focused on ***how*** monitoring and evaluation activities in government and in other supplementary agencies should be structured, with the result that many of the indicators identified were output indicators rather than outcome indicators i.e. they did not provide an actual measure of achievement. "It was concluded in the GWM&ES that the focus of M&E activities in government was still too strong on output evaluation and that it should in future be refocused on outcomes evaluation" (Presidency, 2007a).

The establishment of the GWM&ES in 2005 was a major step forward for good governance in South Africa (Cloete, 2009:308) and despite its shortcomings, filled a gap in terms of policy performance evaluations. Subsequently, in 2009, the M&E

framework shifted to an outcomes-based monitoring (MPAT) model, which identified 12 outcomes as key priorities for government reporting. "Based on the Election Manifesto and the Medium Term Strategic Framework, a set of 12 outcomes were developed through extensive consultation and discussion at both Ministerial and administrative levels" (DPME, 2010:13). These outcomes reflect the desired development impacts government seeks to achieve through its policy priorities. The 12 key priority areas were later reduced to 11, and include (Molepo, 2011) *[own emphasis]*:

Outcome 1: Education
Outcome 2: Health
Outcome 3: All people in South Africa are and feel safe
Outcome 4: Employment
Outcome 5: Economic infrastructure
Outcome 6: Rural development
Outcome 7: Human settlements
Outcome 8: Local Government and services
Outcome 9: Protect and enhance our environmental assets and natural resources
Outcome 10: Create a better South Africa, a better Africa and a better world
Outcome 11: An efficient, effective and development orientated public service and an empowered fair and inclusive citizenship.

Note that Outcome 9 specifically includes environmental outcome reporting.

The aim of the outcomes approach is to clarify what Government expects to achieve, how Government expects to achieve it and to know when Government has achieved it (DPME, 2010:9). "By improving outcomes, rather than outputs, means doing things differently in order to increase the impact Government has on improving the lives of citizens" (DPME, 2010:9).

In terms of the MPAT outcomes based monitoring model, and specific reference to Outcome 9: Environmental assets and natural resources, outcomes were reported by the Department of Monitoring and Evaluation (DPME) in the Midterm Review 2012. Previously the Department of Environmental Affairs produced regular "State of the Environment Reports". These reports provided a general indicator of the state of the various components or sectors that make up the South Africa environment, including inland waters, marine (ocean) waters, wetlands, grasslands, rangeland, deserts, etc. This report has subsequently been altered to

the “South African Environmental Outlook”. It however still provides a general overview of the environment according to components, but does not specifically report on the state of health of the environment, i.e. by using standard indicators and measures to enable one to track the progress and improvement over the years of various initiatives.

In the DPME’s Midterm Review 2012, the report provides a general status of the South African environment, is this case based on the 2006 State of the Environment Report (SOER). Based on this status the Government set itself certain objectives. The MidTerm Review 2012 provides a report back against these objectives since 2009 when the MPAT was implemented.

The DPME MidTerm Review Report (2012) noted that according to the State of Environment Report 2006 (DEA, 2006), South Africa needs to respond to declining groundwater reserves, water quality and the integrity of the country’s ecosystems. Furthermore, that about 34% of the country’s terrestrial ecosystems, 82% of its main river ecosystems and 65% of its marine biozones were threatened, and 50% of the wetlands had already been destroyed and living marine resources were either maximally or over-exploited. Water demand was expected to rise by 52% over the next 30 years, while the supply of water was likely to decline if current trends, due to leakage from old and poorly maintained municipal infrastructure and the loss of wetlands, persisted.

The DPME (2012:35) acknowledged that the cause of deterioration in water quality was not as a lack of the appropriate tools for measurement and intervention, but rather a systematic eroding of management through poor institutional arrangements, insufficient capacity, convoluted decision-making requirements, lack of delegated authority and accountability, and poor use of incentives, disincentives and regulation to address the water quality problems.

In order to address these problems and challenges, the Government committed itself to ensuring the long-term sustainability of natural systems and the environment by addressing four critical problems (DPME, 2012:35):

i) To improve the quality and quantity of water resources by reducing water loss from distribution networks from a level of approximately 30% in 2010 to 15% in 2014.
ii) To increase the number of wetlands rehabilitated from 75 in 2010 to 150 per year in 2014.

iii) To significantly increase the number of rivers with healthy ecosystems from 8 in 2010 to 16 by 2014.

iv) To improve capacity to treat wastewater, by upgrading 80% of sewage and wastewater treatment plants by 2015 and increasing the percentage of wastewater treatment plants meeting water quality standards from 40% in 2010 to 80% by 2014.

With regard to commitment (i), while reducing water loss from distribution networks, may reduce demand, and thereby increase quantity of water resources, the water lost through leaks in the distribution system is not also lost to the environment. The leaked water either infiltrates into the groundwater, evaporates, or runs off back to river; therefore by reducing leakages does not provide additional water to the system, but it will rather reduce demand to a small degree. Similarly, reducing the leakages from the distribution network does not contribute to improved water quality. Lastly, leaking distribution networks is a function of Outcome 8: local government and infrastructure, and contributes towards section 27 of the constitution in respect of access to water.

With regard to commitment (ii) the outcome of rehabilitating the wetlands could be a more useful objective, i.e. area (ha) of functioning wetland rehabilitated as the measure rather than number of wetlands rehabilitated. Every leaking pipe will create an accidental wetland; by simply counting the number of wetlands rehabilitated does not given an indication of volume of wetland function rehabilitated.

With regard to commitment (iii), only 8 of the approximately 284 rivers in the country are considered to have healthy ecosystems, and the DPME objective is to increase this only to 16. This is less than 6% of the rivers in the country, and far short of the 82% of river ecosystems that are threatened (DPME, 2012; DEA, 2006). This commitment falls short of section 24(b)(i) of the constitution to have the environment protected especially with regard to preventing pollution and ecological degradation.

Commitment (iv) is somewhat over-ambitious in its measurable, as 2014 was an election year and no one votes for working sewerage works over houses and schools. However, improving the number of wastewater treatment works complying

with discharge standards will contribute to both improved water quality and improved ecosystem health of the country's rivers.

In addition to the four commitments above, "with respect to sustainable environmental management, government also committed itself to **restoration and rehabilitation such that degraded ecosystems are reduced from 75% in 2010 to 55% in 2014**, and to increasing the hectares of land rehabilitated per year from 800 000 in 2010 to 3 200 000 hectares in 2014. A commitment was also made to integrate environment considerations into the spatial development frameworks of 25 municipalities" (DPME, 2012:36) [own emphasis].

With regard to the challenges in the current public policy Monitoring and Evaluation (M&E) framework performance, Molepo (2011) has identified the following shortcomings:

- There is a lack of integrated statistical system driven by strategic priorities with outputs and outcomes indicators;
- There is no reliable and coordinated reporting mechanism (Duplication on information requests to departments/provinces; burden);
- There is inadequate training;
- Most government departments have not as yet institutionalised M&E (beyond Human Capital reporting);
- There is lack of adequate funding to conduct evaluations (budgeting constraint due to poor institutionalisation);
- There is lack of balance between supply (evidence) & demand (reporting and indicators) side of M&E;
- There is lack of management support & buy-in;
- There is inadequate guidelines to conduct M&E;
- There is inadequate networking & benchmarking.

4.2 Critical evaluation

Section 24 of the Constitution provides for the environmental right, as discussed in previous sections. However, an "environment that is not harmful, protected, etc." is an intangible outcome objective of the constitution, similarly "sustainability" is an intangible impact and outcome. Therefore to measure and report on the achievement of such a right requires a critical evaluation of the policy framework that is aimed at achieving this right. This is done through indicators. Reporting on

the performance of Organs of State, statutes and management measures is monitored by indicators, both qualitative and quantitative. Walmsley *et* al., (2004) highlight that the significance of the information that the indicators provide extends beyond that directly associated with the indicator itself. This research conducts a critical evaluation of the environmental enforcement regulatory and governance framework in water resources management with regard to rehabilitation, using a set of indicators. The indicators are reviewed against the three pillars of the South African environmental regulatory framework i.e. the enabling environment, the institutional roles and the management instruments, to determine any implementation or operational challenges in the framework.

This research derived indicators for the purpose of the evaluation framework. These indicators were derived from the criterion promoted in the Good Governance Guide (Exiner, 2012) in Chapter 2 and the selection of criteria proposed by the International Network for Environmental Compliance and Enforcement (INECE, 2008). In order to determine if the governance and regulatory framework is achieving its Constitutional responsibilities in terms of section 24, the first step of the evaluation is to determine if the governance and regulatory framework is relevant to the objective? To determine this, the framework uses the indicators of relevance, responsive, adequate and effective. The second step of the evaluation is to determine the functionality of the regulatory framework to achieve its responsibility? Supporting indicators for this step include capacity, capability, and importantly, accountability. The final step of the evaluation is to determine if section 24 of the Constitution is being achieved; and importantly is it being reported on. The indicators used in the evaluation are either process or performance indicators, where:

- *Process indicators:* Describe the qualitative and/or quantitative characteristics of a process. They measure ways in which services and goods are provided.
- *Performance indicators:* Provide information about the achievements or outcomes of an activity, a process or an organization.

The evaluation framework and indicators is summarised in Table 4-1.

Table 4-1 Summary of evaluation framework

Evaluation Criteria	Indicator	Question
Step 1: Relevant *Is the regulatory framework relevant to section 24 of Constitution in the context of water resources management?*	**Relevance**	Is the framework relevant to water resources management, compliance and enforcement, and rehabilitation?
	Appropriate	Is the regulatory framework fitting for enforcement-driven rehabilitation of urban watercourse reaches?
	Responsive	Does the regulatory framework respond to enforcement-driven rehabilitation?
	Adequate	Is the regulatory framework satisfactory to the context of enforcement-driven rehabilitation?
	Effective	Does the regulatory framework promote the best use of resources?
Step 2: Functionality *Can the regulatory framework actually achieve section 24 of the Constitution?*	**Capacity**	Are there sufficient resources, especially human resources, to implement the regulatory framework?
	Capability	Are the resources above, enabled to conduct the implementation of the regulatory framework?
	Accountability	Are the resources and relevant Organs of State held accountable for achieving the constitutional objective?
Step 3: Outcomes *What is the current outcome of the regulatory framework in terms of water resources management and enforcement-driven rehabilitation?*	**Achievement**	What are the outcomes of the regulatory framework?
	Reporting	Are there reports available to monitor the outcomes?

As highlighted in the previous section, there is a lack of monitoring and evidence available to conduct a formal outcome-based framework review. The critical evaluation is based on the author's observations and substantiated with evidence from the legislation, annual reports and literature, where available.

The evaluation used both qualitative and quantitative indicators to conduct the critical evaluation, to determine if the South African water resources management

regulatory governance framework is achieving its constitutional responsibilities in respect of section 24, in particular with regard to rehabilitation.

The critical evaluation of the South African water resources management regulatory governance framework is discussed in the following sections.

4.3 Relevance

The relevance indicator questions whether the regulatory framework is important to the matter at hand. In other words, is the regulatory framework relevant to the achievement of section 24 of the Constitution; and is the regulatory framework relevant to enforcement-driven rehabilitation of watercourses?

This indicator purely looks at the relevance of the regulatory framework to the topic of achievement of section 24 of the Constitution and enforcement-driven rehabilitation of watercourses. The critical questions of whether this is actually adequate, appropriate or effective are evaluated under other indicators.

4.3.1 Enabling environment

Section 24 of the Constitution states that [own emphasis]:

> *"Everyone has the right-*
> *(a) to an environment that is not harmful to their health or well-being; and*
> *(b) to have the environment protected, for the benefit of present and future generations,* ***through reasonable legislative and other measures*** *that-*
> *(i) prevent pollution and ecological degradation;*
> *(ii) promote conservation; and*
> *(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."*

Both the National Environmental Management Act, Act 107 of 1998 (NEMA) and the National Water Act, Act 36 of 1998 (NWA) are reasonable legislative measures that give legislative effect to section 24 of the Constitution. This is demonstrated through the principles of both statues discussed in the previous chapter. Furthermore, both statutes include provision for compliance and enforcement. Therefore the enabling environment provided by the NEMA and the NWA are both relevant to the achievement of section 24 of the Constitution and by implication to enforcement-driven rehabilitation.

4.3.2 Institutional Roles

Both the Department of Environmental Affairs (DEA) and the Department of Water and Sanitation (DWS) (at their various spheres of Government) are mandated to implement the NEMA and NWA statutes respectively. Furthermore, both of these Departments include directorates for compliance and enforcement of their respective legislation. Therefore the institutional roles mandated to the DEA and DWS are both relevant to the achievement of section 24 of the Constitution and to enforcement-driven rehabilitation by implication of their guiding legislation.

4.3.3 Management Instruments

By inference of the NEMA and NWA being the key legislation giving effect to section 24 of the Constitution, the management measures provided for by such legislation are therefore relevant to the achievement of section 24 of the Constitution, and to enforcement-driven rehabilitation of watercourses.

4.3.4 Discussion

The regulatory framework, as discussed in Chapter 3, is relevant through the enabling environment, institutional roles and management measures to the matter in hand, i.e. the achievement of section 24 of the Constitution and enforcement-driven rehabilitation of watercourses.

4.4 Appropriateness

The appropriateness indicator questions whether the regulatory framework is fitting for a particular purpose. In other words, is the regulatory framework fitting or suitable in terms of achievement of section 24 of the Constitution, and is the regulatory framework fitting or suitable for the enforcement-driven rehabilitation of watercourses?

This indicator purely looks at whether the regulatory framework is appropriate to the topic of achievement of section 24 of the Constitution and enforcement-driven rehabilitation of watercourses. The critical questions of whether this is actually adequate or effective are evaluated under other indicators.

4.4.1 Enabling environment

The NEMA makes several provisions for environmental management, including the various strategic Acts that are component specific, i.e. the Waste Act, Biodiversity Act, Protected Areas Act, etc. The NEMA provisions only provide management mechanisms for the current and future management of environmental resources

and do not include provisions for the redress or retrospective management or rehabilitation of past poor management or environmental degradation. The provisions of the NEMA, as discussed in Chapter 3, include authorisation permits and various integrated planning measures.

The role of enforcement-driven rehabilitation has been outlined in Chapter 2 of this thesis. In this context, the NEMA makes provision for enforcement measures as discussed in Chapter 3, but these measures fall short with regard to effective rehabilitation of ecological degradation (see Chapter 5) as result of the non-compliance or illegal activities.

The NEMA section 28 directive includes the remedying of the effects of pollution or degradation as a requirement. However the *effects* of the pollution or degradation are not defined, either in scope or limitation (i.e. spatially or time-bound). Noteworthy is that the NEMA section 28 was amended to include provision for application to environmental degradation prior to the Act (section 28(1)(1A)). This is an important inclusion, as it is the only mechanism that provides for the NEMA to retrospectively address environmental degradation, which as highlighted earlier in this research, is a critical component to achieve section 24 of the Constitution.

The NWA makes several provisions for the sustainable management and utilisation of water resources. These include both principles and measures to achieve water reform and redress past water issues as well as measures for the current and future management of water resources. These management mechanisms include various licences and permits, general authorisations and existing lawful uses as discussed in Chapter 3. In theory, these provisions are appropriate to contribute towards the achievement of section 24 of the Constitution, however they are limited in success to their physical implementation and monitoring.

The role of enforcement-driven rehabilitation has been outlined in Chapter 2 of this thesis. The NWA makes provision for enforcement measures. The section 19(3) and 20(4) directives include remedial action in their précis; however the section 53(1) directive does not.

Furthermore, the NWA section 20(4)(a) states that "*a responsible person must take all reasonable measures to contain and minimise the* ***effects*** *of the incident, (b) undertake clean-up procedures; (c) remedy the* ***effects*** *of the incident…*[own emphasis].*"* The section 20(4) directive is only appropriate to emergency incidents, which is clearly defined in the section of law. If the nature of the incident

falls outside of the ambit of a defined emergency incident, then the section 20(4) directive may not be applied. Again, in relation to section 19 and 20, "*effects*" is not defined in the law. This provides an opportunity for subjective interpretation both in terms of the geographic scale of the *effect*, i.e. the extent of the effect being limited to specific site or inclusive of effects within the catchment, and in terms of the physical extent of the *effect* i.e. limited to the scope of the contravention or inclusive of the resultant cumulative environmental impacts to the water resource, its ecosystems and riverine functions.

Sections 53(1)(c) and 53(2)(a) refer to "*rectifying the contravention*" but exclude the "*effects of the contravention*". In other words, only the physical contravention or illegal activity itself requires remedying and the environmental impacts as a result of such contravention are not identified and addressed. In light of these points, the sections relating to compliance and enforcement in terms of the NWA in the context of enforcement-driven rehabilitation, are not completely appropriate.

4.4.2 Institutional Roles

Both the Department of Environmental Affairs (DEA) and the Department of Water and Sanitation (DWS) include directorates for authorising listed activities, for compliance and enforcement, and units for resource protection. There is however no directorates, sub-directorates or units that are tasked with rehabilitation, including the design of or the monitoring of rehabilitation projects, whether of retrospective degradation, current or future degradation, and whether of an initiative driven or enforcement-driven nature. Rehabilitation of ecological degradation is a key criterion in achieving section 24 of the Constitution and in providing sustainable environmental management.

The institutional roles provided by the DEA and DWS are appropriate to a certain extent but exclude–the holistic requirements of rehabilitation as a component for achieving section 24 of the Constitution. Furthermore, the effectiveness of the institutional structures is limited to their capacity and especially their capability in carrying out their mandates.

4.4.3 Management Instruments

As highlighted by Thompson (2006) in section 2.2, the environmental right of section 24 of the Constitution is phrased as a negative right, i.e. that the environmental right enshrines a minimum standard. Therefore the management instruments provided through the NEMA and NWA need to address and ensure this minimum standard.

The management instruments provided by the NEMA and NWA statutes and their institutions include bio-assessment reports, strategic environmental management frameworks (SEMF), resource quality objectives, resource management plans, and norms and standards.

a) Bio-assessments are compiled in respect of the National Environmental Management: Biodiversity Act, Act 10 of 2004 (NEM:BA). The Bio-assessments are conducted for environmental resources that fall within the ambit of the DEA and the South African National Biodiversity Institute (SANBI). As water resources are a mandate of the NWA and DWS, freshwater ecosystems are not included in these bio-assessments. The River Health Programme is conducted under the mandate of the DWS in collaboration with the DEA, however its objectives, methodology and outcomes differ significantly from the Bio-assessments.

b) Strategic Environmental Management Frameworks (SEMFs) are developed in terms of the NEMA and provide an integrated planning framework for the management of the environment through land use planning.

c) Catchment Management Plans are compiled in terms of the NWA to provide integrated sustainable and equitable management of water resources within a water management area.

d) Resource Quality Objectives are developed in terms of the NWA and applicable to the water management areas. These objectives set applicable targets (minimum standards) for the management of each water management area and sub-catchments within the WMAs.

e) Norms and standards. These set minimum standards for outcomes of various activities. Norms and standards can be developed in terms of any legislation or regulation. The DWS produced water quality standards for the receiving environment for various sectors (DWAF, 1996).

In terms of management of resources towards achievement of section 24 of the Constitution, the management instruments provided are appropriate in theory. Their effectiveness is limited to their implementation, and the capacity and capability of the institutions to develop and implement the instruments. In terms of the geographic appropriateness of the instruments, this is reviewed in the next indicator of responsiveness. With regard to enforcement-driven rehabilitation, the

management instruments do not specifically identify rehabilitation, but in developing the catchment management strategy, does allow for provision of identifying rehabilitative needs. Furthermore, the resource quality objectives and the norms and standards can be applied to both proactive driven and enforcement-driven rehabilitation.

4.4.4 Discussion

The enabling environment provides some appropriate mechanisms for the achievement of section 24 of the Constitution and enforcement-driven rehabilitation. The mechanisms provided fall short in addressing retrospective environmental degradation, which is a critical criterion to the success of section 24 of the Constitution. The key enforcement mechanisms i.e. NEMA section 31L Compliance Notice and NWA section 53(1) Directive fail to include rehabilitation of resulting environmental degradation as a prescriptive activity. Furthermore, the mechanisms provided while appropriate theoretically, are limited in their success to their effective implementation.

The institutional roles are generally appropriate to operationalising the legislation. However, the internal structures of the Departments are compartmentalised in alignment with the Chapters of the legislation and limited in terms of integration across functions. There is no specific institutional structure that manages rehabilitation (in general, i.e. not limited to rehabilitation of watercourses). The institutions are limited in their effectiveness to the capacity and capability of their staff to conduct their mandates.

The management instruments provided, in theory, are appropriate for the matter at hand, namely, achievement of section 24 of the constitution and enforcement-driven rehabilitation of watercourses. However, they are also limited in their effectiveness by the institutions' lack of capability to develop and implement them.

4.5 Responsiveness

The responsiveness indicator questions whether the regulatory framework responds to the appropriate issues. In other words, does the regulatory framework respond to the question of achieving section 24 of the Constitution, and does the regulatory framework respond to the issue of enforcement-driven rehabilitation of watercourses?

4.5.1 Enabling Environment

A report by the Department of Environmental Affairs (DEA, 2008) found that the processes and regulations contemplated in terms of the NEMA are too prescriptive, cumbersome and costly, which results in many illegal activities taking place. For example, for the clearing of sediment and flood debris from a bridge, a Basic Assessment in terms of the NEMA Regulations will cost upwards of R150 000 excluding any specialist's studies, while the cost of actually carrying out the work may only be R5 000 - R100 000, and should the activity trigger other legislation such as Water Use licence and Waste Permit, similar permitting processes and costs will need also need to be allowed for.

The principles of the National Water Policy, National Water Act and the National Water Resource Strategies respond to the requirements of an integrated approach to water resources management. These components of the enabling environment are responsive to the matter of achieving section 24 of the constitution, in that their objectives and preambles, in particular section 2 of the NWA, outline how the NWA responds to the rights provided in the Constitution, not limited to section 24.

In terms of rehabilitation, not limited to enforcement-driven rehabilitation, the preambles, principles and objectives are inclusive of the concept of rehabilitation, however the specific provisions of the statutes do not necessarily actually provide for rehabilitation and therefore are not responsive to the need of rehabilitative activities as a component of achieving section 24 of the Constitution.

In enforcement action, an administrative warning notice (either a NEMA S31L pre-compliance notice or ECA s31A pre-directive or an NWA s53(1) pre-directive) is issued with instructions to carry out ***any steps*** the transgressor must take. Directives ***may*** include instructions to conduct rehabilitation of environmental degradation but it is not compulsory, i.e. not a ***must***. Chapter 3 has highlighted that in the legislation relating to enforcement, there is no mandatory assessment of the impacts of non-compliance and mitigation of such impacts, as per the formal EIA process.

In contradiction to the prescriptive and detailed nature of the processes of obtaining formal Environmental Authorisations (including licences and permits), cases of non-compliance or illegal activity are only guided by the requirements included in the NEMA section 31L pre- and Compliance Notice and NWA section 53(1) pre- and directive which state respectively:

- NEMA section 31L (2)(b), a compliance notice is only required to: *set out any steps the person must take and period within which those steps must be taken*;
- NWA Section 53(1) Directive only: *directs a person to take any action specified in the notice to rectify the contravention.*

The section of law does not set out in detail, like the formal environmental authorising process, what those requirements, steps or actions must entail, how the impacts should be assessed or criteria that the cases should be assessed on, for example section 27 of NWA or sections 23 and 24 of NEMA. Therefore the compliance mechanisms provided for in the legislations are not responsive to the remediation of actual environmental degradation, as opposed to the administrative permitting aspect of licencing an activity.

4.5.2 Institutional Roles

In the context of law enforcement, each statute makes provision for regulatory and enforcement functions and inspectorates. Each regulatory body, identified in the relevant Acts, is tasked with ensuring compliance of that specific Act. However, in carrying out the compliance and enforcement functions of one body may require the support of an adjacent enforcement body, due to overlaps in jurisdiction between the statutes, especially when dealing with watercourses. Furthermore, as mandates of institutions are allocated vertically and horizontally across the three spheres of government (national, provincial and local government), it is important to identify who is responsible for enforcement, at which level of government, and what their objectives and enforcement mechanisms to support enforcement-driven rehabilitation activities on rivers are. These are summarised in Table 5.1 in Chapter 5.

Decision-making relating to activities in or along watercourses lies within the mandate of many different institutions and at various spheres of government. In terms of the PAJA, all these decision makers are accountable for their decisions. In the context of good governance, these various administrators should be making coordinated decisions, in consultation with each other. However with regard to enforced rehabilitation activities on watercourses, there appear to be more cases than exceptions, where contradicting decisions by the various institutions/administrators have been made. For example, a municipality in the Western Cape issued an ECA section 31A Directive to a land owner to clean up illegally dumped material on his property and remove alien vegetation. When the

land owner commenced with his clean up, the Provincial Department of Environmental Affairs then issued a NEMA section 31L Compliance Notice, as the clean-up activity required environmental authorisation as it involved the removal of more than $5m^3$ of material and vegetation from the flood plain of the river.

4.5.3 Management Instruments

As highlighted by Thompson (2006) in section 2.2, the environmental right of section 24 of the Constitution is phrased as a negative right, i.e. that the environmental right enshrines a minimum standard. However, as there is so much variability within the environment in South Africa (geographic, physical, biodiversity, demand and supply, etc.), the environment differs across the country and therefore there is no means of applying a uniform minimum standard across the country to the environmental right. In this regard, the NWA promotes the concept of catchment management, i.e. that resources are managed spatially from source to sea, and laterally i.e. integrated between land use and aquatic resource, within a defined catchment area (hydrologically defined area). This concept provides for differentiation in characteristics and demands and thresholds between catchments and allows flexibility in their management objectives and therefore variation in minimum standards across the different catchments. Catchments are not defined by political boundaries or the jurisdiction of spheres of government. The management instruments provided through the NWA are developed according to this catchment approach e.g. Catchment Management Strategy, Water Resource Quality Objectives. There are 19 water management areas (WMA) in the catchment approach that will be managed by 9 Catchment Management Agencies (CMA). This illustrates responsiveness in the NWA management instruments both to an eco-centric approach to resource management, as well as responding to the differing needs, characteristics and challenges of each specific water management area.

On the other hand the NEMA does not specifically promote a catchment, eco-region or biosphere approach. The specific sensitivities of the listed activities identified in terms of the regulations of NEMA are differentiated according to provincial (political) boundaries with some limitations according to type of ecosystems (GN R985 of 4 December 2014). The management Instruments under NEMA are usually aligned to the political or jurisdictional/administrative boundary of the institution developing them. Therefore the NEMA is not as responsive as the NWA to managing natural resources eco-centrically or according to individual characteristics.

4.5.4 Discussion

The NWA, in its approach to water resources management, is responsive to the achievement of section 24 of the Constitution, and accommodates the dynamic nature of the environment.

With regard to enforcement-driven rehabilitation the general mechanisms included in the NEMA and NWA legislation do not promote rehabilitation of ecological degradation, and are thus not responsive to rectifying ecological degradation as a contributor to achieving section 24 of the Constitution.

There is no specific institutional structure that monitors the achievement of section 24 of the Constitution or rehabilitation activities (both initiative and enforcement-driven). In NWA the institutional roles are aligned to the catchment approach, whereas the NEMA institutional roles are aligned to political boundaries. This alignment is shadowed in the management instruments.

The NWA makes an effort to respond to an eco-centric management approach unlike the NEMA. However the regulatory framework does not respond to the role and contribution of rehabilitation in achieving the environmental right.

4.6 Adequacy

The adequacy indicator questions whether the regulatory framework is sufficient in quantity or quality for a particular purpose. In other words, is the regulatory framework suitable for the achievement of section 24 of the Constitution; and is the regulatory framework fitting or suitable for the enforcement-driven rehabilitation of watercourses?

This indicator talks to the theoretical adequacy of the regulatory framework. The actual measurable adequacy is discussed in the indicators of effectiveness and achievement.

4.6.1 Enabling Environment

There are reasonable legislative mechanisms in place to give effect to section 24 of Constitution, and enforcement-driven rehabilitation. As highlighted through the previous indicators, the enabling environment goes a long way towards the current and future management of the environment towards achieving section 24, however there are gaps in the structure, especially with regard to:

- retrospectively addressing environmental degradation;
- applying an eco-centric approach to the geographic management of resources; and
- the rehabilitation of environmental degradation (initiative and enforcement-driven).

A second key challenge relates to the myriad legislation applicable especially to water resources management and in particular riparian and riverine areas. Because there are so many overlapping statutes and mandates, it is often assumed that it is another Department's responsibility. Naiman, *et al.* (1993:211) suggest that "(r)egulatory institutions usually have only one jurisdiction for a portion of the resources in the riparian corridor, and often the institutional mandates are conflicting." For example, the removal of silt or sediment from a river, as a result of bank collapse (from erosion) will require authorisation in terms of:

- National Environmental Management Act, Act 107 of 1998, GNR983 Activity 19 the excavation of $5m^3$ or more of soil from a watercourse;
- National Water Act, Act 36 of 1998, section 21(i) altering the bed, banks, course or characteristics of a watercourse;
- Mineral and Petroleum Resources Development Act, Act 28 of 2002 for the excavation of $5m^3$ of sand if the sediment is then sold to re-coup costs;
- National Environmental: Waste Act, Act 59 of 2008, if the sediment is disposed of;
- National Heritage Resources Act, Act 25 of 1999 for affecting the shell midden of the watercourse or conducting linear activities over 300 metres or longer;
- Conservation of Agricultural Resources Act, Act 38 of 1983 if the river is on land zoned for agriculture; and/or
- National Environmental Management: Protected Areas Act, Act 57 of 2003, if the river is in a mountain catchment area, nature reserve, or protected area, or within the 5km buffer around one of these areas.

Each of these authorisations is obtained through a different institution and application process. In conjunction, provincial legislation and municipal by-laws will also still need to be complied with. Most of these statutes are regulated and enforced by different institutions. This burdensome list of legislation contributes to the complexity of the policy environment that the officials operate within. Thus Deason *et al.*, (2010:688) observe that "(t)he policy environment causes many public agencies to apply independent planning and decision making processes to

address the particular problems falling under their jurisdictions, often with little coordination among program goals and execution, despite the reality that such programs often address interrelated problems of single rivers." These licences are all in terms of National legislation. There is no hierarchy of legislation, which contributes to the burdensome nature of the legislation. Similarly, there is no hierarchy in terms of enforcement mechanisms. The NEMA is usually used as the lead enforcement mechanism because it carries higher punitive action than the other statutes.

Unfortunately, the current South African Environmental legislative requirements are very cumbersome, costly and time consuming (DEAT, 2008). Out of frustration, this drives many people to rather follow the liability rule, and wait to be caught and pay the fine, which is usually cheaper and less onerous than following the formal property rule process and proactively obtaining the necessary environmental authorisations.

Kotze (2005a:75) points out that the various environmental acts prescribe a multitude of procedures, processes and environmental management tools that can cause an overlap of jurisdiction and give rise to confusing authorising authorisation processes and procedures, usually independent of each other, that must be followed by an applicant. Furthermore, there are also various relevant competent authorities involved, and other legislation that may, in addition, be applicable directly or indirectly. Kotze (2005a:75) concludes that fragmentation is evident from the various sectoral, or silo-based environmental acts that exist.

For more discussion and information on the fragmentation in South African environmental governance framework, refer to Kotze (2005a).

4.6.2 Institutional Roles

"Despite developments, the South African environmental governance sphere is fragmented" (Bray, 1995). Kotze (2005a:3) unpacks this fragmentation to include unaligned environmental governance processes, structures, policies and procedures; vertical fragmentation between the different spheres of government, and horizontal fragmentation between the different line functionaries in each sphere; as well as lack of co-operative governance and a lack of an integrated approach to environmental management. "Fragmentation is furthermore exacerbated by unsustainable and uncooperative organisational behaviour patterns inherent in the ranks of government" (Kotze, 2005a:3).

Coupled with the fragmentation and overlapping of jurisdictions, the institutional roles between and across spheres of government are either duplicated or absent, as the case may be. Officials are only delegated to work within the mandate of their designating legislation, and therefore the fragmentation and overlapping jurisdictions are not resolved through the institutional roles.

Craigie (2005:52) notes that the implication of the command-and-control approach is that it requires well-resourced and capacitated enforcement authorities, and that it is also rather inflexible in that it fails to afford authorities the necessary discretion to tailor compliance and enforcement solutions to suit specific situations. Furthermore, Craigie notes that the command-and-control approach provides no incentives to the regulated community to exceed the prescribed legal standard, as it will suffer sanction only if it does not meet the standard, i.e. if the requirement for rehabilitation prescribed by an official is lacking, then the offender has no obligation to exceed the rehabilitation requirement and consider any aspects the official did not include in the directed requirements, if any.

4.6.3 Management Instruments

The adequacy of the administrative mechanisms provided for in the legislation, without qualitative evidence to substantiate it, rests with the interpretation of the judiciary. An example of the judiciary qualifying the adequacy of the administrative tools is illustrated in the example below in the case of *Harmony Gold Mining Company Limited v Regional Director: Free State Department of Water Affairs & Others 971/12*:

> In the court case Harmony Gold Mining Company Limited v Regional Director: Free State Department of Water Affairs & Others 971/12, the validity period of a directive was questioned. Harmony amongst others, conducted gold mining operations in an area known as KOSH. In November 2005 the companies, including Harmony, were issued with a NWA section 19(3) directive, requiring them to take anti-pollution measures in respect of water resources contamination caused by their gold mining activities. The anti-pollution measures were to continue until such time as an agreement and a joint proposal towards the long term sustainable management of water arising from the mining activities in the KOSH area, was submitted to, and approved by the Department of Water Affairs (DWA). Harmony conducted its mining activities on immovable property belonging to ARMGold. ARMGold then sold this immovable property and gold mining business to Pamodzi. In terms of the sale in 2008, Pamodzi assumed Harmony's obligations both in terms of the mining

operations and the directive. In 2009 Pamodzi was liquidated as a result of which, it did not have the finances to comply with the directive.

DWA together with the other mining companies argued that notwithstanding Harmony's agreement with Pamodzi, Harmony still retained the duty to comply with the directive. Harmony disagreed and argued that a directive issued under section 19(3) of the NWA remains valid only for as long as the person to whom it was issued owns, controls, occupies or uses the land in question thus arguing that the directive became unenforceable against Harmony from the date upon which Pamodzi took ownership of the land and control of the mining operations conducted thereon. Harmony applied to have the directive set aside or the declaration the directive become invalid.

The court held that such interpretation by Harmony was absurd and defeatist of the purpose of the legislative provision and would render it ineffective; because a landholder directed to take measures, in terms of section 19(3), would simply evade its obligations under the directive by severing its ties with the land. The court said that the rationale of section 19(3) is to direct the landholder to address the pollution or risk of pollution for however long it may take to do so. That rationale does not fall away when the landholder ceases to own, control, occupy or use the land.

Harmony submitted an application to the Supreme Court of Appeal to appeal the High Court's decision. The Appellate Court dismissed Harmony's appeal.

Based on the High Court's ruling, the administrative mechanisms, especially a NWA section 19(3) directive, are adequate in their intended purpose in that it rests with the implementation of these mechanisms to achieve effectiveness in the physical rehabilitation of the environment.

4.6.4 Discussion

The regulatory framework provides *reasonable legislative and other measures* to achieve section 24 of the Constitution, as supported by the High Court. However, the actual components of the legislation and other measures, especially in terms of the NEMA are fragmented and in some respects underdeveloped. The fragmented nature of the legislation and institutional roles leads to overlaps and gaps in the implementation of functions and mandates. This suggests that the enabling environment and institutional roles are not adequate, and management instruments are only adequate to the extent of their implementation. Similar to section 4.5.3 on Responsiveness, the directives must always include impact

assessments of the activity to identify the resultant environmental degradation including to environmental functions, and activities of rehabilitation that must be carried out. There needs to be more qualitative monitoring and evaluation, especially of enforcement-driven rehabilitation activities to measure the improved state of environmental health, not limited to watercourses only.

The role of rehabilitation in the contribution towards achieving Section 24 is lacking from the regulatory framework, therefore the regulatory framework is inadequate in terms of rehabilitation contributing towards the achievement of Section 24 of the constitution.

4.7 Effectiveness

The effectiveness indicator questions whether the regulatory framework is effective and makes best use of available resources for a particular purpose. In other words, is the regulatory framework effective in terms of achievement of Section 24 of the Constitution; and is the regulatory framework effective for the enforcement-driven rehabilitation of watercourses?

This indicator starts to look at the quantitative rather than qualitative adequacy of the regulatory framework.

4.7.1 Enabling Environment

Feris (in Paterson and Kotze, 2005:131) notes that historically, pre-1998, insufficient enforcement was the main reason for ineffective environmental protection through legislative or other means, i.e. criminal sanctions were ineffective in environmental law in South Africa mainly because the penalties for environmental damage were and still are not severe enough to deter polluters. For example, the CARA penalty is R500, and the NWA penalty is R10 000 (with regard to the Adjustment of Fines Act). The NEMA was the first environmental legislation to raise the penalty for offences firstly by imposing a R1 million fine and this was later increased to R5 million maximum fine (offence in terms of NEMA section 31L). An important point to note is that there are several listed activities in terms of the NEMA, however the maximum fine can only be applied cumulatively and not per contravention.

Feris (in Paterson and Kotze, 2005:131) concludes that although the administrative officials were given extensive powers, they did not always use the powers effectively. Loots (1994) prompts Feris's conclusion, in suggesting that historically

the officials often adopted a conciliatory rather than a confrontational approach towards polluters, with the result that no action was ever taken against offenders. Furthermore, the administrative bodies had no legislative mandate to consider environmental factors or impacts on the environment in their decision-making. In this respect Rabie (1996) argues that where officials might have wanted to support a conservational objective, their actions were set aside on review for taking irrelevant factors into consideration or for pursuing an unauthorised purpose.

Despite the improvements in criminal measures, Craigie (2005:54) points out that one of the noted shortcomings of enforcement tools, that the criminal measures fail to address, relates to the environmental harm caused as a result of the offence. In this regard, Sections 19, 20 and 53 of the NWA relate specifically to compliance and enforcement mechanisms. It is however prudent to note, that while section 19(2) identifies those measures to "(e) *remedy the effects of the pollution; and (f) remedy the effects of any disturbance to the bed and banks of a watercourse*" to be included as measures in a section 19 Directive to remedy the effects of pollution. These measures "***may***" rather than "***must***" be included in the Directive. In other words, unless the enforcement official specifically includes the instruction to "remedy the effects of pollution" in the directive, there is no obligation to actually do so.

4.7.2 Institutional Roles

Craigie (2005:45) highlights that since the establishment of the Environmental Management Inspectorate (EMI), the initial approach adopted in the industrial context has shifted to a more rationalist approach, with punishment being the key enforcement strategy for compelling compliance and achieving improved environmental performance. In other worlds, the use of sanctioning strategies, which focus on the act of breaking the law or rules and doing harm, are used instead of a normative approach.

In respect of the NWA and the establishment of Catchment Management Agencies as institutional bodies to manage and regulate the country's water resources according to water management areas, at the time of writing, only two of the original 19 and subsequently revised 9 CMAs, have been gazetted and are operational.

4.7.3 Management Instruments

With regard to the effectiveness of the compliance and enforcement component of environmental management, the following figures are presented from the National

Environmental Compliance and Enforcement Annual Reports. While there are some enforcement activities taking place, there is no measure indicating the improvement of the state of the environment as a result of such activities.

Table 4-2 provides a summary of the compliance and enforcement activities over the previous financial years 2011/12, 2023/13 and 2013/14.

Table 4-2 Summary of compliance and enforcement activities of the previous financial years (Source: DEA, 2013b, 2014)

Activity	**2011/12**	**2012/13**	**2013/2014**
Warning notices	495	187	228
Administrative Notices (Directive, Compliance notices, pre-notices, pre-directives)	521	577	709
S24G fines (no. of fines) [average fine]	R17 627 233 (86) [R204 967]	R5 385 215 (49) [R109 902]	R16 127 751 (73) [R171 466]
Facilities inspected (Brown sector)	1724	2766 (1321)	2849 (2019)
Proactive inspections	2196	1215	1953
No. non-compliances	1116	2482	1539
Reactive inspections (complaints based)	558	639	896
Follow up inspections	833	675	832

The low number of administrative notices issued is not an indication of good compliance with the environmental legislation, but more a reflection of the need for capacity and capability in the enforcement sector. The compliance and enforcement figures include enforcement actions taken on green sector issues, which are conservation related issues such as poaching, as well as the brown sector issues such as land use infringements. There are no reported compliance and enforcement figures in terms of the NWA, only the cases the DEA prosecuted on behalf of DWS.

In terms of NWA management mechanisms, the NWA provides for the setting of water resource quality objectives. However the methodology for setting these objectives was only gazetted in 2012 and its effectiveness has not yet been measured or reported on.

4.7.4 Discussion

In terms of enforcement to achieve Section 24 of the Constitution, it is difficult to measure how effective the legislation and management tools are, as there is no quantitative measure of improvement of the state of the environment as a result of the compliance and enforcement activities. Similarly, there is no indication of how much money (fines or otherwise) has been spent on rehabilitation of environmental degradation as a result of compliance and enforcement activities (fine monies have been allocated by the courts specifically to rehabilitation activities; how these monies have actually been spent has not been publicly reported on). Furthermore, the application of mechanisms provided in the legislation is not always applied, for example, in the 2013/2014 financial year, 1539 non compliances were identified, however less than half (709) received administrative notices. Of the 709, 95 were pre-directives, 60 were directives, 400 were pre-compliance notices and only 154 were final compliances notices. In the previous chapter it was highlighted that the compliance monitoring and enforcement process as well as administrative justice process require that a warning notice has to be issued prior to a final notice being issued. Therefore of the 709 administrative notices, only 249 were final administrative notices, i.e. of the 1539 non-compliances only 249 received final administrative notices. Assuming all these notices requested appropriate rehabilitation, only 16% of non-compliances were tasked with rehabilitation in 2013/2014, an increase from 6% in 2012/2013 and 14% in 2011/2012. This trend suggests that there are more occurrences of environmental degradation than environmental rehabilitation. However, without a measure of actual improved health of the environment as a result of these activities, it is unclear whether the enforcement activities or the enforcement-driven rehabilitation has contributed effectively to the achievement of section 24 of the Constitution.

4.8 Accountability

The accountability indicator questions whether the regulatory framework accepts responsibility for its role for a particular purpose; in other words, does the regulatory framework account and/or take responsibility for achievement of Section

24 of the Constitution; and does the regulatory framework account and/or take responsibility for the enforcement-driven rehabilitation of watercourses?

The accountability indicator is linked closely to the indicators of reporting and achievement.

4.8.1 Enabling Environment

The NEMA and NWA legislation and its regulatory framework were enacted to enable the environmental right contained in section 24 of the Constitution. From an enabling environment perspective, these frameworks can be held accountable against the achievement of section 24 of the Constitution. Accordingly, the High Court, in *Khabisi NO and Another v Aquarella Investment 83 (Pty) Ltd and Others, ruled that* "(t)he 'other measures' [Constitution section 24(b)] no doubt include those aimed at ensuring environmental compliance and enforcement, and that this imposes a clear and onerous obligation on environmental departments to promote conservation and protect the environment'" (Craigie, 2005:46).

4.8.2 Institutional Roles

The Promotion of Administrative Justice Act, Act 3 of 2000 (PAJA) requires administrative action to be lawful, reasonable and procedurally fair, and includes the right to written reasons for administrative action, as provided for in section 33 of the Constitution of South Africa 1996. The PAJA section 1, requires administrators (which includes an Organ of State or any natural or juristic person taking administrative action e.g. an enforcement official) to be accountable for their decision making. The PAJA section (1) defines a decision as [own emphasis]:

> *"any decision of an administrative nature made, proposed to be made, or required to be made, as the case may be, under an empowering provision, including a decision relating to – inter alia:*
>
> *(a)* ***Making****, suspending, revoking or refusing to make an order, award or* ***determination****;*
>
> *(b)* ***giving*** *suspending, revoking or refusing to give a certificate,* ***direction****, approval, consent or permission;*
>
> *(c)* ***issuing****, suspending, revoking or refusing to issue a licence, authority or* ***other instrument****;*
>
> *(d)* ***imposing a condition*** *or restriction;*
>
> *(e)* ***making a*** *declaration, demand or* ***requirement****."*

Therefore in the issuing of enforcement mechanisms, especially ones requiring rehabilitation activities to be carried out, the administrators e.g. compliance officers, are accountable for their decision making in determining what the rehabilitation objectives are, what requirements are necessary and for the approval of any submitted rehabilitation plans. In this context, the administrators can be called to court to prove and defend their decision-making. According to du Plessis (2005:20) "(t)hese provisions have recently been used by litigants seeking to challenge the validity of administrative enforcement measures, and environmental compliance and enforcement authorities should accordingly be prudent in using such measures to ensure that they withstand judicial scrutiny." As a result, Craigie (2005:50) highlights that there appears to be a reluctance by the environmental authorities to give compliance advice to the regulated community for fear of being held liable for inappropriate advice or of compromising possible enforcement action. However, as ruled by the High Court, there is a "clear and onerous obligation on environmental departments to promote conservation and protect the environment" through compliance and enforcement mechanisms amongst others. "The State can be held accountable in instances where the failure to follow fair procedures may have a negative bearing in the environment and where it may ultimately infringe upon the environmental right" (Feris in Paterson and Kotze, 2005). Therefore the enforcement authorities are accountable to ensure that the compliance and enforcement mechanisms achieve the obligations of section 24 of the Constitution, and enforcement-driven rehabilitation.

The administrative framework rightly holds enforcement officials accountable to fair public administrative justice within their role of conducting compliance monitoring and enforcement functions. However, in terms of holding compliance and enforcement activities, as a function of the regulatory framework, accountability in terms of their role of contributing towards the achievement of NEMA and section 24 of the Constitution, is lacking. The GWM&ES process was established in order to assess the policy performance function. However the GWM&ES process was replaced with outcomes-based reporting, which does not hold the policy or regulatory framework accountable in terms of its objectives, but merely reports on the outputs and outcomes of input objectives. This model is only as good as the input objectives.

4.8.3 Management Instruments

The various management instruments promoted and developed in terms of the enabling environment are accountable in their methodology and outcomes. The management instruments are accountable in that they can be challenged in court in terms of their methodology, application and outcomes. Furthermore, the environmental right is a juristic right, in that the lack of achievement or contribution towards the realisation of the right, may be challenged in court.

4.8.4 Discussion

"The trend in developed countries to complement input and output indicators with outcome indicators, is a trend towards adopting results-oriented policies and work methods driven by various factors, including the demand for enhanced accountability and the demonstration of public value of enforcement work to multiple stakeholders" (Mazur, 2010:8).

There is accountability of the government officials in the process of conducting their jobs. However, the accountability of the Organ of State and the regulatory framework being held accountable for achieving its mandate, is lacking. Mechanisms for accountability are in place. However, this does not mean that the full ambit of the constitutional roles are carried out i.e. officials refusing to give advice on enforcement-driven rehabilitation activities do not contribute to the achievement of Section 24 of the constitution, for which the regulatory framework, of which the official is a component, is accountable.

4.9 Capacity

The capacity indicator questions whether the regulatory framework has the capacity to conduct a particular purpose; in other words, does the regulatory framework have the needed capacity to achieve Section 24 of the Constitution; and does the regulatory framework have the needed capacity for the enforcement-driven rehabilitation of watercourses?

The indicators for capacity and capability are closely linked, where capacity refers to the volume of resources and capability refers to the ability of the resources.

4.9.1 Enabling Environment

The legislative framework makes provision for various mechanisms to both protect and manage natural resources, as well as compliance and enforcement mechanisms to address non-compliant activities. However, as highlighted in the

previous indicators, the enabling environment does not have the capacity to appropriately address enforcement-driven rehabilitation. This is also echoed through the institutional roles and management mechanisms.

Furthermore, Craigie (2005:47) highlights that a number of specific international environmental instruments e.g. the CITES and the control of transboundary movements of hazardous wastes and their disposal, to which South Africa is a party, require the Government to strengthen domestic compliance and enforcement capacity in order to effectively execute the obligations set out therein.

4.9.2 Institutional Roles

A major challenge for environmental compliance monitoring and enforcement are the capacity and capability constraints of the sector. O'Beirne (2011:9) points out that this "refers to both the capacity in terms of the number of resources compared to the number of projects and activities that need to be controlled, as well as the capability to assess and interpret the compliance monitoring information." He goes on to point out that between 1997 and 2006 there were some 44 000 applications for environmental authorisations and permits, with a significant increase after 2006 following the gazetting of the first NEMA regulations; by contrast there were only 866 EMI's in 2007/2008 increased to 1915 by 2013/14, in comparison to the US-EPA[9] in 2002 of 3400 employees just at the EPA's Office of Enforcement and Compliance Assurance (OECA). Of the 1915 registered EMIs, 1252 are Grade 5 EMIs (field rangers), employed at national and provincial parks and tasked with enforcing the biodiversity and protected areas Act of the National Environmental Management Act. Of the remaining 663 EMIs in the country, 78 are Grade 1, 449 are Grade 2, 120 are Grade 3 and 16 are Grade 4 (DEA, 2014). EMIs of Grades 1-4 tackle the "blue" and "brown" sector cases for the country. Of the 663 Grade 1-4 EMIs, only 709 administrative notices were issued in 2013/14. Of the 2849 inspections conducted in 2013/14, 832 were routine inspections, a small drop compared to the more than 44 000 EIA applications that need to be monitored since 1997. Only a Grade 1 EMI may issue a Compliance Notice, but this grade is usually reserved for senior officials such as Chief Directors. In the operational framework, a compliance notice will be drafted by the case officer, usually a grade 2 EMI, and then the Notice is checked and signed by the Grade 1 EMI. The signing of the Notice assigns the accountability to the Grade 1 EMI. There are no

[9] The US-EPA is the Federal Agency for environmental protection. Each State within the US also has its own institutional structure. While the USA is spatially much larger than South Africa, and a comparison of the cumulative state and Federal agency staff is unrealistic, the Federal institution alone provides a starting point for comparison.

officials at the Department of Water Affairs designated as EMIs[10], despite the NWA being a strategic Act of the NEMA.

Conducting compliance and enforcement activities is not limited to EMIs. Other government employees are empowered to use the directives provided for in the regulatory framework, such as the NWA section 19(3), 20(4) and 53(1) directives, the ECA section 31A directive and the NEMA section 28(4) Directive. The total number of these officials is not reported on.

4.9.3 Management Instruments

The implementation of the management instruments is limited by the capacity of officials to conduct and implement the instruments. If there is insufficient capacity, the application and implementation of the instruments would be ineffective and insufficient. The capacity to implement compliance and enforcement instruments, as well as rehabilitation activities is not only limited to the availability of human resources capacity but also to the availability of funding to support such resources and activities.

4.9.4 Discussion

While there is some human resource capacity to conduct compliance and enforcement, this capacity is limited and restricts the potential of the regulatory framework to achieve Section 24 of the constitution, and enforcement-driven rehabilitation of watercourses.

4.10 Capability

The capability indicator questions whether the regulatory framework has the ability for a particular purpose. In other words, does the regulatory framework have the needed abilities to achieve Section 24 of the Constitution; and does the regulatory framework have the needed ability for the enforcement-driven rehabilitation of watercourses?

The indicators for capability and capacity are closely linked, where capacity refers to the volume of resources and capability refers to the ability of the resources.

4.10.1 Enabling Environment

In addition to capacity constraints facing the EMIs, there are capability constraints of within those officials. O'Beirne (2011) highlights that a single case-officer may receive a multitude of applications that have to do with a variety of activities and

[10] At the time of writing this thesis.

multiple potential impacts on the environment; and it is simply unfair to expect the official to be an expert in each and every one of these fields of science, activities, impacts and cases.

Currently the qualifications for individuals in compliance and enforcement posts do not require ecological sciences experience, and a background in law is preferred. While environmental management is a good starting point for reviewing EIA applications, it falls short when determining the impacts of contraventions on ecosystems and their functions. For example, consider these advertised posts in the compliance units of the Departments of Water Affairs and Environmental Affairs respectively, where the specific requirements have a legal rather than scientific emphasis:

Example: Department of Environmental Affairs (as advertised April 2010).

Post: Assistant Director: Reactive Administrative Enforcement

Requirements: A law degree or Environmental Management degree or equivalent relevant three-year tertiary qualification plus extensive working experience. Investigation best practice, knowledge of environmental policies, legislation, international instruments, civil procedure, criminal procedure, constitutional law and administrative law. Knowledge of the justice system and the integration of law and science. Understanding of the compliance and enforcement management system.

Example: Department of Water and Sanitation (as advertised on 24 April 2012)

Post: Deputy Director: Compliance and Enforcement

Requirements: A water related Degree/National Diploma or equivalent Degree/National Diploma. Six to ten years relevant experience in compliance issues. Knowledge in water use, monitoring and enforcement. Knowledge of water use licence applications. Knowledge of the implementation of the National Water Act, 1998 (Act 36 of 1998).

Both of these positions, although senior, are tasked with supervising officials, compiling administrative notices and managing enforcement cases. These senior positions should include an understanding of the ecological aspects as well, in order to ensure that the rehabilitation objectives set by the junior officials are appropriate and adequate.

Compliance enforcement officials do attend training in enforcement procedures, which is primarily focused on the Criminal Procedures Act (Act 51 of 1977) (CPA) and the "legalese" of the relevant environmental legislation. However this training does not include identifying the specific ecological impacts of ecological degradation as a result of contraventions and illegal activities, nor does it include mechanisms for rehabilitation, such as the setting of rehabilitation objectives nor the determining of indicators for monitoring (EMI training manual). Ideally, in line with international practice, the compliance units should include specific specialists, such as botanists, or ecologists, so that cases that affect those ecosystems are managed by the relevant specialist within the enforcement unit. However, these fields of science are not as popular and/or working in the compliance sector is not as appealing, as more lucrative sciences and private sector work, therefore currently there would not physically be enough of these specialists available in South Africa to ensure each of the enforcement units had their own specialist. There are specialists within the Departments, but these officials are tasked with the proactive management of ecological systems and biodiversity in the areas of jurisdiction of their Organ of State. They are usually brought into the compliance process, but only after the pre-notice or pre-directive has been issued, whereas they should be consulted prior to these notices being issued to ensure that the notice addresses and requests the appropriate information and rehabilitation activities.

Table 4-3 indicates the high vacancy rates in the public biodiversity sector (DEA 2011:36). With particular reference to scarce skills, the Department of Labour Scarce Skills List identifies the following (DEA 2011:29):

- It identifies a need for Engineers and Engineering Technologists, but it does not identify environmental/–air quality or water quality engineers or engineers with cleaner production skills on the list;
- It identifies the need for Natural and Physical Science Professionals including 100 Geologists, 150 Geophysicists, 500 Bioengineers and Biotechnologists, 200 Astronomers; 200 Astrophysicists; 200 Atmospheric Physicists, but it does not list all environmental scientific skills that are in demand (e.g. climate change scientists, soil scientists etc.); and
- It identifies a need for 250 Earth Science Technicians; and 1000 Biological Science Technicians, but it does not reflect all environmental

technician scarcities (e.g. oceanographic technicians; environmental science technicians; cleaner production technicians etc.)

Table 4-3 The vacancy rates in the public biodiversity sector (DEA, 2011)

Occupations in the public biodiversity sector	**Number of Posts**	**Number of Posts filled**	**Vacancy Rate**
Nature conservation & oceanographic related technicians	910	441	51.5
Life sciences related professionals	4	2	50.0
Geologists, geophysicists, hydrologists & related professionals	348	193	44.5
Natural Science professionals	853	538	36.9
Agricultural, oceanography, forestry & other scientists	1415	974	31.2
Environmental health professionals	45	32	28.9
Biochemistry, zoology & life science technicians	1517	1110	26.8
Biologists, botanists, zoologists & related professionals	137	103	24.8
TOTAL	**5229**	**3393**	**35.1**

DEA (2011:37) further found that 34% of core staff in the biodiversity sector have responsibilities for which they are not qualified (where qualification is according to SACNSP).

Furthermore, DEA (2011:102) collated the following obstacles to implementation of skills development in the public environmental sector (this includes compliance and enforcement as a component):

- Inappropriate skills development or inappropriate training programmes which do not address the real need;
- Prohibitive costs associated with training courses and access to funding sources for training is limited;
- Time intensive training courses which often limit participation;
- Poor quality training;
- Access to training for rural and under-resourced communities is extremely difficult;

- High turn-over of staff within the environmental sector results in increasing difficulty to retain appropriate skills and experience;
- Fixation on training for EIA and limited focus on other environmental management tools. There is an enormous need for information regarding the EIA processes (despite the course being accredited or not). EIA is becoming increasingly complex and in order to understand it properly, people need some kind of formal capacity building. Currently the ability of the majority of I&APs to engage and respond meaningfully in the EIA process is poor and the process does not offer sufficient and effective learning space to address this shortfall;
- Limited skills development on other environmental tools;
- Bureaucratic and lengthy processes and costs associated with course accreditation, and a lengthy process to have HET institutions accredited in terms of the Advanced Certificate: Environmental Assessment Practice (could take up to 5 years);
- Lack of applicable unit standards for environmental courses, necessitating the unit standards being registered first before applying for the course to be accredited;
- Changing legislation requires courses to be amended and further accreditation of the course which is a time consuming process, and requires a continued need for EIA capacity building as well as other aspects such as strategic environmental planning tools, public participation techniques, specialist fields, etc.;
- Access to legislation and understanding environmental legislation is a major problem;
- No dedicated environmental SETA with the result that environmental issues are currently dealt with through other SETAs.

4.10.2 Institutional Roles

South Africa has strict laws regarding employment equity and Black Empowerment, which in part, contribute to the appointment of less qualified or capacitated staff in order to meet “quota” requirements. The turnover of these “quota” staff is high, with staff remaining in appointed positions for only 1-2 years, “(t)he turnover is essentially as a result of a small supply of appropriately skilled and qualified people” (DEA, 2011:58). Consequently, this high turnover of staff negatively impacts on institutional memory. Kotze (2005b) (in Paterson and Kotze, 2005:117) concurs that there is a general lack of resources (both financial and

human) in South Africa that prohibits the proper implementation and enforcement of environmental legislation and policy. She goes on to qualify that the evidence suggests that many government officials do not have the necessary capacity and competence to evaluate the information provided to them for the sake of facilitating decision-making. The officials are afraid of exposure owing to the rise of mechanisms aimed at promoting transparent and accountable decision-making in South Africa.

4.10.3 Management instruments

The management mechanisms developed in respect of the NWA are capable of improving the health of the water resources in the country. However, these are limited in their ability and success by the incapability of the human resources and financial resources to apply and implement the instruments to their full potential.

4.10.4 Discussion

There are glaring gaps in the capability of the human resources that implement the regulatory framework to achieve Section 24 of the constitution and rehabilitation.

4.11 Reporting

The reporting indicator questions whether the regulatory framework reports on a particular purpose. In other words, does the regulatory framework report on the achievement of Section 24 of the Constitution; and does the regulatory framework report on enforcement-driven rehabilitation of watercourses?

The reporting indicator is closely linked to the indicator of achievement which highlights the outcomes of the regulatory framework. The reporting indicator highlights the various reporting outputs, while the achievement indicator highlights the results from the regulatory framework, which are contained in the reports.

4.11.1 Enabling Environment

There are several forms of reporting on outcomes of the enabling environment that take place.

The aim of the GWM&ES was to provide a policy performance evaluation to ensure the policy frameworks were achieving the outcomes they were intended to achieve, and report on this achievement. This would provide a mechanism for Government review whether it was firstly achieving its promises and objectives, but also to report on its achievements to its citizens. Outcomes-based reporting in the MPAT model, also provides a reporting mechanism based on the achievement of

its set objectives. However, there is no achievement of the objectives without evidence. Similarly, the objectives set at the beginning of the model determine the outcome reported, i.e. if the objectives set are not indicators of the environmental right, then the outcomes will not be a measure of achievement of the environmental right.

The state of the environment is reported in the South African Environmental Outlook Report; however this is fairly general and not measured against specific objectives or qualitative indicators.

The state of the rivers report, produced through the River Health programme, provides a good measurable report on the health of the reaches of each of the rivers of each report. This enables one to compare results of previous reports more accurately, and across different ecosystem indicators. However, this report is not regularly conducted.

Municipalities are evaluated against Blue Drop and Green Drop status, with reference to their water and wastewater treatment facilities respectively. These assessments consider a wide variety of indicators including capacity of human resources to operate the works, and legal compliance amongst others.

None of these reports provides a clear report on the state of the environmental right in the country, nor a measurable indication of the state of the environment. Similarly, there is no reporting in terms of outcomes of enforcement-driven rehabilitation, only in terms of outputs of compliance and enforcement activities i.e. number of administrative notices issued.

With regard to specific provisions in the statutes, there are no sections in the NWA or NEMA and in particular in the compliance sections (sections 19, 20 and 53, and section 28 and 31L respectively) that refer to monitoring and or reporting. Where activities to "*remedy the effects of pollution or contravention"* have taken place, there is no legislated requirement to assess the improvement or impact of such remedying activities. In other words, there is no legislated requirement on reporting, monitoring or measuring of improved river health as a result of compliance and enforcement activities.

4.11.2 Institutional roles

"Traditionally, regulatory agencies' performance has been managed and evaluated largely by reference to their level of activity rather than the outcomes they accomplish" (Mazur, 2010:11). Mazur (2010:17) highlights that output indicators

demonstrate a level of effort towards an outcome but do not reflect the degree to which the outcome is achieved. Therefore by using a combination of output and outcome measures he argues that an enforcement agency should be able to identify patterns between its activities and the occurrence of outcomes and adjust its strategies to ensure that it achieves the right types and extent of outcomes with the resources available. The cost-effectiveness of activities can thus be assessed and reported on, by comparing data on inputs (personnel and resources) with information on outcomes achieved. In relation to rivers, this could be a measure of total length of improved river condition/classification.

4.11.3 Management Instruments

When reporting on compliance and enforcement or rehabilitation activities, with the aim to measure the impact or effect of the particular activities, there needs to be reporting against outcome indicators and not just output indicators as observed in the previous indicators and section.

Table 4-4 provides examples of the difference between input, output and outcome indicators.

Table 4-4 Input, output and outcome indicators

Indicator Type	Indicator
Input *(resources)*	Number of officials employed Number of officials on training course
Output *(activities)*	Number of inspections and investigations conducted Number of administrative notices issued Number of prosecutions
Outcome *(results)*	Amount of pollutants reduced through enforcement actions No. of ecosystems rehabilitated Amount of km's of canals[11] returned to natural watercourses Improved level of Present Ecological State of watercourses

The Department of Environmental Affairs: Technical performance indicator descriptions for the 2017/2018 strategic plan and 2012/2013 annual performance plan, list 140 indicators of technical performance. Table 4-5 provides a breakdown of the ratio of these indicators in terms of input, output and outcome indicators against the environmental programmes.

[11] In the enforcement sector canalisation of watercourses is not limited to the formal stormwater canal, but it also includes re-enforcement of banks e.g. gabion structures, construction of levees or flood defense structures, channel straightening, and reclamation of flood plain areas.

Table 4-5 Ratio of DEA indicators (Source: DEA, 2013b)

Programme	Input	Output	Outcome	Total
Administration	24	34	0	**58**
Environmental quality and protection	0	16	3[12]	**19**
Oceans and coast	1	12	2	**15**
Climate chance	0	12	0	**12**
Biodiversity and conservation	2	15	0	**17**
Environmental programme and projects	8	3	8[13]	**19**
Total	**35**	**92**	**13**	**140**

The majority of the indicators are output indicators i.e. activities, such as number of reports processed, number of cases investigated. Where there are outcome indicators i.e. measure of environmental quality, these relate to the Working for programmes, oceans and coast management, and waste management. The waste management outcomes may potentially be as a result of compliance and enforcement activities but this link is not reported, whereas the "Working for …" programmes and oceans and coast management are initiative-driven rehabilitation projects rather than results of compliance and enforcement actions.

The three waste related outcome indicators are:

i) Percentage increase in waste recycled and recovered;
ii) Percentage increase in hectares of land remediated;
iii) Percentage increase in waste expenditure in municipalities.

In particular indicator (ii) may be as a result of compliance and enforcement activities.

Of the 140 indicators, only one output indicator related to water resources management, in that it referred to number of wetlands under rehabilitation. There were several indicators relating to waste, as mentioned, as well as to natural forests and conservation with regard to land rehabilitation by the Working on Land Programme. With regard to administration, there is one indicator that relates to capability of staff; with a strategic objective that reads: "adequate and appropriately skilled staff." The purpose of this indicator is to improve departmental capacity through ensuring adequacy and appropriateness of skills, with an output indicator

[12] All 3 outcome indicators relate to waste management, in response to the NEM:Waste Act, Act No.59 of 2008

[13] Includes the Working for Programmes e.g. Working for Wetlands Working for Water, Working on Fires, etc., where sites are selected for rehabilitation based on the hectare equivalent of resource gained by implementing rehabilitation activities.

of ensuring operational efficiency. Of the 19 environmental quality and protection indicators, none relate to ground-level compliance and enforcement, i.e. they relate to number of appeals and litigation addressed on time.

The Department of Water and Sanitation results from their 201/2014 to 2015/16 Annual Performance Plan (DWA, 2013) are no better. There are only two outcome indicators, which measure (i) the volume of water saved as an indicator of water use efficiency, and (ii) the volume of water losses reduced as an indicator of water conservation and demand management. Both of these indicators relate to the function of water supply and services, in terms of Section 27 of the Constitution rather than water resources management in terms of Section 24 of the Constitution. The other 99 indicators are input and output indicators. There is no measure of improved state of water resources in the country. Furthermore, there are no indicators, input or output, which relate to compliance and enforcement activities.

With regard to reporting on the actual state of watercourses, the River Health Programme produced a report (DWAF, 2006) highlighting its achievements over 10 years of implementation. By 2006, Ecostatus surveys of rivers have been done on a limited number of river systems in South Africa. All the assessments do show that river systems are mostly in a fair to poor condition, and that rivers have experienced extensive modifications by people (DWAF 2006). Figure 4.1 and Figure 4.2 show that for the rivers assessed, only in very few cases are rivers in a natural condition.

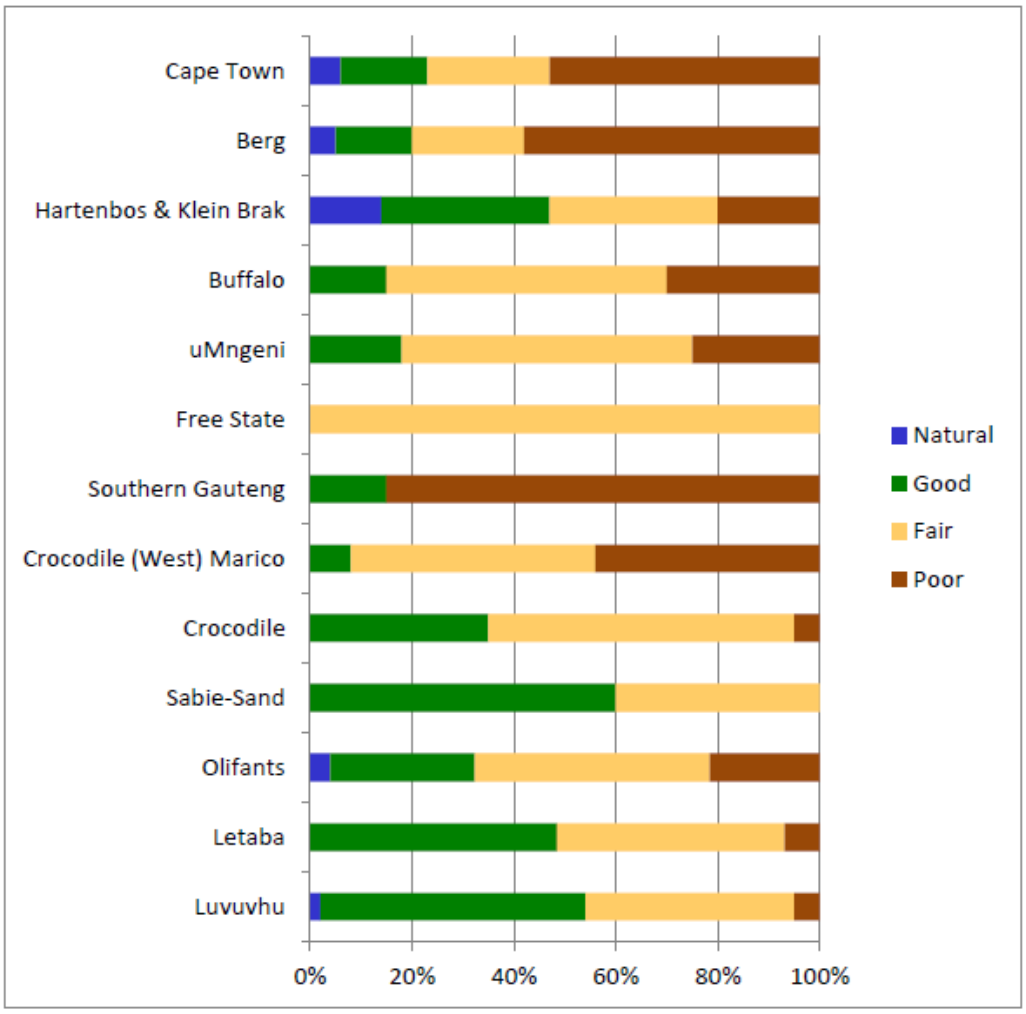


Figure 4.1 Ecostatus of River Health Surveys from 1994 to 2005 (DWAF, 2006; DEAT, 2012)

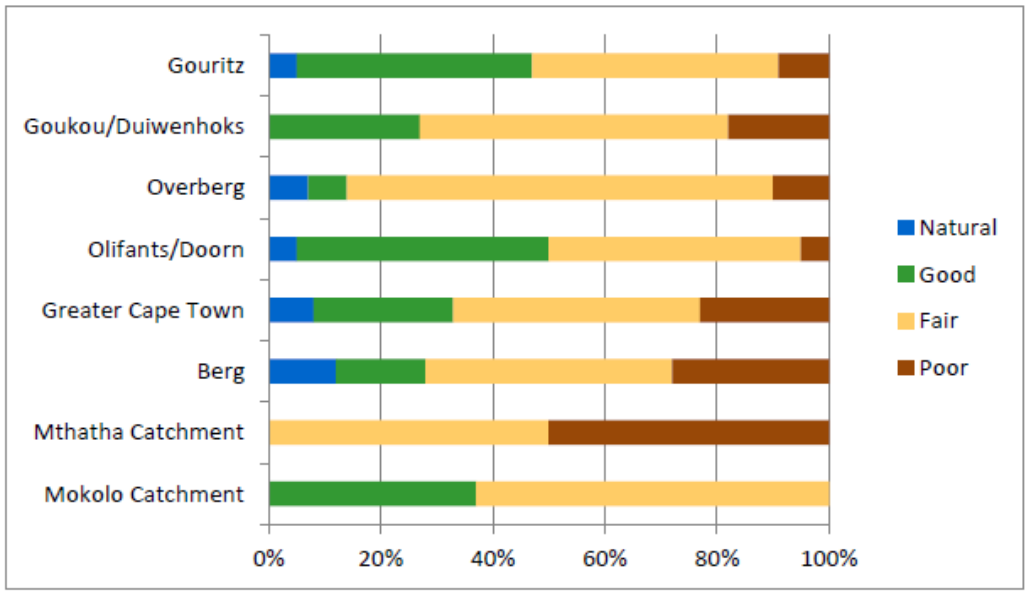


Figure 4.2 Ecostatus of River Health Surveys reported from 2005 to 2006 (DWAF, 2006, DEAT 2012)

4.11.4 Discussion

The indicators being used for reporting are not effectively addressing the problem. There is output reporting but not outcome reporting, i.e. there is quantitative reporting, which is simple and easy to produce but is not representative of the effectiveness of outcomes; and there is a lack of qualitative reporting, which is a more complex reporting process. There is very little reporting on the outcomes of the environmental programmes being implemented. As such, there is no measure against achievement of Constitution Section 24, whether enforcement-driven or otherwise.

4.12 Achievement

The achievement indicator questions whether the regulatory framework is in the process or completed a particular task. In other words, has or will the regulatory framework achieve Section 24 of the Constitution; and has or will the regulatory framework achieve enforcement-driven rehabilitation of watercourses?

4.12.1 Enabling Environment

In terms of the MPAT reporting and the DPME's Midterm Review of the Priorities of Government (2012) the following achievements were reported *inter alia* for the first 5years of the MPAT system (DPME, 2012:36):

- *"Progress has been made on setting water use efficiency targets for the agriculture sector, with efficiency targets set for Impala, one of the 14 big irrigation schemes"* (DPME, 2012:36).

  Comment: Water use efficiency was not one of the initial commitments in terms of Outcome 9. The achievement however is good progress for fulfilment of water efficiency initiatives. Water efficiency is linked to the sustainable use of water, however it does not contribute to the improved quality of available water.

- *"In order to meet the effluent standards, 810 municipal wastewater treatment and 914 water treatment facilities were assessed during the 2010/2011 financial year" (DPME, 2012:36).*

  Comment: Commitment (iv) referred to improving the capacity to treat wastewater by upgrading 80% of the wastewater treatments plants by 2015, and increasing the percentage of wastewater treatment plants meeting water quality standards to 80% by 2014. Assessing a wastewater treatment plant does not increase its capacity or improve its compliance with water quality standards. Implementation of upgrades and maintenance do. This achievement is therefore irrelevant.

- *"The Blue Drop certification programme of 2011 verified the status of drinking water quality and management of supply systems of 162 municipalities. A total of 66 water supply systems have been awarded the Blue Drop certificate for the 2010/11 period"* (DPME, 2012:36).

  Comment: Blue drop status refers to the status of water services, a function of Section 27 of the Constitution. This achievement is irrelevant.

- *"*The Green Drop assessment measures performance of wastewater treatment works. *The number of systems assessed increased from 449 in 2009 to 821 in 2011. The number of systems that scored more than 50% increased from 216 in 2009 to 460 in 2011" (DPME, 2012:36).*

  Comment: The Green Drop report measures performance of wastewater treatment works to a variety of indicators of their operation, a function of Section 27 of the Constitution. Neither being awarded green drop status, nor being more than 50% compliant, means that the treatment works actually comply with water quality discharge standards (Due to the poor indicator rating system, a waste water treatment works can be non-compliant to the discharge quality requirements and still have received

Green Drop Status). Poor quality discharge water has seriously degraded the aquatic ecosystems. This achievement is irrelevant.

- *"The backlog of water use licences is being cleared. Cumulatively from April 2011 to December 2011, 669 applications were finalised with 173 assessed and awaiting final sign-offs. Applications for agriculture, power generation, municipalities, stream flow reduction activities, mining, industries, government agencies and developers have been prioritised" (DPME, 2012:36).*

  Comment: This achievement was not one of the Outcome 9 commitments or objectives. Processing the backlog of applications will however go a long way to reducing illegal activities and administratively manage water resources.

- "*47 municipalities were supported in implementing water conservation and demand management intervention measures to ensure water savings. As a result of interventions put in place to support municipalities through the Accelerated Community Infrastructure Programme, 62.9 million cubic metres of water were saved against the planned 3 million cubic metres*" (DPME, 2012:36).

  Comment: This is a great achievement however it was not one of the Outcome 9 commitments or objectives. Furthermore, setting only 3 million cubic metres of water saving as the target was an insignificant target. In 2004, the country's total demand for water was 12.871 billion cubic metres of water per annum (DWAF, 2004). As population increases, economic development occurs, production demand increases, therefore the overall demand for water has also significantly increased from 2004 to 2012. Water use efficiency is important to resource management, to ensure there is access to water for the future. However this achievement is irrelevant.

- "*A budget of R225 million has been approved for the 2011/12 and 2012/2013 financial periods for the pumping and neutralisation of acid mine drainage (AMD) in the Witwatersrand area. Concerted efforts are being made to ensure that the mines that are regularly monitored for compliance to their water use licences. To date 58% of the 61 mines monitored are compliant*" (DPME, 2012:36).

  Comment: A great achievement, however this was not one of the Outcome 9 commitments or objectives. The report also makes no mention of neutralisation activities for the Witbank area, which has already contributed

significantly to water quality degradation of both potable water supplies and natural resources.

- "*Work to rehabilitate wetlands continued, with approximately 492 wetlands rehabilitated, and monitoring was conducted in the Crocodile catchment at 33 river sites*" (DPME, 2012:36).

  Comment: The report does not distinguish if these are 492 physical rehabilitation interventions, or 492 actual wetlands that were rehabilitated, or if the 492 rehabilitated wetlands was achieved over the monitoring period or cumulatively since the start of the Working for Wetlands Programme. One wetland rehabilitation project may include several interventions, and one wetland rehabilitation may require several projects. The Outcome 9 commitment by Government was to increase the number of wetlands rehabilitated from 75 in 2010 to 150 per year in 2014. As the outcome reported is unqualified, it is unclear if this commitment has been achieved. However, the work done is acknowledged.

- "*The time taken to review and make decisions on environmental impact assessment (EIA) applications has improved. Additional interventions are being implemented to make way for an integrated environmental licencing system, which will continue to streamline the environmental licencing processes required for development projects. As at December 2011, 19 712 environmental impact assessment applications have been received, with 17 185 finalised and 2 528 still in process*" (DPME, 2012:37).
  Comment: This achievement was not one of the Outcome 9 commitments and objectives. It is however acknowledged as being a good achievement, but irrelevant to the matter at hand.

- "*The draft atlas for the National Freshwater Ecosystems Priority Areas (NEFPA) was completed, together with its associated implementation manual, providing spatial data of priority freshwater ecosystems. With 65% of wetland ecosystem types and 57% of river ecosystem types already threatened nationally, the NEFPA tools will inform planning and decision-making on matters that have implications for freshwater ecosystems. The NEFPA identifies rivers and wetlands that need to stay in good ecological condition to support the sustainable use and development of water resources. The focus and emphasis for the rest of the term will be on supporting the use and uptake of the maps in planning*

and decision-making that impact on water resources and freshwater ecosystems for social and economic development" (DPME, 2012:37).

Comment: The outcome 9 commitment (iii) by government was to significantly increase the number of rivers with healthy ecosystems from 8 in 2010 to 16 by 2014. This achievement maps the location of freshwater ecosystems across the country and prioritises them. This achievement does not improve the state of health of the ecosystems of the country's rivers. Furthermore, the tool development based on spatial layering still requires extensive verification and validation. With regard to the figures mentioned in the DPME report, the figures mentioned in the report do not align with the figures quoted earlier in the same report. I.e. in the background information section, the report lists that 82% of river ecosystems are threatened and 50% of wetlands destroyed; whereas in the section on achievement it refers to 65% of wetlands and 57% of river ecosystems as already being threatened over the same time period. While a good initiative, this achievement is irrelevant to the matter at hand.

Despite some good initiatives, in the opinion of the author, the achievements reported in the Midterm Review do not address the Outcome 9 commitments nor the objectives that Government set out in 2009. Furthermore, the GWM&ES was originally designed to conduct a policy performance evaluation, i.e. to ensure that policies being implemented by Government were actually achieving their intended objectives, and contributing overall to their sector's development and overarching constitutional right. The GWM&ES system was changed to the MPAT outcomes-based monitoring. The commitments and objectives that were set in 2009 by Government were not policy-linked outcomes. As commented on, the specific achievements reported in terms of the Outcome 9 have not been achieved, and the reporting on policy performance as originally intended by the GWM&ES has also not been achieved.

4.12.2 Institutional Roles

The Environmental Management Inspectorate programme continues to be rolled-out at various institutions. A key achievement is the increasing number of designated EMIs operating in the regulatory framework.

4.12.3 Management Instruments

The South African Environmental Outlook Report 2012 outlines the state of the South African environment. Excerpts from the report are included:

- "*According to the Atlas of National Freshwater Ecosystem Priority Areas (NFEPA) tributary rivers are in a far better condition than main rivers (Nel et al. 2011). Changes to the condition of a river can be attributed to the loss of natural vegetation, urban expansion, cultivation and mining within a river's catchment area. When the condition of a river declines it will disturb the ecological functioning of rivers and its ability to provide ecological services to surrounding communities* (Nel et al. 2011)" (SAEO, 2012:24).

- "*The National Biodiversity Assessment (NBA, 2011) concluded that in many areas of South Africa, the outright loss of wetlands is estimated to be more than 50% of the original wetland area (Driver et al. 2005:7)"* (DEA, 2012:25)

- "*When compared to the results within the 2006 South Africa Environmental Outlook it can be seen that water quality condition is continuing to deteriorate. This is especially evident near major urban areas and around Gauteng. The results show that concentrated and multiple water quality problems are experienced in areas affected by land transformation, urban settlements and areas highly impacted by people. Compound effects from agriculture, industrial development (including mining) and urban development have had a large effect on the quality of water and its fitness for use."* (DEA, 2012:14).

- "*Of grave concern is that all the dams have been classified with a serious (>0.13 mean annual TP mg/l) or significant (0.047< or ≥0.13 mean annual TP mg/l) risk of algal productivity. This would be expected with high nutrient loads.*" (DEA, 2012:16).

- "*Groundwater pollution and over-abstraction are serious problems in certain parts of South Africa. Poor and deteriorating groundwater quality is widespread and can be attributed to diverse sources in sectors such as mining, industrial activities, effluent from municipal wastewater treatments, storm water runoff from urban and especially informal settlements (where adequate sanitation facilities are often lacking), return flows from irrigated areas, effluent discharge from industries and various other sources* (DWA 2010b)." (DEA, 2012:18).

- "*Pressures are created on these systems* [aquatic ecosystems] *by impacts such as pollution, soil erosion or deposition, extraction of water, afforestation, shifting distribution patterns of fauna and flora, large dams,*

inter-basin transfers and the introduction of invasive alien species. These factors are leading to wide-spread and rapid deterioration of freshwater ecosystems in South Africa (Nel *et al.,* 2011; SAEON 2011; Driver *et al*., 2004)." (DEA, 2012:21).

The sections of the SAEO (2012) presented in this section, illustrate the deteriorating state of the country's aquatic ecosystems. There are many reasons as to why, such as limited budget, poor capacity, unclear objectives, etc. but implementation of the management mechanisms of the general regulatory framework are not achieving their objective of providing the environmental right contemplated in Section 24 of the Constitution.

4.12.4 Discussion

There is no measured or reported achievement of Section 24 of the Constitution through the environmental enforcement process, nor the general regulatory framework. Despite appropriate mechanisms being in place, the state of the South African environment, in particular water resources, continues to decline.

4.13 Summary of Issues

From this critical evaluation of the regulatory framework, key gaps and issues were identified and discussed. These are summarised according to enabling environment, institutional roles, and management instruments.

4.13.1 Enabling environment issues

i. The NEMA and NWA legislation does not provide for the redress of past poor management and environmental degradation. The NEMA section 28(1A) makes provision for issuing a directive in terms of duty of care for impacts that could be as a result of past actions. However where there is no juristic or natural person to issue the directive to, the Department of Environmental Affairs will be responsible for the rehabilitation in terms of Section 28(7). Rehabilitation activities are subject to the same strenuous conditions as new developments, making them costly to implement. Recommendation: The NEMA should include a particular section or chapter to specifically address rehabilitation of the environment, providing sections on requirements of a rehabilitation plan and monitoring plan.

ii. The NEMA and NWA legislation lack important definitions, in the context of compliance and enforcement, for example "effect", in terms of "effect of the

incident" is not defined. This opens a gap for subjective interpretation, for example that "effect" is limited to effects on the site at a specific time as a result of the incident rather than the cumulative effect on the environment as a result of the incident over time.

Recommendation: These definitions should be inserted into the legislation and unambiguously defined.

iii. The two key enforcement mechanisms, NEMA section 31L and NWA Section 53(1) do not specifically include the requirement for the rehabilitation of resultant environmental degradation from contravening activities. These sections focus on rectifying the contravention or breach in law, but not the effects of the contravention. This is a key gap in the enforcement legislation. Despite the improvements in criminal measures, Craigie (2005:54) points out that one of the noted shortcomings of enforcement tools, that the criminal measures fail to address, relates to the environmental harm caused as a result of the offence.

Recommendation: Include a subsection in NEMA Section 31L and NWA section 53(1) to specifically remediate the impact or effects of the contravention.

iv. The proactive (licensing and permitting) sections of the legislation are prescriptive in their composition, requiring detailed assessments of the impact of potential activities (refer NEMA Sections 23(2)(b), 24(4)(a)(iv) and 24G(1)(i)). However, the enforcement sections provide minimal requirements; only NEMA Section 28(4) includes provisions. NEMA Section 31L and NWA Section 53(1) require no identification or assessment of the extent of the effect/impact of contravening activities. This limits the effectiveness of enforcement-driven rehabilitation~~,~~ to the specific requirements of the enforcement official and what they observed during the site inspection.

Recommendation: The NEMA Section 31L and NWA Section 53(1) should be amended to include specific provisions for the identification and assessment of the extent and significant of impacts/effects of contravening activities, as well as to make provision for the compulsory requirement of rehabilitating the identified effects/impacts. These impacts should not be limited to bio-physical impacts but should also include social, economic, cultural and heritage impacts.

4.13.2 Institutional roles issues

i. The structures of the institutions involved in water resources management i.e. DEA, DWS and other spheres of government, are aligned with the sections of the legislation, and the proactive management of the country's water resources. However there is no component that focuses on rehabilitation, for example tasked with identifying rehabilitation needs, implementing rehabilitation projects, monitoring rehabilitation whether initiative-driven or enforcement-driven rehabilitation. Such a unit could address the rehabilitation needs of retrospective environmental degradation, especially with the State now accountable for such rehabilitation, as well as providing assistance and support to initiative-driven and enforcement driven rehabilitation projects, especially in terms of planning, setting objectives and providing technical guidance.

   Recommendation: To implement a rehabilitation sub-directorate within the institutional structures in order to address rehabilitation of historic environmental degradation, for example old and abandoned mines, rehabilitation of Government caused degradation for example impacts to water resources by non-compliant waste water treatment works, as well as to provide support and guidance to public driven or enforcement driven rehabilitation projects.

ii. There are several overlapping statutes affecting water resources. There are a variety of institutions in the differing spheres of Government tasked with enforcement of their respective legislation. This leads to fragmentation of enforcement efforts.

   Recommendation: In order to overcome this fragmentation it is necessary to develop a central agency with officials that are mandated in all the environmental legislation. This will reduce overlaps in mandates, reduce fragmentation of efforts, and enable more effective enforcement, and holistic rehabilitation of environmental degradation. Furthermore, increasing the powers of existing officials to enforce all environmental legislation, will increase the capacity (volume) of enforcement officials to carry out compliance and enforcement activities, a key challenge to implementation of the regulatory framework.

iii. There is insufficient capacity and capability within the institutional bodies in general, and especially in the compliance and enforcement sector. This limits the implementation of the regulatory framework, and thereby limits its effectiveness.

Recommendation: There is a need for more administrative support to the existing capacity. This support is not limited to training, as officials tend to change jobs once they have received training, but rather support through tools, processes or mechanisms so as to support decision making and assist the existing contingent of enforcement officials in their day to day functions, in order to ensure improved effectiveness of the compliance and enforcement sector.

4.13.3 Management instrument issues

i. The NWA applies an eco-centric approach to resource management through the catchment management approach. This enables the management of resources to be flexible and responsive to the needs and characteristics of each catchment. This is in keeping with the holistic concept of sustainability. Whereas the NEMA applies an anthropocentric approach to resource management, institutional responsibilities and management instruments are limited by political boundaries, which the environment does not adhere to.

Recommendation: The NEMA should review a catchment management approach, for example, aligning geographic listed activities to water management areas rather than political boundaries and thereby be more responsive to the environmental resources it manages rather than being responsive to the politics of the day.

ii. Without qualitative monitoring and reporting, i.e. measuring the actual improved health of the environment as a result of interventions (whether proactive or reactive), it is unclear whether the regulatory framework, its policies, legislation or management instruments are being effective in their objectives, and contributing to the achievement of Section 24 of the Constitution. This is a key gap in the monitoring and review of policy implementation.

Recommendation: A policy review is needed of the water resources management sector, compliance and enforcement, and rehabilitation sectors. An appropriate qualitative monitoring programme should be developed to measure the actual environmental health across the country, and thereby set appropriate management and rehabilitation objectives, to improve this current state, and against which to monitor progress of outcomes of initiatives and the general objects of the statutes.

4.14 Conclusion

The regulatory framework is well structured despite requiring a few amendments; however it is limited in its implementation. There is insufficient focus on the role and contribution of rehabilitation, both proactive and enforcement-driven, to contribute towards the achievement of Section 24 of the Constitution; it is important that this is remedied in the legislation. Similarly, the role of rehabilitation needs to be accommodated in the institutional structures as well. The judiciary holds the enabling environment, institutional roles and management instruments accountable for achieving the environmental right, even within the context of compliance and enforcement. Therefore the role of compliance and enforcement in achieving the environmental right is acknowledged. However the actual implementation of the framework in terms of responsiveness, adequacy, effectiveness, capacity, capability and reporting require some attention. Based on the delays in implementation of management measures, fragmentation in the institutional structures and functions, the lack of rehabilitation of environmental degradation, and a State of the Environment Report that illustrates that the water resources of the country are continuing to decline, this critical evaluation concludes that currently the regulatory framework is not contributing to the achievement of Section 24, the environmental right.

Craigie, *et al*., (in Paterson and Kotze, 2005:60) anticipate the findings of the critical evaluation: “South Africa’s environmental compliance and enforcement regime has thus far unfortunately developed in a rather piecemeal manner, focusing on various priority areas and relying heavily on traditional criminal and administrative measures. Pressing capacity and resource constraints, fragmented institutional structures and political pressure for immediate visual results have effectively stunted not only the implementation of these traditional measures but also undermined the opportunity for relevant authorities to step back from their regulatory functions in order to think critically about how to formulate a more effective environmental compliance and enforcement regime for South Africa.”

5 COMPLIANCE AND ENFORCEMENT: STATUS QUO

The critical evaluation of the water resources regulatory framework highlighted some of the challenges and gaps in the enforcement sections of the legislation, institutional structures and management measures. The evaluation highlighted that although compliance and enforcement activities, and in particular, enforcement-driven rehabilitation, have a role to play in achieving the environmental right in terms of Section 24 of the Constitution, these were not being developed or utilised appropriately as opportunities to improve the state of the environment. However, it is not sufficient to review the policy framework alone; the operational aspects of compliance and enforcement also need to be reviewed. This chapter provides an overview of the operational aspects of compliance and enforcement, and the challenges are illustrated in the Case Study of the Bryanston Bicycle Park.

This chapter aims to answer the following question:

i. How is operational compliance and enforcement in the context of the water resources regulatory framework carried out in South Africa? Identify the key challenges.

5.1 Compliance and Enforcement

This section outlines the general compliance and enforcement process applied for environmental contraventions, in particular brown sector (land use activities) cases which include contraventions affecting watercourses.

5.1.1 The enforcement process

The basic enforcement process, as outlined in the Environmental Management Inspector Training Manual, as it pertains to various environment related statutes, is illustrated in Figure 5.1.

The process commences with a site inspection either to monitor compliance of permit conditions, or as a result of a complaint received from the public. Should a violation be identified, the routine site inspection is upgraded to an investigation. If there is a contravention then the official issues a written warning (called a pre-notice,

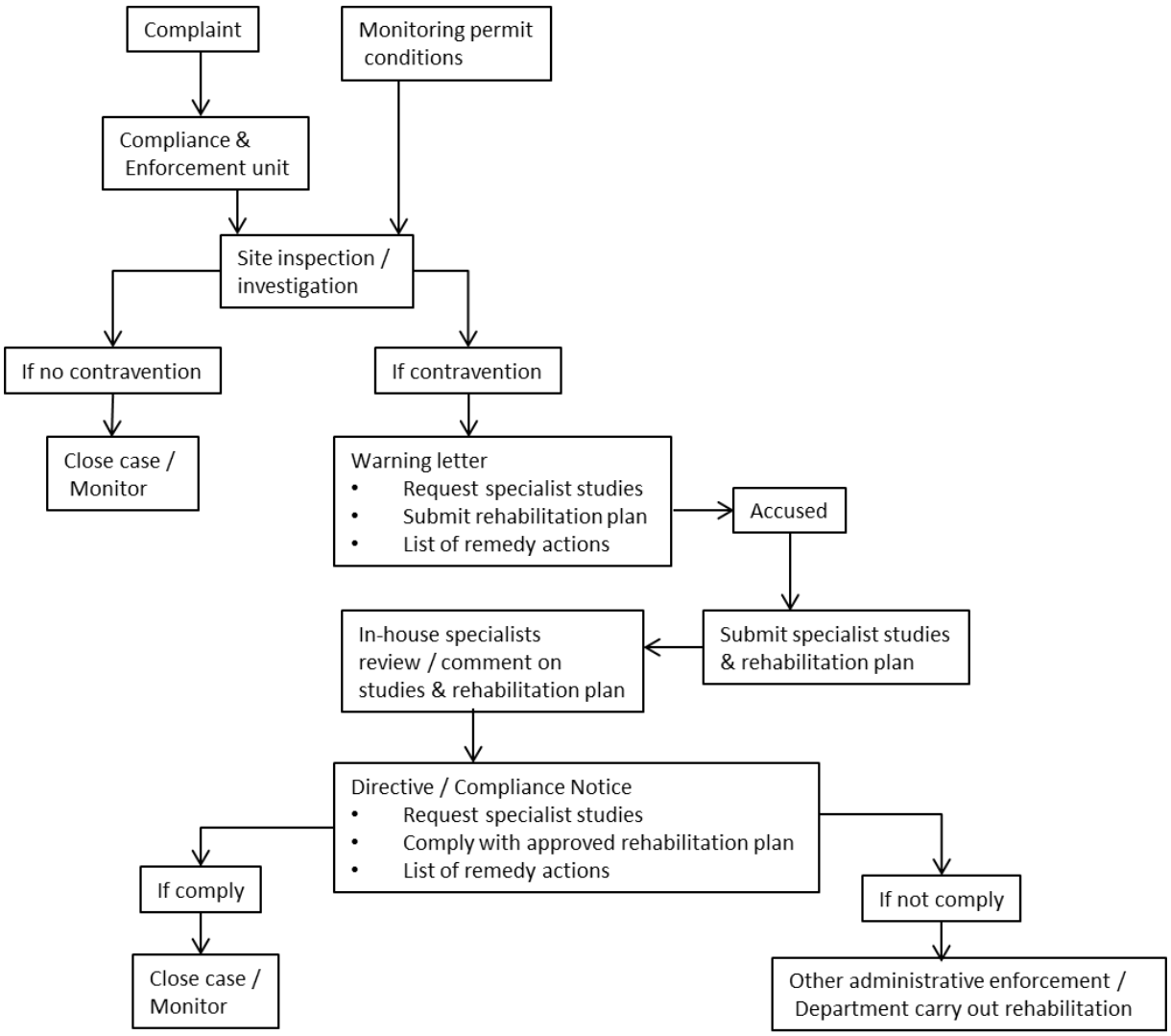


Figure 5.1 The basic enforcement process for issuing administrative notices.

i.e. pre- directive or pre-compliance notice) notifying the transgressor of the Department's[14] intention to issue an administrative notice (Directive or Compliance Notice).

This warning notice also includes a set of instructions to remedy the contravention. These instructions may (note: not must) include the request for specialist studies and a requirement to submit a rehabilitation plan. These

[14] Depending on the transgression will determine which Department is responding e.g. Department of Water Affairs, Department of Environment Affairs, Department of Agriculture, etc.

requirements are limited to the official's observations and capability to observe and interpret ecological impacts as a result of the contravention. These instructions or requirements currently do not include any guidance as to the objectives of the rehabilitation plan or remedial activities, or indicators to measure progress or achievement of the rehabilitation plan.

If specialist studies are requested, these can be (not must be) reviewed by Department specialists if they are available. Upon acceptance of these studies and rehabilitation plan, the official will then issue the directive or compliance notice instructing the transgressor to carry out implementation of the rehabilitation plan. Criminal and civil prosecution may be carried out concurrently to the administrative notices, or as a result of non-compliance with the administrative notices. Table 5-1 provides a summary[15] of the different administrative notices applicable to water resources and the responsible institution.

In compliance with law, the instructions of the directive or compliance notice must be the same as the instructions in the warning pre-notice. Should new information come to light, or any necessary deviations be required, then the existing warning notice must be withdrawn in writing and a new warning notice with those additional requirements or deviations must be issued. Furthermore, once a contravention has been addressed, the same contravention may not be addressed again, in other words a new offence with new evidence is required. This implies that there is only one opportunity to ensure that the appropriate rehabilitation is identified and carried out.

In many cases, the instructions for rehabilitation are commonly issued prior to the detailed studies, resulting in substantive science only being introduced into the enforcement process by the specialist studies after the warning notice is issued. Where in-house specialists are utilised, they are usually brought into the process too late, or only asked to review rehabilitation plans once the warning notice has already been issued.

[15] Correct at the time of drafting the thesis.

Table 5-1 Summary of administrative enforcement mechanisms and responsible institutions.

Institution	Applicable Legislation	Mechanism	Objective	Sphere of Government	Enforcement Inspectorate
Department of Water and Sanitation	National Water Act, Act 36 of 1998	s.19(3) Directive	Prevention and remedying effects of pollution	National, Regional, CMA	Water Control Officer
		s.20(4)(d) Directive	Control of emergency incidents		
		s.53(1) Directive	Rectification of contravention	National, Regional	
Department of Environmental Affairs	National Environmental Management Act, Act 107 of 1998 and SEMAs	s.28(4) Compliance Notice	Duty of care and remediation of significant pollution or degradation of the environment.	National, Provincial	Environmental Management Inspectorate (EMI)
		s.24G Directive	Direct removal and remediation of unauthorised structures		
		s.30(6) Directive	Control of emergency incidents		
		s.31L Compliance Notice	Contravention of the law or a condition of authorisation		
	National Environmental Management: Biodiversity Act, Act 10 of 2004	s.69(2) Directive	Contravention of applicable permit (alien species)	National, Provincial	Competent Authority
		s.73(3) Directive	Contravention of applicable permit (invasive species)		
	National Environmental Management: Waste Act, Act 59 of 208	s.37(1) Directive	Independent site assessment	National, Provincial	Minister or MEC
		s.38(2) Remediation Order	To remediate / rehabilitate		
	Environment Conservation Act, Act 73 of 1989	s.31A Directive	Where environment is damaged, endangered or detrimentally affected.	National, Provincial, Municipal	Government Official
	Mountain Catchment Areas Act, Act 63 of 1970	s.3 Directive	Regulations to conserve land within a defined “Mountain Catchment Area” and 5km buffer.	Provincial	Any duly designated officer of a Department of State

Department of Agriculture, Forestry and Fisheries	Conservation of Agricultural Resources Act, Act 43 of 1983	s.7 Directive	To comply with a control measure.	National Municipal Irrigation Boards	Executive officer and authorised persons
	GN R1048 in terms of section 6 of the Conservation of Agricultural Resources Act, Act 43 of 1983	s.4(2) Directive s.6(2) Directive s.13(2) Directive s.14(2) Directive s.16(3) Directive	Contraventions of specific control measures		
	National Forest Act, Act 84 of 1998	s.4(8) Written Notice	Breach of a particular standard	National, Provincial	Forest Officer
Department of Mineral Resources	Mineral and Petroleum Resources Development Act, Act 28 of 2002	s.45(1) Directive	Ecological degradation, pollution or environmental damage	National	Minister
		s.46 Instruction	Remedy environmental damage (where no mine owner)		Minister
		s.93(1) Order	Contravention of the Act		Authorised person
South African Heritage Resources Agency	National Heritage Resources Act, Act 25 of 1999	s. 45(1) Compulsory Repair Order	Prevention of disrepair of a heritage resource	Regional	Heritage Inspector SAPS
		s.50(10) Stop Order	Stop or prevent degradation of a heritage resources		
Department of Safety and Security	South African Police Service Act, Act 68 of 1995	Section 64E No specific written mechanism	Contravention of legislation and constitutional rights	Municipal	South African Police Service (SAPS)
National Disaster Management Centre	Disaster Management Act, Act 57 of 2002	s.27(2) Directive	Post-disaster recovery and rehabilitation, and preventing escalation of a disaster	National	Minister (member of cabinet appointed)
		s.41(2) Directive	Post-disaster recovery and rehabilitation, and preventing escalation of a disaster	Regional	Premier of the Province
		s.55(2) Directive	Post-disaster recovery and rehabilitation, and preventing escalation of a disaster	District Municipality	Municipal Council

Local Municipalities	South African Police Service Amendment Act, Act 83 of 1998	J534 Fines	Non-compliance	Local Municipality	Municipal Police
	Applicable Municipal By-laws	J534 Fines By-Law Notice	Non-compliance		
	Environment Conservation Act, Act 73 of 1989	s.31A Directive	Where environment is damaged, endangered or detrimentally affected.		
	National Health Act, Act 61 of 2003	s.83 Compliance Notice	Non-compliance	District Municipality	Environmental Health Inspector

These in-house specialists are not usually included in identifying and drafting the rehabilitation objectives or requirements in the warning notices, as they are located in a separate directorate with different mandates. For example, many specialists are located in the respective provincial directorates of nature conservation, and are tasked with the day to day management and proactive management for sustainable ecosystem management, as opposed to compliance and enforcement activities.

In the basic day-to-day enforcement process the official provides limited, if any, guidance as to:

- the impact or the disturbance of ecological functions as a result of the contravening activity;
- objectives that the rehabilitation plan needs to achieve in order to remedy the impacts of the pollution or ecological degradation; or
- Indicators to monitor progress or achievement of the rehabilitation.

This is highlighted in Case Study: Bryanston Bicycle Park (later in this chapter), which highlights the focus on legal box-ticking rather than environmental rehabilitation. Where integrated and targeted enforcement programmes are initiated, such as to monitor a particular industry sector e.g. the paper and pulp industry, a more concerted effort for cooperation between the institution's enforcement units and use of appropriate specialists is undertaken.

While the mandate of regulation is to ensure compliance with the legislation (the quantitative aspect), it also requires the prevention of pollution and ecological degradation (the qualitative aspect). Thus the instructions contained in the directives and compliance notices, while complying with legal processes, also need to set out clear objectives and activities to ensure rehabilitation of contraventions to remedy the effects of pollution and/or ecological degradation. An example of this focusing on the illegal activity and providing little guidance on the rehabilitation activity is given in **Box 2.** The example is an extract from a Directive notice issued by the Department of Water and Sanitation.

BOX 2. Extract from a Notice of Intention to issue a Directive in Terms of Section 53(1) of the National Water Act, 1998 (Act 36 of 1998) (NWA). The activity in particular is a new housing estate that channelled its stormwater directly into a pan (type of wetland).

…

2. The directive that I intend to issue relates to you using water in contravention of the provisions of Chapter 4 of the NWA, specifically Section 22. The intended directive will direct you to stop the unlawful water use(s) within two days from receipt thereof.

3. I have reasonable grounds for believing that you have commenced with or are continuing with an activity defined as a water use in Section 21(c) and 21(i) of the NWA without authorisation as required in terms of Section 22. I have reached this opinion as a result of the following:

4. The Department received a complaint regarding the above matter and officials responded by undertaking site inspections of the property on 8 June 2006, 11 July 2006 and 12 January 2007.

4.1 The findings on the site indicate that you have altered the banks of the watercourse on the property by constructing storm water discharge canals on the banks into the pan, a Section 21(i) water use, on the property without the necessary authorisation in terms of the NWA from this Department.

4.2 The findings on the site also indicate that you have impeded the flow of water in the pan and, altered the banks, bed, course or characteristics of the pan by constructing a bird hide in the pan, section 21(c) and (i) water uses on the property without the necessary authorisation in terms of the NWA from this Department.

or

5. The water uses on the site are as follows:

5.1 Impeding or diverting the flow of water in a water course and altering the bed, banks, course or characteristics of a water course – Section 21(c) and (i)

6. In accordance with Section 3 of the Promotion of Administrative Justice Act, 2000 (Act 3 of 2000), I hereby afford you an opportunity to make representations in writing to me by close of business on **1 May 2007**, should you believe there are any compelling reasons for me not to exercise my powers in terms of Section 53(1) of the NWA to issue a directive which will require you to, amongst others:

6.1 Stop impeding or diverting the flow of water in a watercourse;

6.2 Stop altering the beds, banks, course or characteristics of a water course;

6.3 Submit a storm water management plan to this office;

6.4 Submit a Rehabilitation Plan within 30 days from receipt of the directive for approval to this Department;

6.5 Submit an Gauteng Department of Agriculture, Conservation and Environment (GDACE) approved Environmental Management Plan (EMP) to this office for comments, inputs and approval before rehabilitation work starts, and

6.6 Remove all structures and rehabilitate the bed and banks of the watercourse at your own cost.

7. I would also like to bring to your attention that to use water without an authorisation constitutes an offence in terms of Section 151 of the NWA.

The Notice is focused on bringing the activity into legislative compliance. However:

- Points 4 and 5 explain which listed activities (i.e. NWA 21(c) and 21(i)) required authorisation prior to commencement; however it does not specifically identify any environmental impacts as a result of these activities.
- With regard to point 6:
    - Point 6.1 and point 6.2 instruct the listed activities to stop. However the degradation or impacts as a result of these activities are not identified and may have a continued impact despite the listed activity being stopped i.e. stormwater will still flow into the drain, and drain into the pan, thereby altering the ecological state of the pan.
    - Point 6.3 requests the submission of a stormwater management plan. However there is no requirement that this plan should be compiled by a professional engineer or a hydrologist.
    - Point 6.4 requests the submission of a rehabilitation plan. There is no guidance as to what the rehabilitation plan should address. The stormwater drainage network can be rehabilitated to drain away from the pan. However, the potential accumulation of water, sediment, heavy metals, and hydrocarbons into the pan as a result of the contravening activities is not specifically required to be addressed in the rehabilitation plan. Further, the rehabilitation plan is not required to be compiled by an aquatic ecologist, wetland specialist or any particular specialist.
    - Points 6.4, 6.5 and 6.6 do not identify or request the identification of the ecological impacts to the pan. For example:
        - Water quality assessment due to the accumulation of contaminants being washed in the runoff into the pan.
        - Hydrology assessment due to the increased water level thereby altering the ecosystem of the pan from a pan-type wetland environment to a dam (this alters the plant and bird biodiversity).
        - Assessment and removal of silt washed from the stormwater drainage area into the pan that has impacted on habitat provision and filling up of the pan.

      As the requirements for EMP and rehabilitation plan do not specifically address these issues, the specialist is not required to

consider them in compiling the EMP or rehabilitation plan. Therefore these documents can thus solely focus on the removal of structures and their rehabilitation and not consider the rehabilitation of the ecological impacts.

- There are no objectives for the rehabilitation plan, i.e. should the rehabilitation aim to restore the pan to its pristine state (which it was prior to construction of the housing development), or to rehabilitate some ecological functions of the pan, or to mitigate further damage but leave the ecological state of the pan in the current impacted state.
- There is no requirement to include a monitoring plan to measure progress of the plans (EMP or rehabilitation) or improvement of the ecological state of the pan as a result of the implementation of the EMP and rehabilitation plan.

Volokh and Marzulla (1996:2) identify that "(t)he current environmental enforcement systems often fail to improve the environment – because of unclear regulations, and because environmental enforcers inappropriately concentrate on technical compliance with regulations and not on improving environmental quality," in other words, that enforcement is currently focused on legislative "box-ticking". In addition, Nonet and Selznick (1978) cited in Scholz (1984:386) explain that "(e)nforcement is not viewed as the mechanical task of finding and penalising violators of unequivocal rules, but rather as the necessary elaboration, correction, and detailed specification of regulations required to achieve the intended public purpose." Craigie *et* al (2009:50) concur and highlight that "(t)here appears to be reluctance among environmental authorities to give compliance advice to the regulated community for fear of being held liable for inappropriate advice." The implication is that current compliance and enforcement action is merely to punish an offender, and bring the activity into compliance with the legislation (legal box-ticking). What is often lost in this administrative focused process is that compliance and enforcement is also meant to rehabilitate the resultant impacts of the contravention, e.g. the qualitative aspect to enforcement. This qualitative aspect supports the Department's (Departments of Water and Environmental Affairs) mandates as per Section 24 of the Constitution (Act 103 of 1996), that: "*Everyone has the right:*

*(a) To an **environment not harmful** to their health or well-being; and*

(b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that-

(a) ***Prevent pollution and ecological degradation*** (emphasis added);

(b) Promote conservation; and

(c) Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

O'Beirne (2011:5) illustrates this focus on legal box ticking, "(o)n one project there were several authority audits during the construction of the project but the findings were often misdirected. For example, the EMP contained a requirement to spray water three times a day. Because drought conditions were prevailing a decision was made to stop spraying with water and to use a chemical bind rather, that could be used far less frequently. The authorities ruled that the failure to spray with water constituted a non-compliance despite the reasoning offered for using the binder instead."

This current lack of qualitative support or guidance in the enforcement regime results in the particular illegal activity being addressed, but the objectives for rehabilitation do not adequately or appropriately address the resultant impacts in the environment. This can be attributed to the "insufficient skills and competences amongst environmental practitioners" (DEA, 2008:31). Similarly, as no specific guidance or standard assessment procedure is provided, adjacent cases may be addressed in contrast or even in conflict to each other, such as different objectives or focus areas, especially where adjacent cases arise at different stages in time. For example in the case of two particular EIA applications in Johannesburg, one property is granted an authorisation with a condition of a 30 metre riparian buffer, while the adjacent property downstream requires a 100 metre riparian buffer.

One of the more concerning potential results of this current enforcement regime is that the enforcing institution could be taken to court by the public for failing to:

- carry out its mandate in terms of providing an environment that is not harmful and protected, and preventing pollution and ecological degradation (Constitution, 1996);

- for failing to rehabilitate the impacts of contraventions to the environment (either by the transgressor or by the Department themselves); or
- to set measureable rehabilitation objectives, especially where the illegal activities have resulted in downstream negative impacts such as damage to property or person(s), e.g. from altered flow regimes.

Therefore, as Ludwig and Iannuzzi (2006) point out, "successful rehabilitation requires specification of desired environmental endpoints, and a generally applicable method for valuing and comparing possible rehabilitation endpoints is needed." This is further supported by Rogers and Bestbier (1997), who contend that the proper documentation of decisions that have been taken, including the reasoning behind those decisions, will provide the institutional memory to keep future management on track and this should be a fundamental principle of administrative justice. O'Beirne (2011:9) concurs that for effective enforcement it is essential to obtain high-quality, consistent and defendable information and to ensure that this information is routinely and systematically available. A well-structured rehabilitation plan that outlines the target impacts to be rehabilitated, the objectives of the rehabilitation, the method of rehabilitation, an implementation plan of rehabilitation and a monitoring plan against which to monitor progress, implementation and improvement as a result of the rehabilitation, should be a standard request in enforcement based administrative notices. The detail of such plans will be populated by the specialist studies.

5.2 Case Study: Bryanston Bicycle Park

This case study provides an example of compliance and enforcement currently being carried out. The case study illustrates the gaps and shortcomings in the enforcement process that was followed. The case study highlights the need for a tool to assist the enforcement officials to identify the ecological impacts that require rehabilitation on the site as a result of contravening activities carried out on the site. The case is the Bryanston Bicycle Park, also referred to as the "Bicycle Park".

5.2.1 Context of the site prior to the Bicycle Park

The site is located on road-reserve land in northern Johannesburg, South Africa. The property is owned by the Provincial Department of Transport and includes a tributary to the Jukskei River and a wetland. The land is earmarked for a large

interchange which will cover the whole site and require canalising the stream; Figure 5.2 indicates this interchange and the bold line indicates the extent of the bicycle park. Prior to establishment of the Bicycle Park, the site was unfenced and used for illegal dumping, squatting and criminal activities. The site had infestations of alien and invasive vegetation. Due to increasing housing density in the upper catchment over the last 15 years, poor stormwater retention and directed stormwater flow into the stream, has resulted in the increased runoff onto and across the site. According to Rountree (2011) and based on historical Google images (Google Earth, 2008), "(i)t is apparent that there was erosive channelling upstream and downstream as well as at some sections of the site prior to the establishment of the Bicycle Park." On the property there are several water and sewerage pipelines and servitudes belonging to the City of Johannesburg Metropolitan Municipality that traverse the stream, as well as several sewer manholes.

5.2.2 Establishing the Bicycle Park and subsequent developments

In 2008 an initiative was started to establish a temporary cycling park on the land until such time as the land is developed for the proposed interchange. The Bicycle Park signed a lease with the Department of Transport. The Bicycle Park then erected fencing around the land to secure it; removed 500 squatters from the property with support from the local police; and removed the illegally dumped waste. Furthermore, the Bicycle Park managed to have several overflowing sewer manholes on site repaired, Figure 5.3. The Bicycle Park then proceeded to develop cycling tracks and erect wooden structures on the land, Figure 5.4, so that cyclists could traverse the stream and wetland without damaging the wetland. On-going removal of alien and invasive vegetation was also undertaken. Educational programmes with descriptive posters about the medicinal value of the plants in the wetland were also erected on the site.

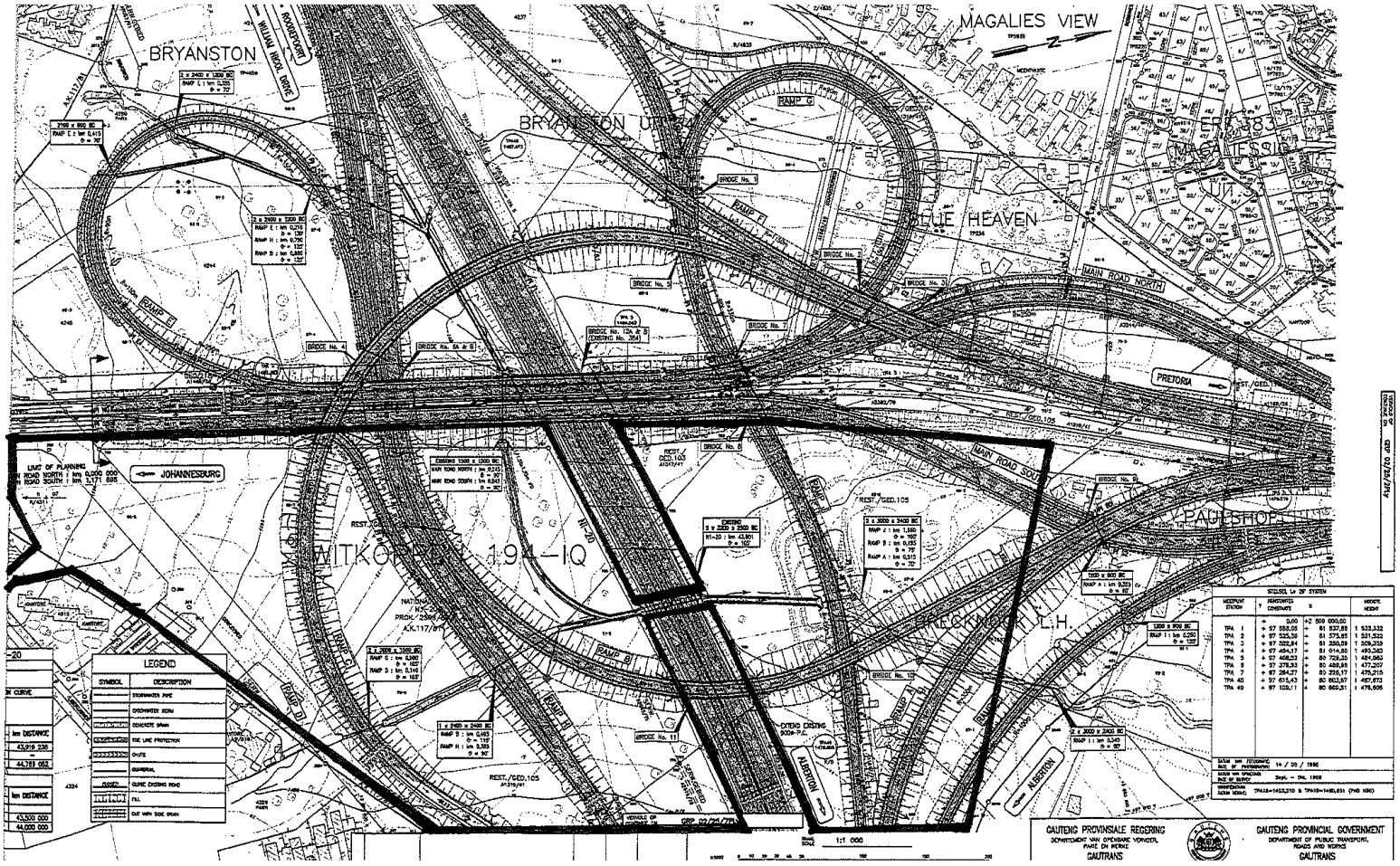


Figure 5.2 Proposed road interchange approved for the site. (Source: Ninham Shand, 1998).



Figure 5.3 One of nine overflowing sewerage manholes prior to the Bicycle Park (Author: 2008)



Figure 5.4 The wooden structures are raised over the wetland to prevent cycling through the wetland and causing damage to the wetland (Author: 2008)

Due to the regular flooding of the site, which poses a safety risk to the cyclists, the Bicycle Park also widened the existing stream channel, Figure 5.5, in an effort to "improve the flow of the stream" i.e. to allow the storm water to drain quicker and prevent flooding of the site. However this "widening" constituted excavation activities, which is a National Environmental Management Act, Act 107 of 1998 (NEMA) listed Activity. The widening of the stream also requires a water use licence in terms of the National Water Act, Act 36 of 1998 (NWA) section 21(i) altering the bed, banks, course, or characteristics of a water course. The widening of the channel led to increased erosion on the site. The Bicycle Park

then installed gabions in certain locations on the site to prevent further erosion of the stream. However, the excavation coupled with the increased stormwater flow resulted in gully erosion and the channelizing of the stream through the wetland.



Figure 5.5 Example of the widening of the stream by the Bicycle Park (Author:2008)



Figure 5.6 Severe gully erosion on the site downstream of the “widened” section of the stream. (Author: 2012)

Subsequent to the establishment of the Bicycle Park, requests by the Bicycle Park and residents were made to the Municipality to improve the management of stormwater in the area to protect the wetland. Flooding both upstream and on the Bicycle park site over the past five years has caused damage to the municipal

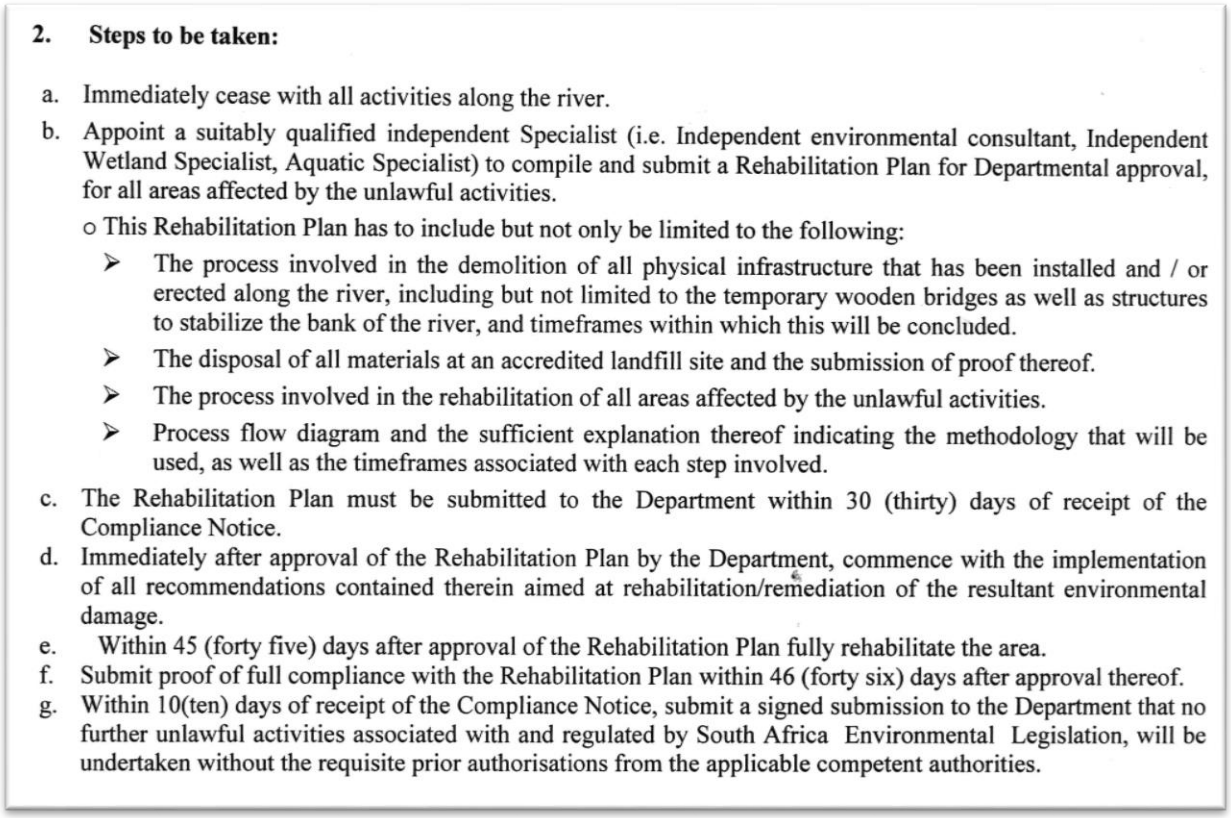
pipe infrastructure, resulting in the Municipality needing to concrete-encase the pipes across the stream on the site. However no mitigation has been implemented to attenuate the flow. The increased flow has exacerbated the erosion in the areas where the Bicycle Park widened the channels causing severe erosion in the stream and wetland (Figure 5.6). Increased urbanisation in the upper catchment of the stream, which has directed stormwater flow into the wetland, coupled with the "widened" channel, resulted in severe gully erosion. Appropriate attenuation and flow dispersal would have reduced the rate of erosion, and mitigated the need for the Bicycle Park to widen the channel in an effort accommodate the flooding. In an effort to prevent further erosion in the stream channel, the Bicycle Park installed several gabions. During several flooding events in the past five years, these gabions were either washed away or severely damaged.

5.2.3 The Complaint

In 2011, three years after the activities of the Bicycle Park, a complaint was received by the Gauteng Provincial Department of Environmental Affairs (Gauteng Department of Agriculture and Rural Development, GDARD) regarding the alleged illegal activities in a wetland and stream. The alleged illegal activities relate to the construction of bridges (wooden structures) within a wetland and the excavation of more than $5m^3$ of soil from a stream, both of which require environmental authorisation in terms of the NEMA prior to conducting the activities. The excavation in the watercourse also required a water use licence in terms of the NWA section 21(i) for altering the bed, banks, course or characteristics of a watercourse.

5.2.4 The Warning Notice

An environmental enforcement official from GDARD conducted a site inspection and then issued a Notice of Intent to issue a Compliance Notice (a warning notice), (Figure 5.7), setting out "rehabilitation activities" (GDARD, 2011).



2. Steps to be taken:

a. Immediately cease with all activities along the river.

b. Appoint a suitably qualified independent Specialist (i.e. Independent environmental consultant, Independent Wetland Specialist, Aquatic Specialist) to compile and submit a Rehabilitation Plan for Departmental approval, for all areas affected by the unlawful activities.

o This Rehabilitation Plan has to include but not only be limited to the following:

- The process involved in the demolition of all physical infrastructure that has been installed and / or erected along the river, including but not limited to the temporary wooden bridges as well as structures to stabilize the bank of the river, and timeframes within which this will be concluded.
- The disposal of all materials at an accredited landfill site and the submission of proof thereof.
- The process involved in the rehabilitation of all areas affected by the unlawful activities.
- Process flow diagram and the sufficient explanation thereof indicating the methodology that will be used, as well as the timeframes associated with each step involved.

c. The Rehabilitation Plan must be submitted to the Department within 30 (thirty) days of receipt of the Compliance Notice.

d. Immediately after approval of the Rehabilitation Plan by the Department, commence with the implementation of all recommendations contained therein aimed at rehabilitation/remediation of the resultant environmental damage.

e. Within 45 (forty five) days after approval of the Rehabilitation Plan fully rehabilitate the area.

f. Submit proof of full compliance with the Rehabilitation Plan within 46 (forty six) days after approval thereof.

g. Within 10(ten) days of receipt of the Compliance Notice, submit a signed submission to the Department that no further unlawful activities associated with and regulated by South Africa Environmental Legislation, will be undertaken without the requisite prior authorisations from the applicable competent authorities.

Figure 5.7 Required rehabilitation activities in the GDARD Warning Notice (GDARD, 2011)

5.2.5 Response to the warning notice by the Bicycle Park

A fluvial geomorphologist and two wetland specialists were appointed by the Bicycle Park. Their studies showed that the channel erosion had commenced prior to the establishment of the Bicycle Park and was increasing due to the increased concentrated and un-attenuated storm water flow from the upper catchment. The erosion had been exacerbated to some degree by the widening of the stream channel by the Bicycle Park, but not by the installation of the wooden structures. Due to the impending development of the interchange only mitigatory actions were identified to be implemented. These included stabilising and preventing further degradation, rather than elaborate and costly rehabilitation that would be removed in the construction process of the road interchange. In addition, maintaining the wooden structures was supported, as removing them would promote cycling through the wetland (which is not a listed activity) but which would in turn cause more severe damage to the wetland. The response by the Bicycle Park also explained the various proactive activities they had undertaken to improve the health of the wetland, such as by removing the illegal dumped waste

and repairing the sewer manholes (Bicycle Park 2011). The Bicycle Park pointed out that erosion would continue to occur as a result of the removal of the remaining gabion structures. Furthermore the erosion would continue due to the increasing stormwater inflow onto the site without attenuation, and that this was the responsibility of the Municipality. Likewise, the concrete encasing of the pipelines was both detrimental to the wetland and unlawful by the same activities, i.e. infilling of $5m^3$ or more in a watercourse (NEMA Regulations 386) and altering the bed banks, course and characteristics of the watercourse (NWA section 21(i)).

The Bicycle Park also highlighted that other institutions should be involved in the remediating process due to overlapping legislation and mandates, as well as other role-players contributing to the cumulative environmental impacts, for example the City of Johannesburg Metropolitan Municipality with regard to the overflowing manholes having a detrimental impact on the water quality and polluting the water resource, The Johannesburg Roads Department with regard to the concentrated stormwater, and the Department of Water Affairs Regional office with regard to impacts on the water course in terms of the National Water Act.

5.2.6 Response by the Department

The report compiled by the primary wetland specialist was not accepted by the Department as it did not address the removal of the wooden structures.

The Department proceeded to issue a Compliance Notice with the same rehabilitation instructions as the warning notice (GDARD, 2012). The argument presented by the Department was that the structures are illegal and must be removed and the site must be rehabilitated to its previous state, despite the fact that the previous state of the property had been in poorer health because of the illegal dumping, squatters, overflowing sewerage manholes and alien and invasive plant infestation.

Furthermore, the Department made no effort to incorporate the other institutions whose mandate was also being infringed, and similarly to include those institutions who were contributing to the impacts on the watercourse. Although the gabions were identified as illegal structures in the watercourse, the resultant erosion and accumulation of environmental impacts on the site as a result of activities taking place upstream of the site were also not addressed by the GDARD.

5.2.7 Response by the Bicycle Park

The Bicycle Park, on its own initiative, contacted the other institutions (including Department of Water Affairs) and role-players to participate in a site meeting, in order to discuss an integrated and holistic way forward on the matter. As these other role-players had not received warning notices, they did not want to participate, as this would be interpreted as an admission of guilt. The other institutions did however attend the site meeting on 21 June 2012, including other Bicycle Park-type initiatives that would be affected by the precedent set in this case, and contributed constructively towards an integrated approach. However, a proposal for carrying out alternative rehabilitation activities on the site in substitution of removing the wooden structures was declined by the GDARD. The Department was only concerned about removing the wooden structures until such time as they were authorised. However, removing the wooden structures would effectively cause the Bicycle Park to close down, as the cycle routes are not accessible without the structures over the wetland, unless the cyclists physically rode through the river and wetland, which although not a listed activity would cause severe environmental degradation to them. The Department of Water Affairs did not pursue the matter.

Due to the impasse with the GDARD, the Bicycle Park has subsequently submitted an application for Section 24G rectification in terms of the NEMA. The Bicycle Park will attempt to mitigate the admission of guilt fine based on the motivation of the other good environmental work the Bicycle Park has carried out on the site. This motivation is supported in writing by various institutions including the South African Police Service and a public petition.

To date the erosion on the site continues to degrade the wetland and watercourse and contribute to downstream impacts of flooding and sedimentation. Figure 5.8 illustrates an erosion gully as a result of on-going directed stormwater onto the site, a new wooden bridge has been constructed over the gully. Note: The location of this photo on the site was not where channel widening activities took place; it is immediately downstream of a stormwater culvert directing flow onto the property.

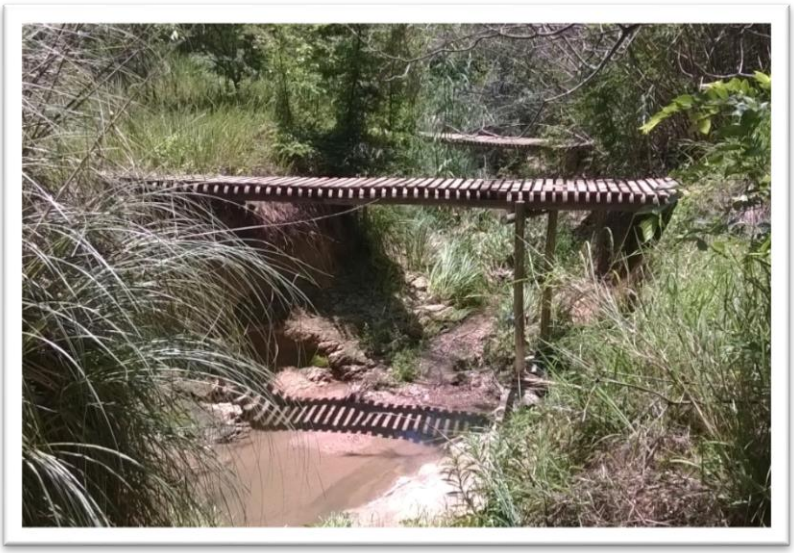


Figure 5.8 Example of ongoing erosion on the site (Author, 2014).

5.2.8 Lost opportunity

The extent of the erosion and loss of riverine function was not considered in the enforcement process. The rehabilitation, directed by the GDARD, was focused on the removal of the wooden bridges which weren't affecting the ecological integrity or riverine functions, and the removal of the remaining gabions which were stabilising the stream banks. The extensive gully erosion, including the downstream illegal activities, was "lost" in the enforcement process. There is a clear lack of understanding of ecological systems, services and functions by the enforcement personnel, as well as lack of guidance on the matter. The enforcement-driven rehabilitation focused on the literal activity, i.e. the wooden bridges, and overlooked the actual ecological degradation and impacts to river functions. Furthermore, the cumulative impact of the other role-players activities or lack of activities, e.g. poor stormwater management entering the site, was not considered. The need for the storm water to be attenuated in order to reduce the flow rate and hence erosion rate through the wetland was not addressed or considered by the GDARD in the enforcement process. The jurisdiction and role of the NWA was also not considered or included by the GDARD.

5.2.9 Discussion

This example is being used to illustrate how the enforcement process is focused on the legislative box-ticking of the activity and not on preventing pollution or ecological degradation and the rehabilitation thereof. For clarity, a discussion with

the complainant identified that they (complainant) “only wanted the gabions to be fixed to prevent further erosion in the stream and wetland and weren’t concerned about the wooden structures” (Personal correspondence).

The GDARD compliance notice identifies the appropriate specialists, however the guidance given by the Department as to what the specialists should focus on, only deals with the removal of the wooden structures and “the areas affected by the unlawful activities” (GDARD, 2011). However, the extent of the erosion gullies extended past the areas of unlawful activities, including upstream, downstream and other stormwater gullies draining into the wetland. The cumulative impact of all the activities impacting on the watercourse was greater than the illegal bridges, gabions and channel widening. However, this cumulative aspect was not considered. Rehabilitating the site of the unlawful activities would be impossible without addressing the stormwater management issue. Rehabilitation of the gully channels would involve installing several gabion or check-dam structures, which in terms of the enforcement notice, the existing ones had to be removed.

The cumulative impacts of not only the wooden structures and the widening of the stream channel, but also of the un-attenuated and increasing storm water, the overflowing sewer manholes and the concrete encased pipelines traversing the stream would require a coordinated approach between the role-players. Consequently this would require a more detailed assessment of the site and the impacts on the ecological services provided by the wetland and stream on the site. Such an assessment would enable the compilation of a more comprehensive rehabilitation plan in order to achieve the sustainable rehabilitation of the site. Alternatively, a set of administrative tools to inform the current capability of enforcement officials of the critical issues on the site and guidelines towards remedying these issues would also improve the accountability and reasonableness of the official’s decision making.

5.3 Operational Challenges

Apart from the policy framework challenges discussed in chapter 3 and 4, there are operational challenges in implementing compliance and enforcement. This are identified through experiential learning and observation through the illustrated case study rather than a formal assessment.

5.3.1 Summary of issues

In summary, the key operational challenges and gaps identified include:

i. In-house specialists

The involvement of in-house specialists (aquatic ecologists, botanists, etc.) in compliance and enforcement cases can be restricted by the non-availability of these specialists due to their primary Conservation Directorate-based work requirements. From the author's experience working in the sector, the in-house specialists are only consulted to review the submitted rehabilitation plans, and not to guide the development / request for rehabilitation plans.

Recommendation: It is suggested that a dedicated ecologist work with the compliance and enforcement units to discuss cases with officials prior to issuing of warning notices, to ensure the instructions contained in the notices are inclusive of appropriate rehabilitation requirements. This will also provide in-house training and experiential learning to the compliance officials for future cases.

ii. Multiple parties

In the case of the Bicycle Park, there were several parties and, hence, several activities that were accumulating in the excessive erosion of the stream channel through the wetland. The Bicycle Park did widen the channel in some parts, in what they believed was beneficial to reduce the flooding on the property as result of the increasing stormwater flowing onto the property. The directed stormwater into the stream and wetland from the new developments in the catchment resulted in increased flows in the stream and wetland. This coupled with the widened channel resulted in the excessive erosion of the stream channel through the wetland. The enforcement process only focused on the Bicycle Park's activities, without considering the role or impact of the increased stormwater onto the site. Similarly, without considering the role of the stormwater in the impacts on the site, the enforcement process was placing all the responsibility on the Bicycle Park to rehabilitate the stream, and the rehabilitation would need to accommodate the increasing stormwater on the site without apportioning responsibility to Jo'burg Roads Agency whose mandate is the management of the stormwater.

The enforcement process, as described in Figure 5.1, does not make provision for integrated enforcement action across several independent transgressors. It requires a unilateral process to be

applied against each individual transgressor. The increased directed stormwater is not an illegal activity, however the resultant impact would fall within the ambit of NEMA section 28 Duty of Care, where the juristic person would be the Jo'burg Roads Agency.

Recommendation: the enforcement process needs to consider and be able to accommodate multiple transgressors and cumulative impacts.

iii. Cumulative impacts

Watercourses, in particular, are systems in the environment, therefore impacts may accumulate downstream of contravening activities. The legislation sections of NEMA section 31L and NWA section 53 do not require an assessment of the impacts or extent (scale, duration, location) of the impacts of contravening activities. Where impacts are identified as a result of contravening activities, these are usually limited to what has been observed by the enforcement official during the site inspection. Similarly, impacts as a result of activities upstream (contravening or otherwise) may also contribute to the cumulative impact of the activities on the particular site. In the example of the Bicycle Park, the widening of the stream would have resulted in some erosion and incision of the channel. However, the change in landuse of the upper catchment and resultant increase in directed stormwater flow increased the extent of erosion and degradation on the site.

Recommendation: It is recommended that an impact assessment, similar to the following NEMA sections, be required as part of the enforcement process and informs the rehabilitation plan:

- NEMA Section 24G(1)(i) assessment of the nature, extent, duration and significance of the consequences for or impacts on the environment of the activity including the cumulative effects;
- NEMA section 23(2)(b) identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities; or
- NEMA Section 24(4)(a)(iv) investigation of the potential consequences for or impacts on the environment of the activity

and assessment of the significance of those potential consequences or impacts.

This will enable all affected parties to work from the same information and understand what impacts the rehabilitation plan needs to address.

v. Multiple enforcement agencies

As highlighted in the previous chapters, there is a myriad of legislation resulting in overlapping mandates and jurisdictions between institutions and spheres of government. In the case of the Bicycle Park, the Department of Water and Sanitation was not involved in the compliance process. Ideally, the GDARD enforcement official should have consulted with the DWS regarding the case, as there was a clear overlap in mandate. The DWS could have issued its own administrative notices instructing rehabilitation activities contrary to the GDARD instructions. The Bicycle Park would then have been caught in the middle, as siding with any particular institution would result in non-compliance with the other.

Recommendation: It is recommended that a formal implementation protocol be developed and implemented, for example in terms of the Intergovernmental Relations Framework Act, Act 13 of 2005, between the enforcement institutions regarding co-operative enforcement, including who to contact, how to contact them, and guidance on which agency should take the lead per case.

vi. Beneficial illegal activities

In the example of the Bicycle Park, the construction of the wooden bridges was to protect the wetlands and watercourse from the cyclists riding through and damaging the wetlands. The bridges also limited the cyclists to crossing the wetland and watercourse at specific points. Cycling through a wetland or watercourse is not a listed activity. The beneficial impact of the bridges to the environment was not considered in the enforcement process. Despite the further degradation this would incur to the wetland, the bridges had to be removed. Similar to the example described by O'Beirne (2011:5) regarding the spraying of water versus the spraying of binder for dust suppression, these examples correspond with Nonet and Selznick (1978) cited in Scholz (1984:386) that enforcement needs to be more than just the "mechanical" administration of the law and the penalising

of violators. Contraventions need to be considered holistically, i.e. the positive benefits as well as the negative impacts of contraventions, and that enforcement requirements should be responsive to this, for example by off-set mitigation/rehabilitation.

Recommendation: In cases where the removal of the "illegal" activity has the potential to cause more damage to the environment, for example the wooden bridges at the Bicycle Park, then offset mitigation measures should be considered as part of the rehabilitation process.

5.4 Way forward

The process of rectifying the problems identified will require a two-pronged approach. Firstly, there is a need to conduct a thorough policy review. This research has touched on the enforcement and enforcement-driven rehabilitation components, but a holistic policy review needs to be conducted. It is 21 years since democracy in South Africa and 18 years since the NWA and NEMA were enacted. There needs to be an actual state of the environment assessment, measured against baseline data, and a detailed action plan as to how to go forward and ensure our environment does not pose a safety risk to our health and well-being. There needs to be both institutional and legal reform to address the discrepancies and overlaps in the legislative mandates of the institutions and organs of state tasked with the various components of water resources management (in its many resource facets e.g. environment, mining, agriculture, service delivery, etc.). There needs to be an increase both in capacity and capability of enforcement officials in the appropriate fields (not only in riparian management but in terrestrial and other ecosystems as well) (refer DEA, 2008:31). However this will still take much time and is linked to the wider context of South African social maturing, i.e. environmental science is not viewed as a "money making" employment field and therefore there is little interest in these fields of science. However, these challenges can be accommodated by developing management tools that are responsive to the capabilities of officials, and that can guide and support the existing officials in their day to day functions, thereby increasing their capabilities in the process.

Secondly, administrative tools need to be developed to ensure the accountability of enforcement officials in their decision making and to promote that the

appropriate rehabilitation of ecological degradation is adequately designed and carried out. The development of these tools should be carried out as an interim measure to support the enforcement regime while it still matures and the staff capabilities develop.

The South African environmental enforcement regime is still in a "developmental" stage, and as it matures, the necessary capacity, capability and institutional support will evolve. In the interim, it is crucial to ensure tools, guides and mechanisms are available to support the regulators and enforcement officials thereby enabling lawful, reasonable and procedurally fair decisions resulting in the prevention, and where necessary, appropriate rehabilitation of pollution and ecological degradation.

The literature (FISCRWG, 2001; May *et al.,* 1997; Soman *et al.,* 2007; Karr, 1991) highlights that there are many environmental impacts as a result of anthropogenic activities. Contraventions contribute to these anthropocentric triggered impacts. There are various components of riverine reaches, and ecological integrity, rehabilitation objectives and activities that need to be taken into account when designing rehabilitation plans for contraventions, as well as consideration of the scale of severity of the contraventions themselves. Although it would be a difficult task to draft a prescriptive section of legislation to guide rehabilitation, as rehabilitation activities cannot or should not be applied uniformly across cases, the merits, impacts and situation of each individual case need to be assessed. Therefore, a decision-support tool would be more practical to:

- help identify priority impacts as a result of contraventions;
- help to identify rehabilitation objectives (e.g. rehabilitation, restoration or remediation);
- help identify the necessary specialists and studies that are needed to inform the rehabilitation plan; and
- help identify potential rehabilitation activities and monitoring measures.

6 APPLIED RESEARCH TOOLS

6.1 Introduction

Chapter 4 Critical Evaluation of the South African water resources regulatory framework and Chapter 5 Compliance and Enforcement: Status Quo have highlighted several problems and gaps in the policy framework that supports compliance and enforcement, and its role in contributing towards the achievement of Section 24 of the Constitution. In the absence of policy guidance there is currently a heavy reliance on the capability of enforcement officials to guide the enforcement mechanisms appropriately, especially with regard to enforcement-driven rehabilitation; capability which is not necessarily there. Enforcement-driven rehabilitation provides an opportunity to improve the state of the environment in South Africa and contribute towards the management class and resource quality objectives set for the management of the country's water resources. In the absence of appropriate management instruments to guide enforcement officials, this research has developed three tools to assist enforcement officials in their tasks:

1. Legislation Search Tool (LST), provides a searchable database of the national environmental legislation indicating overlaps with adjacent statutes and indicating which spheres of government are mandated for the various sections of the legislation.
2. Site Inspection Checklist (SIC) provides a site inspection description form to guide officials during their site inspections to record relevant observations.
3. Dashboard Tool (DT), based on the observations in the SIC flags potential issues of ecological degradation that require further detailed studies by specialists to appropriately inform the rehabilitation plan.

The development of the tools, together with the relevant Guideline[16] document was supported through a Water Research Commission project. The candidate was the project manager and principal researcher of the project supported by several riverine ecologists and specialists.

[16]) Braid, S. (2014) *Tools to determine enforcement-driven rehabilitation objectives on urban river reaches*. (TT 594/14). Water Research Commission (WRC), Pretoria.

6.2 TOOL 1: Legislation Search Tool (LST)

As already discussed in Chapter 3, the South African environmental legislation affecting riverine systems is both complex and overlapping, and at times contradictory. There is no hierarchy in the legislation, save the NEMA and the SEMA's of the Waste Act, Biodiversity Act and Protected Areas Act. The NWA is not secondary to the NEMA. As enforcement officials are only mandated to work within the jurisdiction of their allocated legislation, a tool was developed to assist officials in identifying overlaps with other legislation and therefore overlaps in jurisdiction with other institutions.

6.2.1 Tool Design

The author conducted an extensive review of all the applicable South African national environmental legislation. The review identified sections of the legislation that were relevant to rehabilitation activities in urban rivers, authorising processes and enforcement mechanisms. Common themes or words were also identified across the different sections. The various sections of legislation, the relevant sphere of government mandated with the section of legislation and the identified theme or search words were captured into a draft database set up in an Excel spread sheet. Table 6-1 provides a summary of the identified applicable sections of national legislation.

The draft database spreadsheet was then workshopped with the various relevant institutions to ensure its comprehensiveness and that all interpretations were appropriately captured. The workshop was held in Pretoria on 29 May 2012, with representatives from the Department of Water and Sanitation, the Department of Agriculture, the Department of Environmental Affairs, the South African National Heritage Association, City of Cape Town Metropolitan Municipality and Advocate Maritza Uys (former head of the Water Tribunal). Guided by their mandates and applicable legislation, the officials discussed the identified sections of the national environmental legislation compiled by the author, their interpretations of the sections and validated the attached search words (tags) to each of the identified sections of legislation. The updated spreadsheet was then captured into a searchable database (16 Acts and 82 tag words). An interface was programmed in *Python*, an open source programme, to enable users to search specific sections of the legislation or to search the identified search tags for applicable legislation. The results of these two searches present all the sections that are applicable or overlap with the searched section of legislation or the searched tag word. Open

source software was used to enable easy access by officials to the database, i.e. no licensing requirements.

Table 6-1 Applicable Environmental Legislation reviewed for the Legislation Search Tool Database

Act	Regulation	Sections
National Heritage Resources Act, Act 25 of 1999 as amended	The Act	Sections: 28, 34(1), 38, 45, 50,51
	GN 1512 *GG* 24116 of 6/12/2002 Types of Heritage Objects	Sections: 1, 11
Lakes Areas Development Act, Act 39 of 1975 - repealed in whole by NEM:PAA	The Act	Sections: 1, 11(1), 15
Mountain Catchment Act, Act 63 of 1970 as amended	The Act	Sections: 2, 3, 4(1), 10(b), 11, 14
Dumping at Sea Control Act, Act 73 of 1980 as amended	The Act	Sections: 2, 5, 6
National Forest Act, Act 84 of 1998 as amended	The Act	Sections: s.3(3)(c), 4(8), 7(1), 10(1), 11(3), 12(1), 58, 66
	GN 773 in GG 30183 of 24 August 2007	Schedule A, sections: 1(a), 1(b), 1(c)
National Veld and Forest Fire Act, Act 101 of 1998 as amended	The Act	Section: 16
National Environmental Management: Biodiversity Act, Act 10 of 2004 as amended	The Act	Sections: 52, 53, 56(1), 57(1), 65(1), 69, 70(1), 71(1), 73, 75, 76
	GN 1147 of GG 30293	Appendix 1, sections: 4, 6, 8; Appendix 3
	GNR 151 in GG 29657 of 23 February 2007	Publication of lists of critically endangered, endangered, vulnerable and protected species.
	GN1477 of GG 32689	Draft National List of Threatened Ecosystems. 6 November 2009
National Environmental Management: Protected Areas Act, Act 57 of 2003 as amended	The Act	Section: 86
	GNR 1061 of GG 28181 28 October 2005	Sections: 4, 25(1), 39, 40, 41, 42, 45, 46, 47, 61, 64
	GNR 99 in GG 35021 of 8 February 2012	Sections: 33, 36, 39, 40, 43, 44, 51, 52, 54
Hazardous Substances Act, Act 15 of 1973 as amended	The Act	Sections: 3A(1), 9, 18, 19
	GNR 453 in GG 5467 of 25 March 1977 as amended	Section: 10
	GNR 247 of GG 14596 in 26 February 1993	Sections: 5(1), 13, 17, 26

	Regulations relating to Group IV Hazardous Substances	
Disaster Management Act 57 of 2002 as amended	The Act	Sections: 20, 27, 34, 41, 47, 55
Mineral and Petroleum Resources Development Act, 28 of 2002 as amended	The Act	Sections: 5, 20(1), 27, 37, 38, 39, 41(2), 43(5), 45, 46, 50(1), 53, 98, 99
National Environmental Management: Waste Act, Act 59 of 2008 as amended	The Act	Sections: 2, 7(2)(d), 16, 19(1), 20, 21, 25, 26(1), 27, 37(1), 39, 40(1), 41(1), 65, 66, 67, 68, 81(2)
Conservation of Agricultural Resources Act, Act 43 of 1983	The Act	Section: 6, 7
	GN R1048 in GG 9238 of 25 May 1984 as amended	Sections: 3, 4, 6, 7, 8, 9(1)(d), 9(2), 13, 14, 15A, 15B, 15C, 15E,16
	GN R1047 *GG* 9238 May 1984	Sections: 6, 11, 12
National Water Act, Act 36 of 1998	The Act	Sections: 19(3), 20(4), 21, 22, 32, 36, 37, 38,39, 53
	GN 399 in GG 26187 of 26 March 2004 (sub-sections 21(a) and (b) extended in GN 970 of GG 35909 of 30November 2012)	1.7, 1.8, 1.9, 1.10, 1.11, 1.12
	GN 399 in GG 26187 of 26 March 2004 (extended in GN 94 of GG 36153 of 11 February 2013)	3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
	GA 1198 in GG 32805 of 18 December 2009 **Applies to Organs of State only**	2, 7, 8, 9 ,10
	GN 1199 in GG 32805 of 18 December 2009	2, 7, 8, 9, 10, 11
National Environmental Management Act, Act 107 of 1998 *as amended*	The Act	Sections: 24, 28, 30, 31L,
	GN R 544 *GG* 33306 18 June 2010 *as amended* (repealed GN R386 of April 2006)	Activities: 9, 11, 12, 18, [19], [20], 37, 39, 40, 41, 52, 55
	GN R 545 *GG* 33306 18 June 2010 *as amended* (repealed GN R 387 of April 2006)	Activities: 10, 17, 19, [20, 21, 22]
Environment Conservation Act, Act 73 of 1989 *as amended*	The Act	Sections: 31A

Note: For the purposes of this research, the database only included national legislation applicable to rivers. This does not include estuaries as these are viewed as a different ecosystem and the scope of this research is urban rivers.[2]

6.2.2 Tool Development

The legislation search tool provides two types of search functions as illustrated in Figure 6-1.

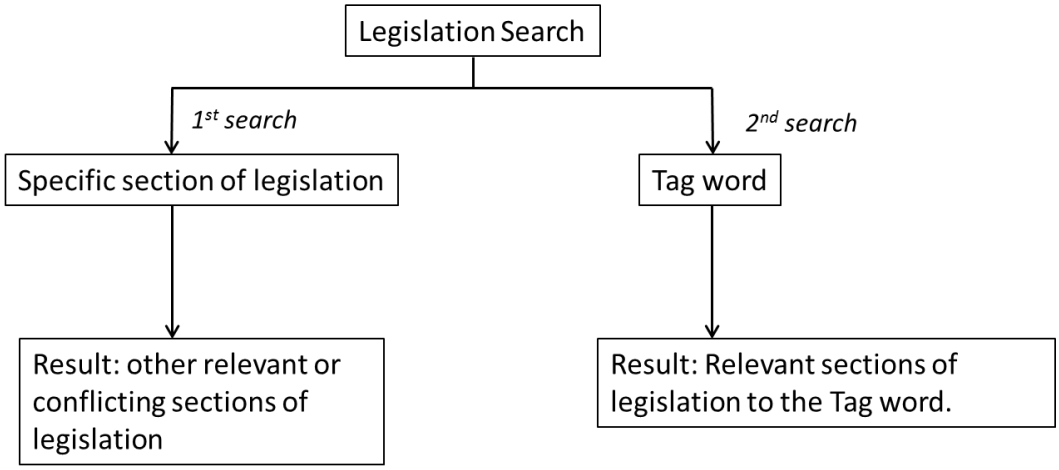


Figure 6-1 Legislation Tool flow diagram

The first search type is for where the user is familiar with a particular section of legislation, and the second where the user selects a word to identify what legislation they are looking for.

In the first search type – by section of legislation, Figure 6-2, the user selects the particular section of legislation they are familiar with, in the left hand pane Figure 6-3. This is selected from the drop-down menus of the legislation and regulations. Then they scroll through the sections to the appropriate section. The user "clicks" on the appropriate section, and on the right hand pane the other applicable legislation will appear, Figure 6-4.

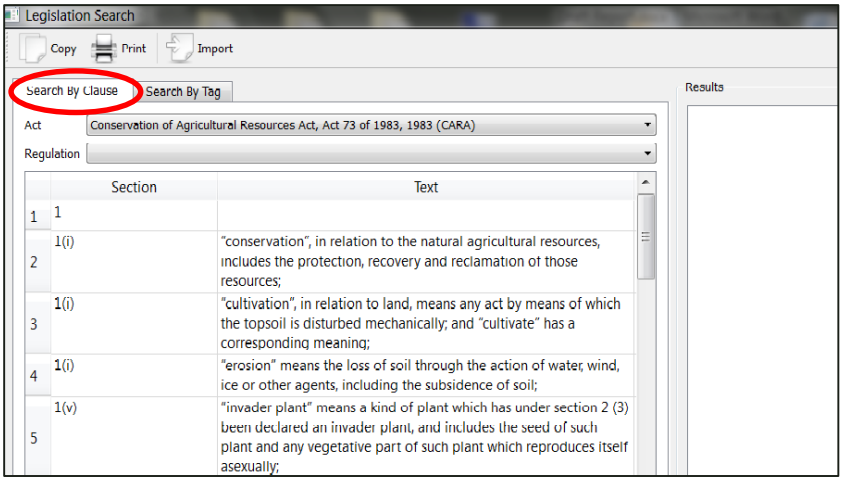


Figure 6-2 Search by Clause of legislation

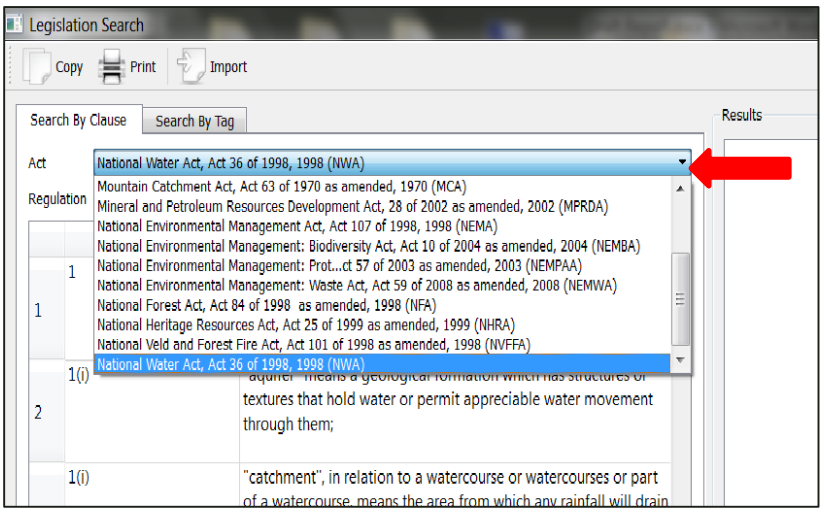


Figure 6-3 Select statute or regulation

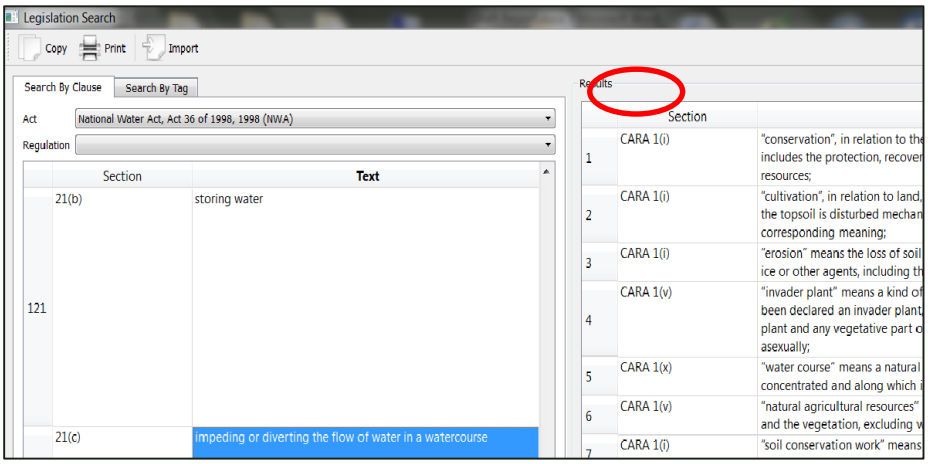


Figure 6-4 Click on particular section, and results appear on the right pane

In the second search type – by tag word, Figure 6-5, the user “clicks” on the Tag search label, then selects the appropriate word from the list of words on the left hand pane. Once selected, the relevant sections of legislation linked to the selected word will appear in the right hand pane Figure 6-6.

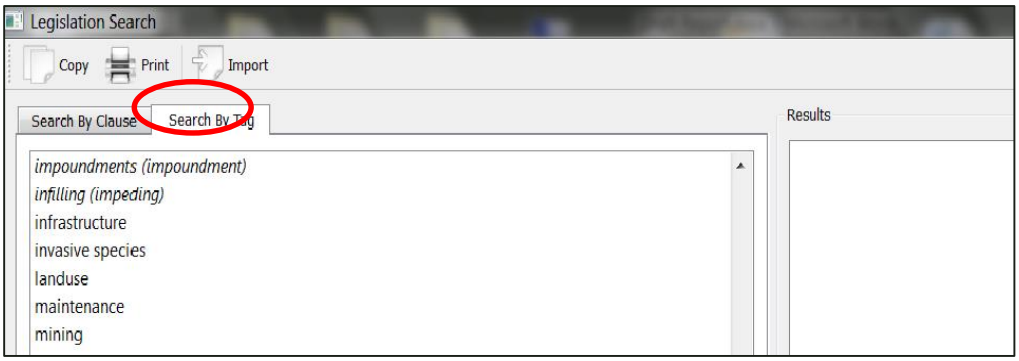


Figure 6-5 Search by tag words

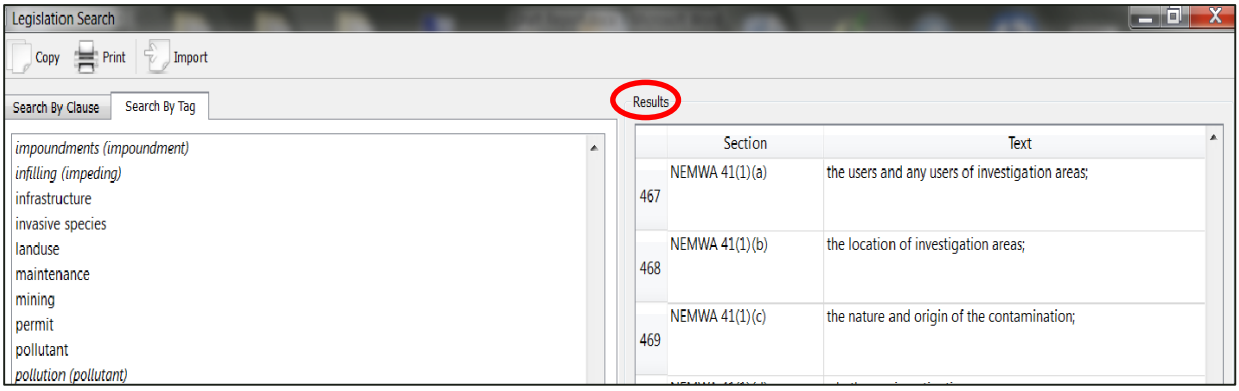


Figure 6-6 Click on tag word and results appear on right pane.

In both search options the right hand pane can be expanded in size and the user can scroll through the columns. The information presented includes the particular Act, the section number, the section text, other search word tags that are linked to that particular section, as well as the sphere of government responsible for that particular section of legislation. The search results can be printed.

6.2.3 Tool Testing

Two programmes were developed for this tool. The first programme provides for the capturing and editing of legislation (Legislation Edit). The second programme conducts the search of the database (Legislation Search). The editing programme will be provided to the institution that takes ownership for the programme and will

be responsible for the maintenance and updating of the database. This will prevent different edited versions of the database being used by different institutions. The search programme (Legislation Search) will be made available to all users. Users may be required, by the owning organisation, to register on a database for the tool; this enables the "owning institution" to notify users of updates to the database and other useful information. There are no licences or operating system requirements to run both of the programmes. The user requires a basic computer to the run the programmes.

6.3 TOOL 2: Site Inspection Checklist (SIC)

6.3.1 Objective

When responding to a complaint or an issue of non-compliance the officials must conduct a site inspection. When conducting these site inspections there is a Standard Operating Procedure (SOP) for Environmental Management Inspectors (EMIs) (EMI Operating manual, chapter 5). This SOP however does not specify what criteria should be observed or assessed during the site inspection but rather serves as a guide as to how to record samples, photos, protocols etc. Without a formal record of observation of basic criteria on the site, new officials working with the case are unsure[17] of the impacts occurring on the site and continue to focus their attention only to the legal contravention rather than ecological rehabilitation.

The objective of the Site Inspection Tool is to provide a uniform record or checklist of site inspection observations linked to basic riverine components.

6.3.2 Methodology

Development of the Site Inspection Tool consisted of two phases. Firstly, it was determined if there is an existing tool suitable for application in the enforcement context. If not, then secondly the development of an appropriate site inspection tool for use by enforcement officials was undertaken. The methodology of each Phase is further described.

Phase I

To conduct a comparative review of existing river assessment tools to determine their suitability for use in the enforcement context.

[17] As the case is processed it may go to court, which could take three years to reach the court; if there is no record of the observations made on the site, it is difficult for the officials both to remember what was observed, as well as for new officials to understand what the objectives of the enforcement were.

Step 1: Identify existing river assessment tools to be considered.

Step 2: Review the methodologies of each tool against the requirements of the current enforcement requirements.

Step 3: Test the existing tools on a case study site, i.e. the Bryanston Bicycle Park.

Step 4: Review the findings.

Phase II

If the findings of ***Phase I*** are unsuitable, to develop and compile an appropriate site inspection checklist to guide officials in basic observations during site inspections. The tool should provide a standard record of site inspection (additional information can still be attached).

Step 1: Compile a list of criteria and measures that provide an appropriate record of site inspection. In order to compile the list, the following sources were used:

- Review of literature and existing guidelines and manuals;
- Consultation with specialists on the proposed criteria as to suitability, ease of use, reliability, etc.

Step 2: Compile the criteria and measures into a system or procedure that meets the requirements of the current enforcement context. In developing the inspection system, draw on the positive components identified in the comparative review in Phase I.

Step 3: Test the system on a case study site, e.g. Bryanston Bicycle Park.

Step 4: Review the findings.

6.3.3 PHASE I: Comparative analysis of existing river assessment methodologies and tools

To conduct a comparative review of existing river assessment tools to determine their suitability for use in the enforcement context.

6.3.3.1 Step 1: Identify existing river assessment tools

The literature was searched and reviewed for various types of river assessment tools for river rehabilitation. Many of the tools reviewed were procedural guidelines with steps for designing rehabilitation projects, writing project proposals, sourcing

funding to support rehabilitation project, public support for rehabilitation projects, etc., rather than for a river assessment. From literature and international best practice, the most relevant or common existing site assessment methodologies were identified as:

i. River Health Programme and EcoClassification (South Africa)
ii. River Rehabilitation Assessment (South Africa)
iii. Environmental Reconnaissance Checklist (South Africa)
iv. River Habitat Survey (United Kingdom)
v. Stream Planning Procedure (Australia)
vi. Stream Visual Assessment Protocol (United States)
vii. Problem and Opportunity Identification (United States)

These included methodologies developed in South Africa as well as international methodologies.

6.3.3.2 Step 2: Review of existing river assessment tools

An assessment was conducted of the seven identified existing riverine assessment methods to determine their suitability for use by enforcement officials. The existing methods were reviewed based on a set of enforcement usability criteria. These criteria were determined from the findings of the previous chapters of this thesis. The criteria include:

- Assessment of riverine functions versus ecosystem health;
- Suitability for use by a non-scientist (e.g. a person with no background in aquatic science);
    - Complexity of use;
    - Limited mathematical based methodology;
    - Limited detailed/complicated terminology;
- Suitability for site/erf specific assessment versus river reach;
- Limited technical sampling requirements/measurements needed e.g. water quality or flow rate sampling;
- Ability to indicate specific functions or aspects requiring rehabilitation;
- Not overly-time consuming or heavily reliant on background information.

River Health Programme and EcoClassification (South Africa)

In 1994, the Department of Water Affairs and Forestry (DWAF) initiated the River Health Programme (RHP) with the intention of serving as a source of information regarding the overall ecological status of river ecosystems in the country. The theory is that the integrity of the biota inhabiting the river ecosystem will provide a

direct indication of the health of the river as whole. The River Health System uses the EcoClassification methodology to determine the biological response of biota to changes in biophysical changes. However, the RHP focuses mainly on the biological responses as an indicator of ecosystem health, with only a general assessment of the cause-and-effect relationship between the drivers and the biological responses (Kleynhans and Louw, 2008:A1-11; DWAF, 2008:xi). All these factors are scored in terms of a Present Ecological State (PES) and classified (natural to poor), which provides an ecological and management perspective of river condition (ecostatus); this is shown in Table 6-2 (Kleynhans et al. 2005). The results of the RHP provide a very good indication of our human use impacts as well as the value of our management actions to secure our water resources for future generations (DEA, 2012).

Table 6-2 River Health categories.

Category	Ecological Perspective	Management Perspective
Natural (N)	No or negligible impact	Relatively little human impact
Good (G)	Biodiversity and integrity largely intact	Some human-related disturbance but ecosystems essentially in good state
Fair (F)	Sensitive species may be lost, with tolerant or opportunistic species dominating	Multiple disturbances associated with the need for socio-economic development
Poor (P)	Mostly only tolerant species present; alien species invasion; disrupted population dynamics; species are often diseased	High human densities or extensive resource exploitation

The suite of tools used to provide information on river health includes a set of indices:



The Index of Habitat Integrity: Assesses the impact of disturbance such as water abstraction, flow regulation, and river channel modification on the riparian zone and in-stream habitats.



The Geomorphological Index: Assesses river channel conditions and channel stability. (Channel conditions are based on physical structure such as weirs, bridges, or dams,

and the type of channel such as bedrock or alluvial. Channel stability is based on the potential for erosion.)



The Riparian Vegetation Index: Determines the status of riparian vegetation, based on a species composition, structure and extent of cover, presence of juvenile indigenous species, cover of invasive alien species, and human influences.



The South African Scoring System (SASS): Assesses the presence of families of aquatic fauna (invertebrates) and their sensitivity to changes in water quality.



The Fish Assemblage Integrity Index (FAII): Assesses fish assemblages in homogenous fish habitat segments, based on catch size, condition and expected species representation classes.

Healthy rivers provide goods and services (water supply, natural products, breakdown of pollutants, conservation, flood attenuation, recreation and spiritual value), which contributes to human welfare and economic growth, as well as sustains biodiversity (RHP 2005). Using these ecosystem goods and services in an irresponsible or unsustainable manner has a negative impact on the status of the river health and its available future use resource quality.

The EcoClassification Modules are an in-depth methodology for determining the Present Ecological Status (PES) for river health. The process includes six assessment index models, one per component of riverine ecosystem assessed, i.e. geomorphological driver assessment index (GAI), physico-chemical driver assessment index (PAI), fish response assessment index (FRAI), macro-invertebrate response assessment index (MIRAI), riparian vegetation response assessment index (VEGRAI), and finally the index of habitat integrity. This process is far too complicated, complex, time consuming and costly to meet the needs of the enforcement official conducting a screening inspection; therefore the methodology was not conducted on the assessment case study, however a desktop review of the methodology against the assessment criteria was conducted. The outcomes of the assessment of the River Health Programme

against the criteria are included in Table 6-3. An RHP assessment was conducted in 2005 of the catchment within which the case study is located; the results of the 2005 assessment are included in Appendix A. Although a complex process for the enforcement officials, the RHP provides a suitable and appropriate methodology for the specialists to follow where detailed specialist studies are requested in the enforcement process. This provides a uniform methodology for specialist studies across all enforcement cases.

Table 6-3 Assessment Criteria of River Health Programme

Criteria	Comment
River Function vs River Health	Focus specifically on river health
Complexity of use	Very complex. Requires specialists to conduct the different index assessments
Mathematical requirements	The index assessments require mathematical calculations
Technical terminology	Includes technical terminology
Suitability for Site/erf specific	Catchment scale appropriate
Technical sampling	Technical sampling required
Indication of specific functions for rehabilitation	Identifies degradation in the ecosystem. These could be used to set rehabilitation objectives. Limited to river health not river function
Time consuming	Very time consuming
Other comments	Too complex and time consuming for rapid screening in the general enforcement process. Could provide a standard methodology for the specialist studies requested through enforcement notices.

River Rehabilitation Assessment (South Africa)

Quinn (2003) developed a decision support system for rehabilitation and management of riparian systems. The full decision support system includes a decision support flowchart to inform physical interventions to be carried out for selected activities. The River Rehabilitation Assessment proposed by Quinn *et al*., (2003) was designed for the rural and agricultural setting, rather than urban watercourses. "The micro-scale assessment is based on the approach of Peterson (1992), which was specifically developed for lowland agricultural

streams" (Quinn, 2003:44). The methodology proposes three types of assessment at various scales, namely, that of macro-scale aimed at the catchment landscape, an intermediate-scale assessment aimed at groups of reaches of similar characteristics, and a micro-scale assessment aimed at the instream ecosystem, river banks and surrounding vegetation. For the purpose of assessing this methodology for the context of site screening by enforcement officials, a micro-scale assessment of the case study site was conducted; this is included in Appendix A.

The methodology is simple to follow. The assessment should be repeated for each 100m interval on the site. The methodology includes completing an assessment for per river bank and instream channel of the site. The scores are predetermined based on the characteristic selected to describe the indicator. This is a useful system as the official does not need to score the site but rather select the most appropriate characteristic, i.e. using a qualitative value rather than a quantitative value.

The process is a habitat assessment approach suitable to the South African context that maps riparian habitat assets and problems. The assessment procedure is fairly straight forward, using a score sheet, which involves some mathematical formula. While it includes a detailed assessment of habitat integrity, it does not include an assessment of water quality or species occurrence, in particular invertebrates, to confirm the habitat assessment. The land use component is very basic and does not look at particular impacts as a result of the adjacent land use. The assessment does provide a good scoring mechanism for its evaluation. The assessment can be applied on a site scale or a reach scale. The assessment of the methodology against the enforcement tool criteria is summarised in Table 6-4.

Table 6-4 Assessment criteria for river rehabilitation assessment process.

Criteria	**Comment**
River Function vs River Health	Focus on river health
Complexity of use	Straight forward methodology. Relies on score sheet and simple mathematics.
Mathematical requirements	Requires some simple mathematical calculations
Technical terminology	Includes technical terminology

Suitability for Site/erf specific	Micro-scale assessment is appropriate for site/erf context
Technical sampling	Based on observations, no sampling
Indication of specific functions for rehabilitation	Identifies degradation in the ecosystem. But does not indicate what components of the ecosystem in particular require intervention.
Time consuming	The score sheet is quick, the mathematics takes a bit longer.
Other comments	Not appropriate for the urban setting. It provides a quick screening but does not provide the output indication of what rehabilitation objectives need to be set, e.g. flow rate, habitat, etc.

Environmental Reconnaissance Checklist (South Africa)

The Environmental Reconnaissance Checklist forms part of the Environmental Decision Support System, developed by the South African Department of Water Affairs and Forestry in 2004, Integrated Environmental Management Series 1 (IEMS). The Environmental Reconnaissance Checklist was designed to assist the Department of Water Affairs officials to incorporate environmental issues when considering the conceptualisation phase of a development application. This falls within the ambit of initiative-driven rehabilitation rather than enforcement-driven rehabilitation. Furthermore, the checklist is based on a desktop review of the development documents and does not include a site characterisation prior to the development, e.g. a baseline characterisation against which to measure impacts. In the updated third version of the Integrated Environmental Management Series (2011), the Environmental Reconnaissance Checklist was no longer included. The checklists focused on the EIA system.

The Checklist highlights important elements to consider when reviewing a development, whether proactively (EIA process) or reactively (through compliance mechanisms), such as considering the impacts on groundwater and indicators on social, economic, cultural and heritage elements as well. However, answering these indicators is relative to the capability of the official completing the assessment, i.e. if an official does not understand or is not aware of the potential impacts on groundwater, then these indicators are not going be answered appropriately. The checklist is subjective relative to the knowledge and interest of the official completing it. Furthermore, the checklist does not get into the detail of

the impacts on the various elements, or how these should be remediated. The summary of the assessment criteria to the EIA Reconnaissance Checklist is present in Table 6-5. The checklist is not appropriate as a screening tool for a site inspection, however it could be used in back-office work when developing the compliance strategy for managing a site, in order to ensure that all the issues are identified and the responsible departments are notified.

A Checklist was completed for the case study site and is included in Appendix A.

Table 6-5 Assessment Criteria for EIA Reconnaissance Checklist

Criteria	**Comment**
River Function vs River Health	Neither
Complexity of use	The Checklist requires observation, document review and comment. The observation and comment is limited by the official's capability to identify impacts on the site.
Mathematical requirements	No mathematical requirements
Technical terminology	Some technical terminology
Suitability for Site/erf specific	Suitable for site specific assessment
Technical sampling	Based on observations, no sampling required
Indication of specific functions for rehabilitation	The methodology does not identify areas for rehabilitation or mitigation
Time consuming	Completing the checklist can be time consuming, depending on how much information is readily available.
Other comments	Not appropriate for an enforcement screening, however it could be used in back-office work to guide the enforcement strategy for the site.

River Habitat Survey (RHS) (United Kingdom)

The United Kingdom Environment Agency developed the River Habitat Quality Survey to assess and record the physical character of rivers and streams in the UK and Isle of Man (EA, 1998). "The River Habitat Survey is a system for assessing the character and quality of rivers based on their physical structure; it

has been developed to help the conservation and restoration of wildlife habitats along rivers and their floodplains" (EA, 1998:x). This inherently suggests that it is initiative driven. The RHS is based on a simple process illustrated in Figure 6-7. The map-based attributes contained in Section A, require office-based research. The standard field survey contained in Section B onwards is based on field observations at the site and the various transect points. Each category is assigned a scoring method. The scores are ranked **0** to **3** based on the occurrence of features in each section. "The Habitat Quality Assessment (HQA) score for a site is the total of all the component scores in the categories of the survey." (EA, 1998:77).

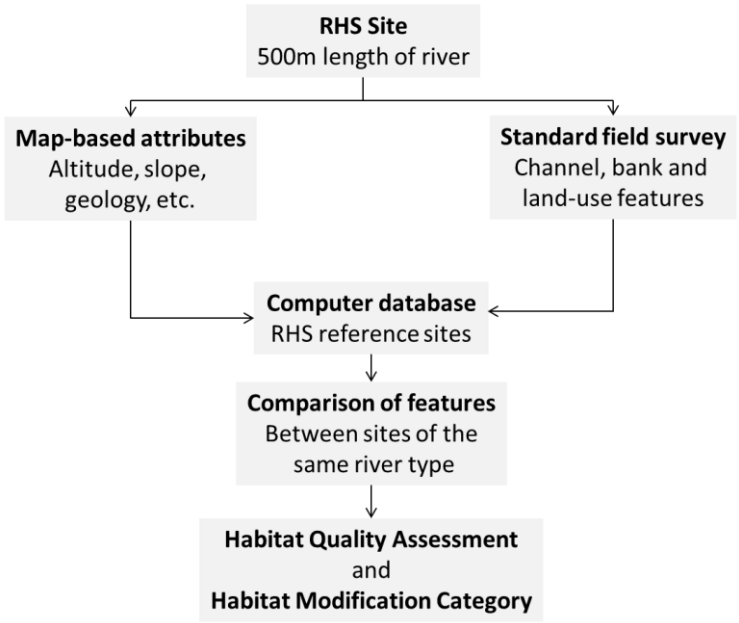


Figure 6-7 Introduction to how River Habitat Survey works (EA, 1998:7)

A River Habitat Survey was conducted for the case study site Bryanston Bicycle Park and is included in Appendix A.

The survey is well laid out, very basic and suitable for "layman" use. However it is very long and requires ten (10) assessments at different transects of the reach. The results are then compared to the results of a reference site assessment. While this provides a comprehensive assessment of the reach of river, it is not necessarily appropriate for the enforcement context which is usually site specific and usually relates only a short reach of river. This would require the development of a database of different reference sites according to the different ecoregions, geology, climates, etc., of the country. This in itself is potentially a

useful tool, but is not readily or easily available for enforcement officials to implement immediately.

The completed survey form provides a detailed characterisation of the site, but does not highlight particular components that may require rehabilitation or intervention. The assessment methodology is designed for United Kingdom (UK) and Irish environments. In particular, some of the terminology and the vegetation types are different to the South African context, for example moorland, heath, bog or fen in the UK are usually referred to as marsh or vlei in South Africa; similarly species such as Alders, Giant Hogweed, Japanese Knowtweed and Himalayan Balsam are not regularly found in South Africa. The Survey would require adaptation to the South African context.

"The habitat quality assessment scoring system is basically a broad measure of the diversity and 'naturalness' of the physical habitat structure of a site, including both the channel and river corridor. The HQA score is determined by the presence and extent of habitat features of known wildlife interest recorded during the field survey. Rare features such as waterfalls more than 5m high and extensive fallen trees attract additional points" (EA, 1998:14). In other words the more habitat features there are observed during the site inspection, the higher the score for the site, with regard to habitat provision. The fewer observed habitat features, the lower the score. The score does not provide an indication of which habitat features are missing or require rehabilitation. The score provides a general indication that habitat provision is good or not. There is no measure or relativity of the score, i.e. 20 and below is poor. In order to determine the relativity of the score, the official would then conduct an assessment of another site, e.g. a reference site, of same river type and similar characteristics. The habitat scores of the two sites can then be compared to ultimately determine the relativity of the habitat score of the non-compliant site. This would still require the official to interpret the comparison and identify the areas or components that require rehabilitation.

The primary objective of the survey is to provide an indication of habitat quality, rather than the full spectrum of river functions. However, the assessment provides a good framework. The structure is simple to follow. Some of the indicators and scoring mechanisms are also relevant.

The survey provides an attractive assessment record of the river transects. The score methodology does not score all the indicators. The survey compares the features of the different transects with a database of already assessed rivers and their features. The survey distinguishes between river banks and active channel. The score does not provide an indication of the state of the river, nor does it guide an enforcement officer as to what functions should be targeted for rehabilitation. The indicators used are relevant for a site inspection checklist. The assessment of the River Habitat Survey against the enforcement criteria are summarised in Table 6-6.

Table 6-6 Assessment Criteria of River Habitat Survey

Criteria	**Comment**
River Function vs River Health	River habitat
Complexity of use	The methodology is simple, but the forms are quite complex to complete. The official needs to understand what all the abbreviations and indicators refer to.
Mathematical requirements	There is some mathematical requirements, especially in Section A
Technical terminology	There is technical terminology
Suitability for Site/erf specific	The assessment can be conducted at a site scale. It must be repeated every 50m across the site.
Technical sampling	No sampling required
Indication of specific functions for rehabilitation	The methodology does not identify areas for rehabilitation or mitigation
Time consuming	The assessment can be time consuming, especially the completion of Section A.
Other comments	The tool is not appropriate for enforcement screening. It is too technical. However, some of the indicators could be included in a specific enforcement tool.

Procedure for Stream Rehabilitation (Australia)

Rutherfurd, Jerie, and Marsh developed a Rehabilitation Manual for Australian Streams (Rutherfurd *et al.,* 2000). The Australian manual outlines a 12-step procedure for stream rehabilitation. The first step is to develop a vision and goals, then to share the vision with the community e.g. garnering support, and only

thirdly to describe the stream condition. This procedure supports initiative driven rehabilitation, rather than enforcement-driven rehabilitation, which requires the objectives and goals of the rehabilitation to be set as a priority. In order to compile this description requires an understanding by the planning team of the different elements, potential problems and resultant impacts, as well as research into the various elements. This does not suit "layman" use or the tight timeframes of enforcement procedures. The 12 Step process involves the following (Rutherfurd *et al.*, 2000):

Step 1: What are the goals for rehabilitation?
Step 2: Who shares the goals for the stream?
Step 3: How has the stream changed in European settlement?
Step 4: What are the stream's main natural assets and problems? (Describe stream condition)
Step 5: Setting priorities: which reaches and problems should be worked on first?
Step 6: What are the strategies to protect assets and improve the stream?
Step 7: What are the specific and measurable objectives?
Step 8: Are the objectives feasible?
Step 9: What is the detailed design of the project?
Step 10: How will the project be evaluated?
Step 11: How will the project be planned and implemented?
Step 12: Has the project worked?

In Step 4, in describing the stream, the procedure provides a list of attributes to consider. These attributes include: Diversity and populations of animals and plants, riparian vegetation, flow regime, longitudinal connection along the river, lateral connections across the floodplain, water quality and structural complexity and stability (Rutherfurd *et al*., 2000). These attributes are useful to help identify impacts on the site and could contribute to a site inspection checklist.

To follow this process requires extensive community and stakeholder engagement. The process is aimed at initiative-driven rehabilitation of river reaches rather than enforcement-driven rehabilitation. The process is time consuming, costly and requires extensive specialist input.

Due to the nature of the process being initiative-driven, the process was not completed on the case study site. A desktop review of the methodology was conducted, and the outcomes are reported in Table 6-7.

Table 6-7 Assessment Criteria for Procedure for Stream Rehabilitation.

Criteria	**Comment**
River Function vs River Health	General river assessment of problems and assets.
Complexity of use	Lengthy process; requires specialist inputs into the design of the rehabilitation plan.
Mathematical requirements	There will be some mathematics in the component sections
Technical terminology	The process itself is not too technical
Suitability for Site/erf specific	Applicable to a reach of river rather than site specific.
Technical sampling	Some sampling may be required to determine a baseline. Sampling will be required for monitoring purposes.
Indication specific functions for rehabilitation	The process includes a step to identify problems that require rehabilitation. These are identified by the planning team.
Time consuming	The process is quite lengthy and time consuming. The process is all-inclusive from planning to design and implementation.
Other comments	The procedure is suitable for initiative-driven rehabilitation projects rather an enforcement screening.

Stream Visual Assessment Protocol (United States of America)

The Natural Resources Conservation Service in the United States Department of Agriculture, developed a Stream Visual Assessment Protocol as part of their National Water and Climate Centre Technical Note 99-1 (USDA, 1998). The Stream Visual Assessment Protocol provides a basic level of stream health evaluations. "It can be successfully applied by conservationists with little biological or hydrological training" (USDA, 1998:1), this make this protocol usable by laypersons. The protocol has a very easy to follow layout which is good for layman use. It includes good context questions, such as weather on the day of assessment and 2 days prior. The protocol is also the only one to include a site

layout diagram. The methodology provides a good narrative per score as well as good layman's guidance for observing the indicators. However, the completed sheet only includes the numerical score, and one needs to look up each of the reference scores to determine the site characterisation. The method provides a good record of assessment but no interpretation of what the assessment means in terms of river function or river health. The assessment protocol provides four prescribed descriptions for the site. The assessor selects the best description for the site. The descriptions have pre-assigned scores, for example Table 6-8.

Table 6-8 Example of descriptions in the Visual Stream Assessment Protocol.

Channel condition				
Natural channel: no structures, dikes. No evidence of down-cutting or excessive lateral cutting		Evidence of past channel alteration, but with significant recovery of channel and banks. Any dikes or levies are set back to provide access to an adequate flood plain	Altered channel; <50% of the reach with riprap and/or channelization. Excess aggradation; braided channel. Dikes or levees restrict flood plain width.	Channel is actively down cutting or widening. >50% of the reach with riprap or channelization. Dikes or levees prevent access to the flood plain
Score	10	7	3	1

The assessment protocol does not distinguish between river banks and active channel. The assessment is carried out on a segment of river as a whole. The final score is either: poor, fair, good or excellent, but this is not categorised into habitat quality, or river function; it is a simple aggregate of river condition. This system is too simple and does not provide guidance to enforcement officers as to where rehabilitation activities should be targeted to improve the condition of the river and its functions.

A Visual Stream Assessment was conducted on the case study site and is included in Appendix A.

An official could potentially review the visual assessment score sheet to determine which components of the scorecard were low scoring to guide the rehabilitation. In terms of assessing the protocol against the criteria for an enforcement screening tool, Table 6-9 summarises the assessment.

Table 6-9 Assessment Criteria of Stream Visual Assessment Protocol

Criteria	**Comment**
River Function vs River Health	General river assessment
Complexity of use	Simple protocol to follow, based on observations
Mathematical requirements	Basic mathematics to calculate the score
Technical terminology	There is some technical terminology, but the description answers mitigate this.
Suitability for Site/erf specific	Applicable for a site or river reach
Technical sampling	No sampling required
Indication specific functions for rehabilitation	The protocol does not specifically identify impacts or ecosystem components/functions that require rehabilitation or intervention.
Time consuming	The process is quite quick
Other comments	Easy to follow process, the assessment form provides a record of observation that can be compared in later assessments. However, the results do not provide any indication of what needs to be rehabilitated or the resultant impact/degradation on the site.

Problem and Opportunity Identification (United States of America)

The Federal Interagency Stream Corridor Restoration Working Group (FISCRWG) compiled a comprehensive report on Stream Corridor Restoration (FISCRWG, 2001). The document explains in detail the components and importance of stream corridors, as well as the principles, processes and practices of stream corridor restoration. As part of the process of conducting restoration, the report includes a six step Problem and Opportunity Identification process, which includes (FISCRWG, 2001:4-16):

Step 1: Data collection and analysis

Step 2: Definition of existing stream corridor conditions (structure and function) and causes of disturbance.

Step 3: Comparison of existing conditions to desired conditions or a reference condition.

Step 4: Analysis of the causes (disturbances) of altered or impaired stream corridor conditions.

Step 5: Determination of how management practices might be affecting stream corridor structure and function.

Step 6: Development of problem and opportunity statements.

The FISCRWG report also provides a list of Measurable Attributes for Describing Conditions in the Stream Corridor. Similar to the Australian Procedure for Stream Rehabilitation, there is a list of attributes or characteristics to be reviewed when describing the site conditions; the attributes need to be described by personnel with some understanding of the different attributes and is not suitable for laypersons. Furthermore the attributes do not include a scoring mechanism to indicate what characteristics should be of concern. The characteristics do include water quality and species occurrence but exclude land use characteristics and specific river function. The process suggests the following measureable attributes,

Table 6-10, for describing conditions in the stream corridor which is useful for tool development.

Table 6-10 Measurable attributes for describing conditions in the stream corridor (FISCRWG, 2001:4-21)

Hydrology	- Lateral (bank) erosion
- Total (annual) discharge	- Floodplain scour
- Seasonal (monthly) erosion	- Channel avulsions / realignments
- Peak flows	- Meander and braiding processes
- Minimum flows	- Depositional features
- Annual flow durations	- Scour-fill processes
- Rainfall records	- Sediment transport class (suspended bedload)
- Size and shape of the watershed	
Erosion and Sediment Yield	**Water Quality**
- Watershed cover and soil health	- Colour
- Dominant erosion processes	- Temperature, dissolved oxygen (BOD, COD, and TOC)
- Sediment delivery ratios	
- Rates of surface erosion and mass wasting	- Suspended sediment
- Channel erosion processes and rates	- Present chemical condition
- Sediment transport functions	- Present macro-invertebrate condition
Floodplain /Riparian Vegetation	**Aquatic and riparian species and critical habitats**
- Community type	

- Surface cover Type distribution
- Canopy
- Community dynamics and succession
- Recruitment / reproduction
- Connectivity

Channel Processes

- Flow characteristics
- Substrate composition
- Channel dimensions, shape, profile, and pattern
- Floodplain connectivity
- Evidence of entrenchment and/or deposition
- Aquatic species of concern and associated habitats
- Riparian species of concern and associated habitats
- Native vs introduced species
- Threatened or endangered species
- Benthic, macro-invertebrates, or vertebrate indicator species

Corridor Dimension

- Plan view maps
- Topographic maps
- Width
- Linearity, etc.

The process was originally designed for initiative-driven river restoration projects in the United States of America. The process requires extensive data collection upfront, then data analysis and from that determining what the issues are that need to be addressed. This process is not appropriate for the enforcement screening process. However, the process is more suited to the specialists conducting specialist studies on the site, in their process of identifying impacts and problem areas and developing a detailed rehabilitation plan.

A Problems and Opportunity Identification assessment was not conducted on the case study site because it is too detailed and specialised for enforcement screening. A desktop review of the methodology was conducted. The results of this assessment are included in Table 6-11.

Table 6-11 Assessment Criteria for Stream Corridor Restoration: Problem and Opportunity Identification

Criteria	**Comment**
River Function vs River Health	Assesses both
Complexity of use	Quite detailed and specialist information required
Mathematical requirements	Mathematics may be required in specific ecosystem component assessments
Technical terminology	There is some technical terminology.
Suitability for Site/erf specific	More applicable for a river reach rather than a specific site
Technical sampling	Sampling may be required in specific ecosystem

	component assessments
Indication specific functions for rehabilitation	Ultimately once the data analysis is complete, the key issues to be addressed in the rehabilitation plan will be identified.
Time consuming	Quite a lengthy process.
Other comments	More appropriate for initiative-driven rehabilitation projects. Requires the official to identify the impacts, rather than guiding the official based on observations.

6.3.3.3 Step 3: Testing tools on the case study

As part of the review process the tools were tested on the case study site of the Bryanston Bicycle Park. The detailed assessments and score sheets are included in Appendix A. A summary of the results of each of the existing tools tested is included in

Table 6-13 and summarised below.

Table 6-12 Summary of the results of the existing river assessment tools.

	River Health Programme and EcoClassification	River Rehabilitation Assessment	Environmental Reconnaissance Checklist	River Habitat Survey	Stream Planning Procedure	Stream Visual Assessment	Problem and Opportunity Identification
Results	Poor	Fair	No overall score or result	No overall score or result	Not tested	Poor	Not tested

- River Health programme and EcoClassification: Each of the integrity indexes for habitat, riparian zone habitat, fish assemblage, macro-invertebrate and water quality scored as **poor,** with the resultant overall score being **poor**. This suggests that rehabilitation measures should be identified to address each of these issues.
- River Rehabilitation Assessment: The quality class score for either river bank was determined as **fair** but the recommended action was **major rehabilitation is needed**. The quality class score for instream habitat

was **good**. However the total quality class for the site was **fair**. Although the need for *major rehabilitation* was identified, it does not provide guidance on what aspects of the river banks require rehabilitation e.g. habitat provision, bank stability, etc.

- Environmental Reconnaissance Checklist: This methodology is a questionnaire style checklist. The methodology does not produce an output score for the site.
- River Habitat Survey: This methodology also does not provide an overall output score or result for the site. The site can be compared to a reference site in order to determine areas that require rehabilitation.
- Stream Planning Procedure: due to the lengthy process and reliance on specialist assessments, this methodology was not tested on the case study site.
- Visual Stream Assessment Protocol: The overall score for the site assessment was **2.28**. This is ranked as **poor**. The outcome does not provide guidance as to was causing the low score (environmental degradation) and what the rehabilitation should focus on.
- Problem and Opportunity Identification: due to the lengthy process and reliance on specialist assessments, this methodology was not tested on the case study site.

The outcomes of each of the tools assessed: of the 7 tools, 2 were not tested, 2 did not provide an outcome result, of the three that did provide an outcome result, 2 scored the site as “Poor” and 1 scored the site as “Fair” but needed major rehabilitation.

6.3.3.4 Step 4: Findings of the comparative review

The findings of the comparative review are summarised in

Table 6-13. Each of the existing assessments reviewed had strengths and weaknesses:

- In general the tools were useful for proactive river rehabilitation. International tools would need to be updated to SA context and even eco-region context.

- The context questions of the Stream Visual Assessment Protocol are important for putting the conditions observed on site on the day of assessment into context of the weather conditions of the previous days. This is important when considering turbidity and flow regime. Also the Protocol's inclusion of a site layout diagram provides a reference of observations for people reviewing the case report without being on site themselves, as well as a reference when following up with inspections and evaluation.
- Many of the procedures included a comprehensive assessment of habitat integrity but did not include water quality as an element of habitat integrity and do not confirm the habitat assessment with an invertebrate assessment. In order to have a realistic "snapshot" of the river at the time of the assessment, the water quality is crucial.
- The first driver of change to a riverine system is the anthropogenic change in the catchment of the river system. This ultimately relates to a change in land use or anthropogenic activities, which were not covered in as much detail as biological integrity in the methodologies. These assessment methods focus on species specific aspects or requirements and not on the holistic and integrative aspect of ecosystem services and functions. Only the Problem and Opportunity Identification methodology considered river function.
- The methodologies incorporated a range of useful indicators, however these reported on the physical features or status of the site, but did not take this further in terms of flagging specific problems that these observations were linked to, or whether they required rehabilitation interventions or not.

In general the methodologies are good and useful for initiative drive rehabilitation however none are suitable for current use in the South African enforcement context for rapid site inspection. The methodologies are generally too long and complex.

Three of the tools provided an outcome score for the site, but only the EcoClassification provided some indication to which components required rehabilitation. However these components were limited to elements of habitat provision and no other functions.

The River Rehabilitation Assessment (South Africa) and the Stream Visual Assessment Protocol (United States of America) system were user friendly. An

official can select a site characterisation or site description rather than them determining a numerical value, i.e. qualitative description rather than quantitative description. The numerical value is based on the selected description which is based on the "naturalness" of the site. This helps narrow the scope of answers that could be produced based on the official's skills and capability. This is a useful structure for the methodologies.

Several of the tools considered the features of the site, e.g. banks, instream and landuse, rather than the site as a whole. This is useful to guide an official as to where on the site potential problems are located that are required to be addressed.

Table 6-13 Summary of findings of the comparative review of existing tools.

	Tools reviewed						
Criteria	**River Health Programme and EcoClassification**	**River Rehabilitation Assessment**	**Environmental Reconnaissance Checklist**	**River Habitat Survey**	**Stream Planning Procedure**	**Stream Visual Assessment**	**Problem and Opportunity Identification**
River Function vs River Health	River Health	River Health	Neither	River Health	None	None	Both
Complexity of use	Complex	Simple	Limited by official's capability	Complex	Complex	Simple	Complex
Mathematical requirements	Yes	Yes	No	Yes	Yes	Yes	Yes
Technical terminology	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Suitability for Site/erf specific	Catchment/ reach scale	Site/erf suitable	Site/erf suitable	Site/erf suitable	Reach scale	Site/erf suitable	Reach scale
Technical sampling	Yes	No	No	No	Yes	No	Yes
Indication of specific functions for rehabilitation	Identifies degradation in the ecosystem	Identifies general degradation of the ecosystem	No	No	Identifies issues by planning team	No	Yes
Time consuming	Very	Yes	Yes	Yes	Yes	No	Yes
Other comments	Too complex and time	Not appropriate for urban	Not suitable for	Not suitable for	Suited to initiative-driven	Easy to follow. Can be	Suited to initiative-driven

	consuming for rapid screening purposes	setting	enforcement-driven screening	enforcement-driven screening	rehabilitation	used for site inspection purposes	rehabilitation

Although the methodologies as a whole are not applicable to the enforcement context, elements of the tools can be used to compile or develop an enforcement specific site inspection checklist.

Methodologies such as the EcoClassification, Stream Planning Procedure and the Problem and Opportunity Identification should still be used by the specialists when conducting their detailed assessments of the sites. These tools provide regular methodology and comprehensive assessment for detailed studies.

The River Habitat Survey made use of a database of existing reference sites. This tool could potentially be useful for setting rehabilitation objectives. However this will require a considerable amount of work to identify suitable reference sites for different stream characteristics in the different ecoregions, geology, vegetation types, etc., of the country. The National Freshwater Ecosystem Priority Areas (NFEPA) spatially maps potential sites of priority. However it is not a database of stream characteristics, and many of the mapped sites have not been ground truthed or verified.

In the context of guiding and supporting the enforcement officials to identify environmental degradation, and therefore identify impacts that require rehabilitation or remedial interventions, the existing methodologies reviewed do not meet the criteria. However some of the indicators and the structure of the methodologies should be drawn on in the development of an enforcement specific site screening tool.

6.3.4 PHASE II: Development of an appropriate Site Inspection Checklist tool (SIC)

6.3.4.1 Tool design

In an effort to standardise site assessments that involve urban rivers this research compiled a Site Inspection Checklist (SIC). The SIC provides a rapid screening tool to guide officials to make ecological observation on the site during their site inspections in order that they, the officials, may request the appropriate detailed studies to be conducted. The SIF provides a record of observations of uniform criteria by all enforcement officials. The form will serve as part of the site

inspection report and additional notes, photos, sample results, etc., can still be attached to the form. As the form is standardised this enables easy comparison of results between the initial inspection and follow-up monitoring inspections. Furthermore should there be a change of officials dealing with the case the original inspection observations are easily and clearly recorded. The tool was developed using applied science and concepts drawn from existing methodologies and assessment tools both to inform the structure of the inspection checklist tool, as well as the selection of criteria and indicators in the checklist.

The objective of this tool is to compile an appropriate site inspection checklist to:

1. Provide a basic standard record of site inspection observations (additional information can still be attached); and
2. Guide enforcement officials to make basic observations of the state of riverine area during river related site inspections.

6.3.4.2 Tool Development

The development of the Site Inspection Checklist Tool followed the following steps:

Step 1: Compile a system for the site inspection checklist

Step 2: Determine the criterion, indicators and measures

Step 3: Compile all the indicators and information gathering requirements into a form

Step 4: Test the system on case studies.

Step 5: Review findings.

6.3.4.3 Step 1: Compile a system for the site inspection checklist

The site inspection checklist should require the official to make an observation of various characteristics of the site, however this should not be limited by the technical ability of the official conducting the inspection. From the comparative review of the selected existing methodologies, the systems used in the River Rehabilitation Assessment (RRA) and the Stream Visual Assessment Protocol (SVAP) were particularly user friendly and not reliant on the official having a technical background. These systems were based on a characterisation of "naturalness" of the site. The indicator provided several descriptive measures that described the site; the official then selects the appropriate description for the indicator as per their observation of the site. This system is an easy to use system and forms the basis for the development of the Site Inspection Checklist Tool. This process is illustrated in Table 6-14.

Table 6-14 Example of an indicator and measures in a qualitative system.

Criterion	Measure	Best description √
Indicator	Description 1 e.g. Pristine	
	Description 2 e.g. Good	
	Description 3 e.g. Fair	√
	Description 4 e.g. Poor	

The aim of the tool is to provide a rapid screening of the site using simple observations. The tool is not aimed to be an evaluation or assessment of the state of the site, and therefore the tool should be based on qualitative descriptions of the site rather than a numerical or value based ranking system.

The system was therefore setup as a checklist, with a series of indicators each with a set of description measures. The official then selects the best description of the site. The completed checklist provides a summary of observations of the site made during the site inspection. The system is quick to complete and does not require mathematical calculations or complex sampling. Sampling of water quality, for example, is still carried out by the appropriate personnel or specialists but the enforcement officials are not limited by the sampling.

6.3.4.4 Step 2: Determine appropriate criterion, indicators and measures

Norris and Thoms (1999:199) observe that "(m)uch emphasis is being placed on rapid biological assessment in Australia, United States and the United Kingdom, particularly using indices such as the Index of Biotic Integrity (IBI) (Karr, 1981) and the benthic-IBI (B-IBI) (Plafkin *et al.*, 1989; Kerans & Karr, 1994), AUSRIVAS (Australian River Assessment System) (Simpson *et al.*, 1996), and RIVPACS (River Invertebrate Prediction and Classification Scheme) (Wright, 1995)." Furthermore, Maddock (1999:374) notes that "(s)ome river restoration initiatives aim to improve the water quality (Jordan, Gilpin & Aber, 1987) whereas others aim to improve the ecological integrity of river systems (RRP, 1993)." In contrast, the enforcement-driven process requires a tool to rapidly screen impacts on river function, in order to determine further detailed specialist studies and thereby set appropriate rehabilitation objectives.

In order to determine whether activities, specifically non-compliant activities, have impacts on riparian habitats, one needs to determine indicators of change. According to UNEP (2004), indicators can be defined as being the measurements or statistical parameters that help us to present a meaningful picture of what is happening within the environment. This is useful to assist one to track changes over time and thereby identify trends. In this manner indicators communicate important information to the audience. Selecting appropriate indicators for a given context is important. Gras et al. (1989), cited in Bockstaller and Girardin (2003:640) define an indicator as "a variable which supplies information on other variables which are difficult to access (….) and can be used as a benchmark to take a decision". Bockstaller and Girardin (2003) go on to note that indicators serve two functions, one is informative in that they provide simplified information about complex systems, or characteristics that are difficult to measure, and the other is as a decision-support function to achieve a certain set of objectives. Referring specifically to water management, Seager (2001) is of the opinion that indicators allow us to present scientific information to policy-makers who make decisions about water management, as well as to those who have to live with the consequences of the management decision. "For purposes of clarity, it needs to be fully understood that some indicators measure the physical, chemical or biological changes that have resulted from an intervention. Other indicators refer to the activities that lead to such changes" (UNEP, 2004:28). In relation to rivers and watercourses, indicators can be divided into multiple assemblages based on whether they generate an impact or whether they respond to an impact. The fundamental concept is that certain components affect change and are thus called "drivers", and there are the consequential results of the drivers - the affected components, e.g. the response indices (Kleynhans and Louw, 2008). Figure 6-8 illustrates the interaction between these components, e.g. between the impacts to system drivers and the resultant biological response. Similarly we can use indicators to understand or illustrate the cause to- and impact-on riverine functions.

From the literature and the criteria of the comparative assessment methodologies, the key criteria to consider in the SIC should include:

- Site description
- Land use
- Water quality
- Hydrology

- Geomorphology
- Biodiversity
- Invertebrates
- Riparian vegetation
- Habitat provision.

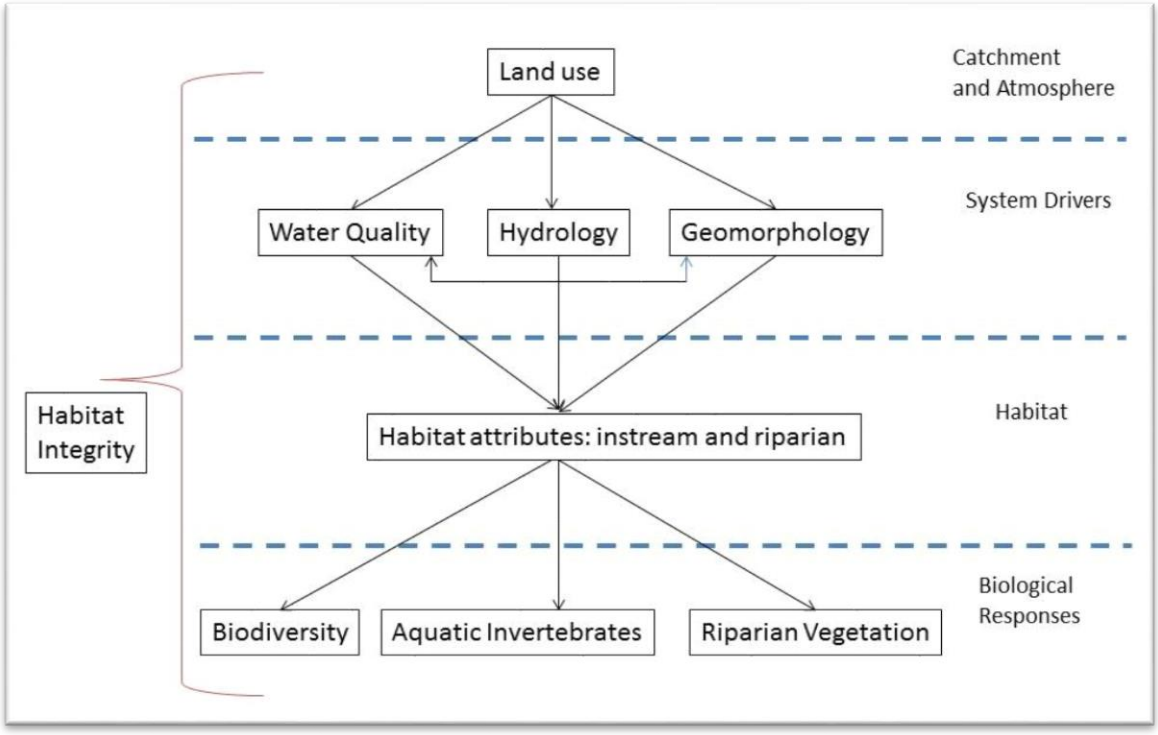


Figure 6-8 Interaction between drivers and biological responses. (Adapted: Kleynhans and Louw, 2008:A2-7)

The site screening checklist will be used by enforcement officials in the current context of environmental enforcement in South Africa and therefore needs to be:

- Easily understood by a “layman” with no background in aquatic sciences or ecology, not too technical nor full of jargon.
- Provide a uniform structure of observations from the site inspection. The site inspection records which have informed a decision by the enforcement official may be requested by the public in terms of Public Access to Information Act, Act 2 of 2000 (PAIA), therefore site inspection records must be kept structured and easily readable.

- Assess river function rather than river health, as a more holistic assessment;
- Provide a basic characterisation of the site;
- Be usable across a spectrum of enforcement officials;
- Should ideally link to the detailed management instruments developed in terms of the National Water Act, Act 36 of 1998 for river classification, e.g. the EcoClassification modules;
- Be comparable with later assessments, i.e. for monitoring purposes.
- Provide sufficient information to support the officials to make reasonable decisions in determining the rehabilitation objectives and activities.

Therefore the measures of the indicators should be easily observable and not complex descriptions or terminology.

Identify applicable indicators and measures

There are many guideline documents and manuals available from around the world for riverine rehabilitation or riverine management, however these are predominately based on Initiative Driven Rehabilitation using river health as the guiding objective rather than Enforcement-driven rehabilitation and assessing river function. These existing documents, as well as the relevant indicators from the comparative analysis of existing methodologies were used in order to identify and derive indicators and measures, and later to determine scale of impact in the Dashboard Tool. Table 6-15 provides a summary of these guidelines and documents.

Table 6-15 List of riparian rehabilitation guidelines and manuals used to inform indicators and measures

Country	Title	Urban /Rural	Initiative Driven/ Enforced Rehabilitation
Australia	**A Rehabilitation Manual for Australian Streams.** Rutherfurd, I., Jerie, K., and Marsh, N. (2000). Cooperative Research Centre for Catchment Hydrology, Monash University.	Both	Initiative Driven
United States	Urban Subwatershed Restoration Manual Series. **An Integrated Framework to Restore Small Urban Watersheds.** Schueler, T. (2005). Center for Watershed Protection. U.S Environmental Protection Agency.	Urban	Initiative Driven
	Stream Corridor Restoration: Principles, Process and Practices. Federal Interagency Stream Restoration Working Group (1998)	Both	Initiative Driven

	www.usda.gov/stream_restoration/		
	Restoring Streams in Cities. A guide for planners, policymakers and Citizens. Riley, A. (1998). Island Press, Washington D.C.	Urban	Initiative Driven
	Visual surveys and assessments: an overview River voices **12**(4) (2002), Oregon, USA	Urban	Both
United Kingdom and Ireland	**River Restoration Manual of Techniques.** Vivash and Murphy (1999). The River Restoration Centre, United Kingdom.	Both	Initiative Driven
	River Habitat Quality. River Habitat Survey. Raven, P.J., Holmes, T.H., Dawson, F.H., Fox, P.J.A., Everard, M., Fozzard, I.R., and Rouen, K.J. (1998). Environment Agency	Both	Initiative Driven
	Green City Guidelines. Advice for the protection and enhancement of biodiversity in medium to high-density urban developments. Brennan, C and O'Connor, D. (2008) UCD Urban Institute Ireland.	Urban	Initiative Driven
South Africa	**A decision support system for rehabilitation and management of riparian systems.** Quinn, N. (2003). Water Research Commission, Pretoria. 1064/1/03.	Rural	Initiative Driven
	EcoClassification. Kleynhans *et al.,* (1999), DWA 2008	**Both**	Initiative driven
	Wetland Fix. Assessment, Management and Restoration of South African Wetlands. Wyatt, J (1997). Rennies Wetland Project	Rural	Initiative Driven
	WET-Tools	Wetlands	**Both**
	Field Guide to Present Ecological Status Scores. Southern Waters (2001)	Urban river catchments	Initiative driven, maintenance
	River Maintenance Guidelines. A practical Guide to Good Practice. City of Cape Town, Transport, Roads & Stormwater Directorate. (2002)	Urban	Maintenance

Walmsley (2009:8) suggests that the significance of the information collected by an indicator extends beyond that information directly associated with the indicator itself. He proposes that there are several classes and categories of indicators and their use depends on the context in which they provide information. These different types of indicators are listed in

Table 6-16, own emphasis.

In the context of this research, the proposed indicators of the Site Inspection Tool are process indicators, in that they screen the impacts to riverine functions, i.e. flag potential impact to the ability to provide riverine function. The specific indicators in the tool include both qualitative (descriptive) measures.

Table 6-16 Types of reporting and performance management indicators (Walmsely, 2009:8)

Indicator Type	Comment on usage and context
Qualitative indicators	Provide descriptive and contextual information
Quantitative indicators	Provide contextual and explanatory information based on numerical values that require data collection
Process indicators	**Describe the qualitative and/or quantitative characteristics of a process. They measure ways in which services and goods are provided.**
Input indicators	Measures resources, both human and financial, devoted to a particular program or intervention (i.e. number of workers, energy used). Input indicators can also include measures of characteristics of target populations (i.e. number of farmers receiving irrigation water).
Output indicators	Measure the quantity of goods and services produced and the efficiency of production (i.e. number of people served, speed of response to complaints)
Outcome indicators	Measure the broader results achieved through the provision of goods and services (e.g. economic and social benefits achieved through provision of irrigation water)
Programme-level indicators	Provide information on results for which a programme, sub-programme or department is responsible
Performance indicators	Provide information about the achievements of an activity, a process or an organisation

It must be noted that the aim of the tool is to screen impacts to the river function rather than measure the actual river health or function, and therefore the actual assessment does not use quantitative indicators of ecosystem health. More technical and rigorous methods of assessment should be used by the specialists conducting their detailed studies. The purpose of the tool is for the enforcement officials to screen potential issues and therefore request detailed studies.

An initial list, of criteria and indicators was compiled from interrogating the literature and existing methodologies. This list was then discussed with appropriate specialists to confirm their suitability, usability and functionality for the purpose of the tool and the context of enforcement. During the desktop testing and initial field testing several of this indicators were dropped because they were too complex. The initial list of indicators is included in Table 6-17, indicators marked with * were dropped through the iterative process. Some indicators are purely for record keeping purposes, e.g. land use and % cover. Some indicators can be further interpreted to flag potential issues that require more detailed assessment e.g. bank erosion and armouring. This interpretation for "flagging" was further developed in the Dashboard Tool.

Criteria and Indicators from the River Rehabilitation Assessment (Quinn, 2003), Stream Visual Assessment Protocol (USDA, 1998) and River Habitat Survey (EA, 1998) were compiled into a foundation list of criteria and indicators for the Site Inspection Tool. This was reviewed and additional indicators or site issues requiring observation were included, such as litter, discharge outlets and water quality components to form the initial list. The initial list of indicators was discussed with various specialists including Mark Rowntree, a fluvial geomorphologist, Martin Kleynhans, an hydraulic engineer, Dr Amanda (Mandy) Uys, an aquatic ecologist, Nico Rossouw, a limnologist and water quality specialist and Dr Karl Renecke, a botanist. (These specialists were part of the Water Research Commission project team to provide specialist review on the development of the tool and guidelines). Based on the feedback from these specialists, and results of the case studies, the list of indicators was adjusted. The final list of indicators and measures are discussed in detail in the section: The Site Inspection Checklist Indicators.

The indicators were further broken down into measures and scores. Measures were assigned to each indicator to "measure" the level or extent of impact of the indicator. These measures are based on descriptions, e.g. the official selects the best description that suits their observation of that indicator on the site.

The initial list of indicators was a supposition that the indicators included could provide an indication of the impact to riverine function. This could be observed through the measure of the indicators, in that the cumulative measure of indicators and activities would provide an indication of the deviation away from normative

riverine function. The foundation indicators were drawn from known and applied riverine assessment methodologies and therefore assumed to be validated indicators. The measures of the indicators were derived from the literature (e.g. FISCRWG, 2001; EA, 1998, USDA, 1998).

Table 6-17 Initial list of criteria and their indicators.

Indicator types	**Criterion**	**Indicators**

Qualitative indicators for reporting purposes	Site Description	• *Building orientation (facing river or not)**
		• Land use and % cover
		• Ground cover
		  ○ Type
		  ○ % cover
		• Height of vertical banks (60°-90°)
		• Substrate description
		• *Substrate embeddedness**
		• Vegetation Composition
		  ○ Type
		  ○ % composition
		  ○ *Structure**
		  ○ *Canopy cover**

Process indicators for assessment purposes	Site character	• Erosion on site • % Invasive vegetation • Continuity of the riverine zone • Dumping / rubble • Litter
	Erosion and armouring	• Macro channel bank erosion • Extent of erosion on S-bends • Bank armouring • Active channel bed erosion
	Hydrology	• State of discharge outlets • Canalisation / Channelling • Levees / flood prevention bank • Abstraction • Impoundments • Culverts / Bridges • Flood debris
	*Aquatic invertebrates**	• *Macro-invertebrates** • *Diatoms**

	Water Quality	• Water Quality
		  ○ Colour
		  ○ Odour
		  ○ Observed clarity

		○ *Measured clarity** ○ Temperature ○ Foam ○ pH ○ Oily sheen ○ Nutrients ○ Oxygen ○ Indication of life • Discharge Quality ○ Colour ○ Odour ○ Temperature ○ pH ○ Foam ○ Oily sheen

Note: *Indicators that were dropped through the iterative testing process are in italics and marked with *.*

The Site Inspection Checklist Indicators

The following sections describe the criteria, indicators and present the measures identified for the Site Inspection Checklist and Form. The list of indicators was refined for practicality and reduced-complexity purposes; the list of indicators described is the final list of indicators used in the tool. The detailed description of the relevance of each indicator is included in the Guideline Manual (Braid, 2014). When conducting observations of the riverine zone, the zone is composed of the active channel and the left and right flood zone banks as illustrated by Figure 6-9. The active channel is the part of the channel that receives water flow most often. It is usually marked by noticeable banks on either side of the channel (Freeman and Rowntree, 2005). Regular storm events such as 1:2 or 1:5 year events occur within the active channel. The flood zone is the area between the regular flow of the active channel and the maximum height of major floods e.g. the 1:100 or 1:200 year flood plain. These are also referred to as the macro-channel. The channel banks are the left and right banks of the flood zone. The left bank refers to the left hand side of the water course when looking downstream, i.e. with the flow of water.

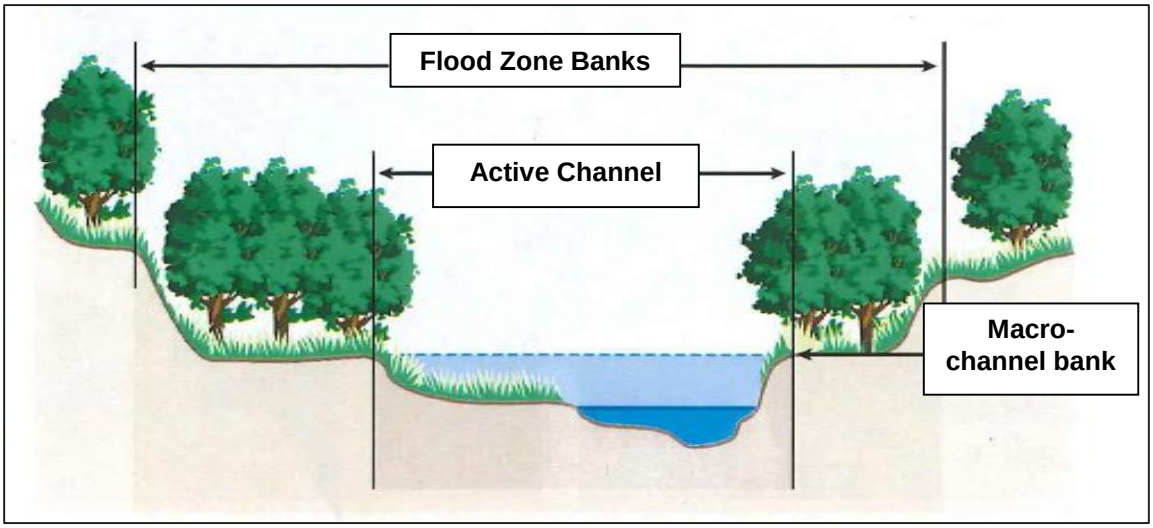


Figure 6-9 Cross section of a river channel indicating areas of observation (Adapted FISCRWG, 2001:1-18)

Each of the proposed indicators is discussed further. The indicators are grouped according to criterion as per Table 6-17.

Criterion: Site Description

Indicator: Land Use

The indicators in this criterion look at the anthropogenic changes in the catchment and adjacent to the riparian corridor. As the land uses cannot be rehabilitated, these indicators are not measured/scored. The land use is recorded in the SIC for record purposes and to provide a site description. The land use activities may contribute to the degradation of ecosystem functions and these can be remedied through an Operational Environmental Management Plan.

The City of Cape Town (2009b:5) has observed that "watercourses in urban areas are important to a city's biodiversity network, integral to the stormwater management system and generate recreational and economic opportunities". However, urbanization has greatly impacted watercourses. Such impacts include "declining water quality, diminishing groundwater recharge and quality, stream channel degradation, increased overbank flooding, floodplain expansion, loss of ecosystem integrity and functionality and loss of biodiversity" (City of Cape Town, 2009b:5). Natural river restoration processes such as absorption, attenuation and quality improvement of runoff have also diminished" (City of Cape Town, 2009b:5), as well as increased flow due to increased runoff and change in biodiversity

abundance and composition. Many of the criteria and indicators still to be discussed in this section address these specific impacts. The indicators for land use include both the activity and the estimated percentage cover of the activity on the whole site. The land use activity is described according to Table 6-18 and the percentage coverage of the whole site according to Table 6-19. The land use measures are guided by the land use zoning types. However without the actual town planning scheme or title deeds of each property, the actual zoning of the property would be unknown. The land use is thus derived from observation. The list of descriptions of land uses are guided by the zoning types but have been described so as to be easily observable.

Table 6-18 Description of land use activities on the whole site.

Measure	**Description**
	Agriculture
Dry	Agriculture: dry cultivation (no irrigation)
Irrigated	Agriculture: irrigated cultivation
Livestock	Agriculture: livestock farming
Mix irrigated	Agriculture: mixture livestock and irrigated cultivation
Mix dry	Agriculture: mixture livestock and dry cultivation
	Education
Fields	Educational buildings and sports fields
No fields	Educational buildings with no sports fields
	Forestry
Woodlot	Forestry: woodlot, cluster of trees
Indigenous	Forestry: Indigenous plantation
Plantation	Forestry: Alien plantation (Eucalyptus, pine, etc.); Orchards
	Mining
Surface	Mining: Surface mining (includes, quarries and borrow pits)
Underground	Mining: underground mining
Sand	Mining: Sand mining
	Recreational / Open Space
Open	Recreational: sports fields, nature reserve, park, etc.
Closed	Recreational: other; buildings, developed, etc.
Government	Recreational: Military bases
	Commercial

Commercial	Commercial: includes office parks, shops, medical centres, hotels, banks, parking areas, etc.
	Industrial (including WWTW)
Heavy	Industrial: heavy / toxic, includes production of energy, chemicals, steel, plastics, oil refinery, etc. Waste Water Treatment Works (WWTW)
Light	Industrial: light includes manufacture of consumer products, clothes, electronics, furniture, etc.
	Residential
Low	Residential: Low density = < 4 houses per hectare
Medium	Residential: Medium density = 5-25 houses per hectare
High	Residential: High density = >26 houses per hectare

For the purpose of this indicator, roadways and parking are included into each of the land use types. For specific parking areas, the measure of commercial should be used.

The estimated percentage cover relates to the proportion of the site that is occupied by each of the land use types and is described according to Table 6-19.

Table 6-19 Percentage coverage of land use activities

Measure	Description
0-20%	Little to no cover
21-50%	Some activity, less than majority of site
51-80%	Majority of site, with some areas excluded
81-100%	Almost to Full cover of the site

Indicator: Ground cover

"The greater the extent of hardened surfaces (e.g. roofs, parking lots, etc.) or area of compacted bare soil in the catchment, the lower the infiltration of storm-waters and therefore the greater the surface runoff and increase in floodpeaks" (Macfarlane*, et al.*, 2008), as well as reduced infiltration and groundwater recharge. Figure 6-10 illustrates the relationship of increased runoff related to increased coverage by impervious surfaces. Note how as the percentage of impervious cover increases, that the rate of evapotranspiration and infiltration (both shallow and deep) decreases, while runoff increases. According to FISCRWG (2001:3-23) as little as 10% increase in impervious surfaces can lead to stream degradation.

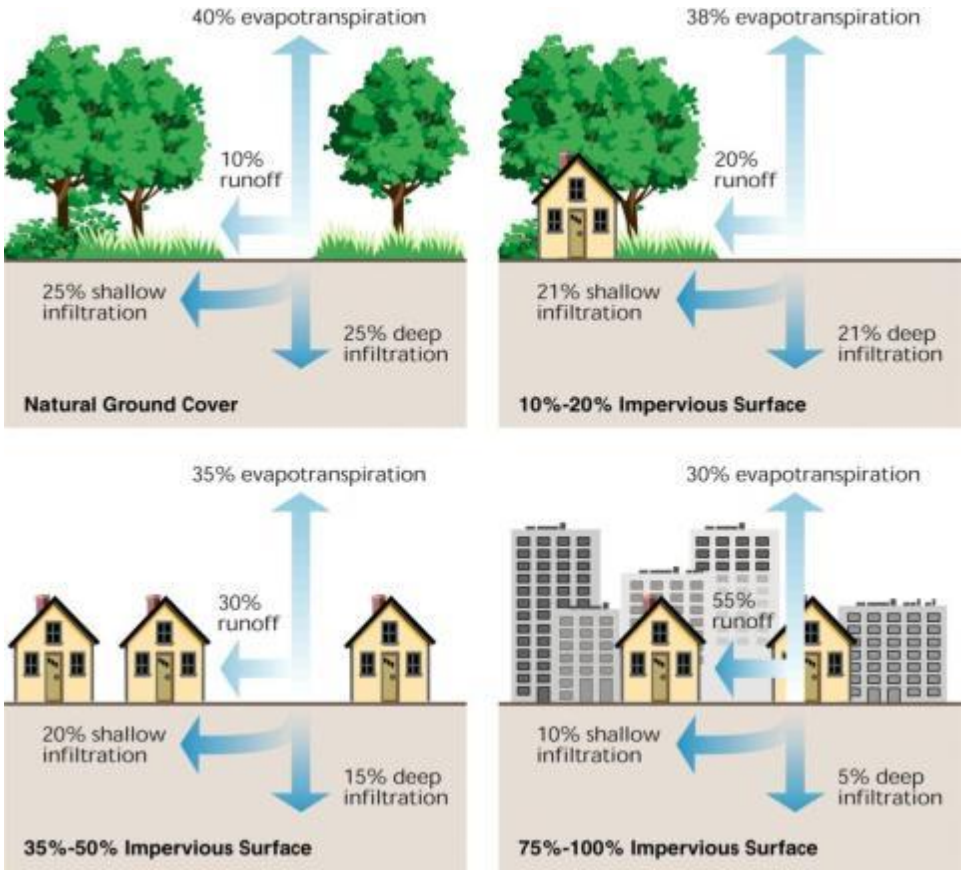


Figure 6-10 Relationship between change in ground cover and runoff. (FISCRWG, 2001:3-23)

The type of dominant ground cover is measured according to the type of ground cover as well as the percentage coverage of each type of ground cover on the site. The observation of ground cover type and the percentage coverage are indicated in Table 6-20 and Table 6-21.

Table 6-20 Type of ground cover

Observation	Description
Vegetated	Natural vegetation in excess of 30cm height (natural or invasive)
Kikuyu grass	Vegetation below 30cm height e.g. manicured lawns, kikuyu grass, etc.
Pervious	Pervious surfacing, such as planted pavers, gravel, brick paving, bare uncompact soil, etc.
Compacted soil	Bare compacted soil.

Impervious	Impervious surfacing, such as tar, concrete, etc.

Table 6-21 Percentage coverage of ground cover

Measure	Description
None	No coverage on the site
0-30%	Small coverage on the site
30-60%	Large coverage but not majority of the site
=>60%	Majority to total coverage on the site

Ecological functions of flood attenuation, sediment trapping, carbon storage, water quality and habitat provision are all affected by activities impacting on or reducing the absorption of runoff on the site, e.g. impervious ground cover reduces vegetation cover and habitat and prevents sediment trapping.

Indicator: Height of Vertical Banks (Banks of 60°-90°)

According to the USDA (1998) high and steep banks are more susceptible to erosion or collapse. Similarly high banks lead to channelling of the river with reduced opportunity for floods to reach the flood plain or associated wetlands, which in turn can contribute to reducing the riparian zone and drying out the wetlands. The heights included into the indicator measures were derived from the River Habitat Quality Survey method (EA, 1998). These were discussed with both a hydraulic engineer and fluvial geomorphologist. The height of the bank provides a basic indication if the river is separated from its floodplain. The height of vertical banks is measured from the edge of the active channel to the height of the bank, and is described according to Table 6-22. The height of the vertical banks provides a record of observation and is not scored in the Dashboard Tool.

Table 6-22 Height of vertical banks

Measure	Description
>4m	Height of bank from active channel edge more than 4metres
2-4m	Height of bank from active channel edge between 2 and 4metres
1-2m	Height of bank from active channel edge between 1 and 2metres
<1m	Height of bank from active channel edge less than 1metres
None	No vertical banks

Indicator: Channel substrate description

The substrate (sediment type) provides in-channel habitat for various aquatic organisms. Fine substrate materials generally provide habitat for smaller organisms such as worms and snails, while large materials such as cobbles and boulders provide habitat for larger organisms such as crabs and fish. Each river system has different characteristics which will influence each individual river and reach-of-river substrate composition. The measure of channel substrate composition is therefore only a record of the site description. The channel substrate observation is described according to Table 6-23. The measure is based on a graded grouping of substrate types, where the substrates are classified according to Thirion (2008) Table 6-24.

Table 6-23 Substrate description measure

Measure	**Description**
Fine	River bed is predominantly silt, mud, clay and sand (substrate materials < 2mm)
Gravel mix	River bed is predominantly gravel, pebbles & sand (substrate materials 2-100mm)
Coarse	River bed is predominantly gravel, cobbles & boulders (substrate materials >100mm)
No sediment	River bed is concrete bed, bed rock, no substrate materials or sediment.

Where the substrate types are classified according to Table 6-24.

Table 6-24 Types and size of substrate (Thirion, 2008)

Material	Size class (mm)
Bedrock	
Boulder	>256
Cobble	100 – 256
Pebble	16 – 100
Gravel	2 – 16
Sand	0.06 – 2
Silt / mud / clay	<0.06

The measure of substrate embeddedness was removed from the checklist as it was too complex to observe or measure within the context of the tool and the target user-group.

Indicator: Riverine vegetation composition

Riparian vegetation is identified in DWAF (2008) as providing a number of critical functions within the river system, such as stabilisation of river channels, banks and floodplains, flood attenuation, water quality and temperature (e.g. shade), habitat provision, and migration corridors.

Plants offer resistance to the passage of water and plant roots provide resistance to erosion by water by binding the surface of the soil. Flows slowed due to in-stream plants such as reeds, limit bank erosion, but may also result in accumulation of sediment (accretion or aggradation) through the deposition of suspended solids as the slowed water loses its energy to transport the materials.

The riverine vegetation is composed of both the riparian vegetation e.g. on the flood banks, and the aquatic vegetation and in-stream vegetation in the active channel. DWAF (2005:16) explains that riparian areas represent the interface between aquatic and upland ecosystems; the vegetation in the riparian area may have characteristics of both aquatic and upland species. Many of the plants in the riparian area require plenty of water and are adapted to shallow water table conditions. Due to water availability and rich alluvial soils, riparian areas are usually very productive. Tree growth rate is high and the vegetation under the trees is usually lush and includes a wide variety of shrubs, grasses, and wildflowers. According to Graham and Louw (2009) trees are woody perennials, usually single stemmed in an undamaged state, with a distinct upper crown. Shrubs are woody perennials with two or more stems arising from near the ground, are generally smaller than trees and without a trunk. Kleynhans and Louw (2007) classify the non-woody component as comprising of grasses, sedges, forbs, and all other herbaceous plants. The non-woody component includes species such as *Phragmites spp.* (Common Reed), the *Restios* spp., *Typha* spp. (Bulrush), *Juncus* spp. (Rushes), aquatic (hydrophytic) grasses, and aquatic sedges. Both perennial and non-perennial streams support riparian vegetation. The flood zone vegetation type is described according to Table 6-25, whereas the vegetation type in the stream is described according to
Table 6-26**.** Vegetation composition refers to the presence of different types of vegetation on the site as well as their relative proportions (% cover) in the assemblage, as measured according to Table 6-27.

While the presence of some aquatic vegetation is normal in streams, high levels of nutrients, especially phosphorus and nitrogen, in the water of the active channel

promote the overabundance of algae and floating rooted macrophytes (USDA, 1998).

Table 6-25 Flood zone: dominant vegetation type.

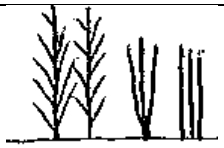
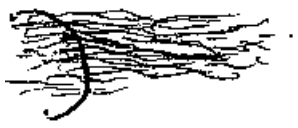
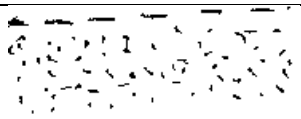
Observation	Description: Flood Zone (Banks)	
Wild flowers		Herbs and flowers e.g. *Nasturtium* spp.
Grasses		Grasses e.g. Kikuyu grass (*Pennisetum spp.*)
Reeds		Reeds, and sedges e.g. Common Reed (*Phragmites* spp., *Restio* spp.)
Shrubs		Shrubs
Trees		Trees and saplings e.g. Eucalyptus (*Eucalyptus* spp.), Wattle (*Acacia* spp.), Willows (*Salix* spp.)

Table 6-26 In-stream: dominant vegetation type.

Observation	Description: Active Channel (In-stream)	
Filamentous		Hair-like algae or algal mats on rocks
Free floating microscopic		Algae that gives the water a green colour (phytoplankton)
Free floating aquatic		Water weeds that float, e.g. Water Hyacinth (*Eichhornia* spp.), Water Lettuce (*Pistia* spp.), Red Water Fern (*Azolla* spp.).

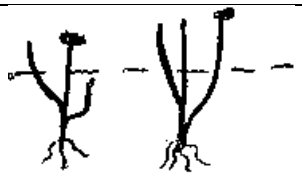
Rooted emerging		Water plants that protrude from the water and have visible roots, e.g. Bulrush (*Scirpus* spp.), Common reed (*Phragmites* spp.)
Rooted submerged		Water plants that are entirely submerged in the water, e.g. Parrot's Feather (*Myriophyllum* spp.) and water weed (*Egeria* spp.)

Table 6-27 Riparian vegetation composition: % (percentage) cover

Measure	Description
80 – 100% cover	There is total or near total dominant plant type cover on the site.
60 – 80% cover	More than half the site is covered with this plant type.
30 – 60% cover	There are some large patches of plant type cover on the site.
10 – 30% cover	There is small scattered plant type cover on the site.
0 – 10% cover	There is little or no plant type cover on the site.

Vegetation composition in riverine areas varies from one part of the country to another, according to factors like climate, geology and water quality, therefore for the purpose of the Site Inspection Form riverine vegetation composition is a record of description of the site rather than a measure of impact.

The measures of vegetation structure and canopy cover were removed from the checklist as it was too complex to observe or measure within the context of the tool and the target user-group.

Criterion: Site Character

Indicator: Erosion on the site

This erosion refers to erosion taking place on the whole site, excluding of the riverine area. Erosion in the riverine area is still to be addressed in later indicators. There are three types of erosion that can occur on site, that of sheet, rill and gully erosion.

Sheet erosion occurs when surface water moves down a slope or across a field in a wide flow and peels off relatively uniform sheets or layers of soil. Because the topsoil disappears evenly, sheet erosion may not be noticeable until much damage has been done. (Miller, 1998:553)

Rill erosion occurs when the surface water forms fast flowing little rivulets that cut small channels in the soil. (Miller, 1998:553).

Gully erosion occurs when rivulets of fast flowing water join together and with each succeeding rain event cut the channels wider and deeper until they become ditches or gullies. Gully erosion usually happens on steep slopes where all or most vegetation has been removed. (Miller, 1998:553).

Dongas occur where severe gully erosion has caused deep ditches, e.g. greater than 1 metre deep.
The erosion on site indicator is observed according to Table 6-28.

Table 6-28 Erosion on the site

Observation	Description
None	No erosion on site
Sheet	Evidence of sheet erosion on site
Rill	Evidence of rill erosion on site
Gully	Evidence of gully erosion on site
Donga	Deep gullies forming dongas on site

Ecological function of flood attenuation increases due to greater channel width; however the other functions of sediment trapping, carbon storage, water quality and habitat provision are all affected and reduced by erosion taking place on the site.

Indicator: Percentage of vegetation is alien and/or invasive

Exotic, alien and invasive plant species are often major contributors to changes in indigenous riverine vegetation composition (Chamier, *et al.,* 2012) and biodiversity. Where natural vegetation is disturbed, alien and invasive plants tend to dominate the re-growth. Invasive and water-intense plant species are specifically problematic, including black wattles, Port Jackson, eucalyptus, lantana, queen of the night, potato tree and kikuyu grass. For the purpose of the site assessment, the measure of infestation is estimated based on the percentage of vegetation being alien and/or invasive vegetation species in relation to indigenous species on the site and is recorded for both the flood banks as well as the active channel. The percentage of vegetation that is alien and/or invasive is measured using Table 6-29.

Table 6-29 % (percentage) of vegetation is alien and/or invasive species

Measure	Description
unknown	Not sure of the alien or invader plant species.
no AIP	All indigenous, no alien and/or invader species.
1 -10 %AIP	Scattered alien and/or invader species.
11 – 40% AIP	Occasional clumps of alien and/or invader species.
41 – 60% AIP	Concentrated patches alien and/or invader species.
60 – 100% AIP	More alien and/or invader species than indigenous.

Many enforcement officials may not be able to differentiate between indigenous and alien or invasive plant species, therefore the Guideline Document (Braid, 2014)[18] includes:

- a list of indigenous wetland and riverine vegetation indicator species per Province;
- a list of common riverine alien and invasive species.

Where available, images of the plant species on these lists have also been provided**.** It was identified during the case studies with enforcement officials, that enforcement training should include a basic course in alien and invasive plant species identification and management. This is applicable to all ecosystems and not limited to watercourses.

Alien and invasive vegetation reduces habitat provision for indigenous and endemic species. However, at the same time it increases flood attenuation by slowing floodwaters, and trapping sediment. The vegetation material and sediment trapping contribute to carbon storage. Alien and invasive plant species still provide a productive function, for example black wattle can be used as fuel wood for burning, or making furniture.

Indicator: Continuity of riverine Zone

This indicator refers to the vertical continuity of both the riparian corridor between the site and adjacent erven (upstream-downstream riparian corridor) measured in the flood bank, as well as the horizontal continuity of the riparian zone between the terrestrial zone and the water's edge (terrestrial-instream zone), e.g. the bank measured in the active channel.

[18] Refer Braid, S. (2014).

The riverine zone can be disrupted by obstacles such as walls, roads, trenches, pipelines, impervious surfaces, site clearing, cleared vegetation, dumping, etc., causing fragmentation of the habitat corridor. It is important to determine the continuity of the riverine corridor in order to determine its suitability as a migration corridor, habitat provision and ecological function of the riverine zone. As an easy observation for officials, the continuity of the riparian vegetation in the riverine zone is described according to Table 6-30.

Table 6-30 Continuity of the riverine zone

Observation	Description
Continuous	The riparian habitat corridor is intact and links to adjacent properties with riparian vegetation (length). The riparian habitat zone is intact and links between the terrestrial zone and the watercourse edge (width).
Fragmented	The riparian habitat corridor and vegetation is interrupted, disturbed, or broken up into smaller sections (length). The riparian habitat zone between the terrestrial area and water edge is interrupted (width).
None	There is no riparian corridor and/or zone on the site.

According to USDA (1998:9), "(a) healthy riparian zone is one of the most important elements for a healthy stream ecosystem. The quality of the riparian zone increases with the width and complexity of the woody vegetation within it. This zone:

- Reduces the amount of pollutants that reach the stream in surface runoff;
- Helps control erosion;
- Provides microclimate that is cooler during the summer providing cooler water for aquatic organisms;
- Provides large woody debris from fallen trees and limbs that form in-stream cover, create pools, stabilize the streambed, and provide habitat for stream biota;
- Provides fish habitat in the form of undercut banks with the ceiling held together by roots of woody vegetation;
- Provides organic material for stream biota that form the base of the food chain in lower order streams;
- Provides habitat for terrestrial insects that drop in the stream and become fish food, and habitat and travel corridors for terrestrial animals;
- Dissipates energy during flood events; and

- Often provides the only refuge areas for fish during out-of-bank flows (behind trees, stumps, log, etc.)."

Indicator: Dumping in the river channel

Dumping is the intentional disposal of solid waste on the specific site. The solid waste may vary in composition, including garden refuse, building rubble, product waste, medical waste, household waste, etc. The measure for dumping is based on the occurrence of solid waste affecting or covering a 100 metre stretch of the watercourse. Dumping is measure on both the flood banks and the active channel; and is measured according to Table 6-31.

Table 6-31 Dumping / Rubble

Observation	Description
None	No evidence of dumping on the site.
0-10%	Dumping affects / covers a small portion of a 100m stretch.
10-25%	Dumping affects / covers up to a quarter of the 100m stretch.
25-50%	Dumping affects / covers up to half of the 100m stretch.
=>50%	Dumping affects / covers more than half or the majority of the 100m stretch

Dumping reduces flood attenuation and habitat provision and can contribute negatively to the water quality function. Dumping prevents the subsistence/cultural use of the river and reduces the aesthetic appeal at that point.

Indicator: Litter in the river channel

For the purpose of this research, litter differs from dumping, in that it is solid waste that has been washed down the watercourse to the site from within the catchment. The accumulation of litter in the watercourse contributes both to poor water quality as well as to reduced habitat provision. Litter can trap aquatic organisms and wildlife such as birds causing them to starve and die. Litter is observed on the flood zones as well as in the active channel over a 100m stretch; and measured according to Table 6-32.

Table 6-32 Litter

Measure	Description:
None	No evidence of litter.
<10 pieces	10 pieces or less of litter over a 100m stretch.
10 – 50 pieces	10-50 pieces litter visible over a 100m stretch.
>50 pieces	More than 50 pieces of litter over a 100m stretch.

Criterion: Erosion and armouring

Indicator: Macro-channel Bank Erosion

During the daily regular flow of water in a watercourse or small rain events e.g. 1:2 year, the banks that are affected by these flow conditions form part of the active channel. The macro-channel or flood bank is the area between this regular flow of the active channel and the maximum height of a major flood, e.g. 1:100 year flood occurrence. Macro-bank erosion is a measure of erosion within or along these floodplain banks on the site, and measured according to Table 6-33.

Table 6-33 Macro-channel (flood zone) bank erosion

Observation	Description
None	No erosion or cutting of macro-channel bank length
>5%	Erosion of >5% of macro-channel bank length
>20%	Erosion of >20% of macro-channel bank length
>50%	Erosion of >50% of macro-channel bank length

Erosion in the macro-channel reduces habitat provision, reduces carbon storage, reduces provision of subsistence resources and reduces the aesthetic appeal of the river.

Indicator: Extent of erosion on S-bends

A cut bank, also known as a river cliff, is a naturally occurring phenomenon that is exaggerated by urban impacts. Cut banks are usually found along meandering streams (S-bends), where the outside bank of a watercourse is continually undergoing erosion (Tarbuck and Lutgens, 2002:279). The cut banks are located on the outside bend of the watercourse. They resemble a small cliff, and are formed by the erosion of the bank by the fast flowing water in the watercourse. Cut banks are typified by erosion protection measures such as gabion baskets or concrete walls. Cut banks are nearly vertical and often expose the roots of nearby plant life. Often, particularly during periods of high rainfall and higher-than average water levels, trees and poorly placed buildings can fall into the stream due to mass wasting events. The erosion around a cut bank can be exaggerated by increased flows and site clearing resulting in the cut bank extending further than just the river bend and causing the river bank to become unstable. Cut banks are the area of a stream where the water is flowing the fastest and the deepest, making them rather dangerous. Cut banks are measured according to

Table 6-34. Increased area of cut banks results in increased flood attenuation from a wider channel, increases sediment load from bank collapse, reduces carbon storage because of the banks eroding away, reduces habitat provision, reduces the water quality function by increased sediment load, reduces the subsistence and cultural utilization of the river bank and makes the river less aesthetically appealing.

Table 6-34 Extent of erosion in S-bends

Measure	Description
None	No cut banks along the river bend
<10%	Less than 10% of bank is cut / eroded in the river bend
11-50%	Between 11-50% of bank is cut / eroded in the river bend
>51%	Erosion/bank collapse extends well past the bend of the river

Indicator: Bank Armouring

Protecting the channel banks is essential to protecting the riparian zone. The bank is where the horizontal groundwater and active channel watercourse interaction takes place. The banks form the riparian habitat of the riverine corridor. According to the USDA (1998) extensive bank-armouring of channels to stop lateral cutting usually leads to more problems (especially downstream). Watercourse and bank interaction are threatened by armouring such as by gabions, stacked tyres, shuttering, walls and berms. Armouring can be of differing levels of interference in the river system, for example engineered armouring completely cuts off the interaction between watercourse and river banks and leads to channelling of the watercourse. Similarly, armoured banks such as armouring the full length of the bank with gabion baskets also reduces the bank-watercourse interaction, although during flood events there may still be some interaction. Exposed soil or bank collapse still provides for some bank-watercourse interaction but has reduced habitat provision, and carbon and sediment trapping. By contrast, toe-armouring or vegetated banks still promote bank-watercourse interaction while stabilising the watercourse bank from erosion. The indicator for bank modification is described according to Table 6-35.

Table 6-35 Bank armouring

Observation	Description
Vegetated	Banks are vegetated
Toe	Gabions or similar at the base of bank only
Occasional	Some protection along the reach
Armoured	Gabions along the reach
Engineered	Cement / concrete walling along the reach
Exposed soil	Banks are exposed soil with no vegetation or armouring

Indicator: Active channel bed erosion

According to the USDA (1998:7) “Active down cutting (bed erosion) and excessive lateral cutting are serious impairments to stream function.” Some active channel erosion is normal in a healthy stream; however excessive active channel erosion occurs where riparian zones are degraded or where the stream is unstable because of changes in hydrology, sediment load, or isolation from the flood plain. Both conditions are indicative of an unstable stream channel. Active channel bed erosion is observed by erosion of the banks within the active channel; the daily flow is “disconnected” or deeper than the active channel banks. Active channel bed erosion or active down cutting is described according to Table 6-36.

Table 6-36 Active channel bed erosion

Observation	Description
None	No bed erosion
Degradation	Some (<1m) incision of the active channel
Channelling	Deep incision (>1m) of the active channel

Criterion: Hydrology Indicators

Indicator: State of discharge outlets

Discharge outlets increase flow at a point source. Where these outlet structures are not adequately designed, these can cause further erosion and damage to the riparian area. In addition, discharge points introduce point source pollutants into the watercourse e.g. swimming pool back-wash, industrial discharge, stormwater, etc. For this indicator only the state of the discharge structure is assessed; the quality of the discharge water is assessed in the Water Quality criteria. The discharge outlet indicator is observed whether there is erosion or bank collapse

around the point of discharge or the discharge out and is described according to Table 6-37.

Table 6-37 State of discharge outlet structures

Measure	Description
None	No outlets on site
Good	Outlet in good condition, no erosion
Poor	Outlet with erosion, bank collapse, etc.

Discharge outlets contribute additional contaminants to the water quality. Where structures are in good condition they provide a small interruption habitat provision, whereas structures that have collapsed or eroded provide a larger interruption to habitat provision. Outlet structures offer no flood attenuation, carbon storage, subsistence or cultural resource, or aesthetic appeal. For recreational fishing, some discharge outlets may provide increased access to fish feeding in the warmer water from the discharge outlet.

Indicator: Canalisation / Channelling

The act of intentional channelling or canalising of a watercourse is a process of straightening a watercourse and directing its flow according to human demand rather than natural occurrence. Channelling can also occur naturally through erosion processes, where increased or directed flow erodes the water channel thereby deepening the channel. The watercourse is then limited to that particular channel and will require a major flood to alter it. Formal canalisation includes concrete canals for a reach of river. Informal canalisation includes erosion gullies and piecemeal straightening or retraining of the reach of river. The canalisation/channelling indicator is described according to Table 6-38.

Table 6-38 Canalisation / Channelling

Observation	Description
Natural	Natural river course, no canalisation or course straightening
Occasional	Occasional straightening or channelling of the river course
Deeply Eroded	Channelling of the river from erosion, down-cutting, or excavation
Straightened	Complete artificial channel or river course straightening

Canalising or channelling of the watercourse reduces flood attenuation and sediment trapping, as well as carbon storage, water quality function, habitat provision, provision of subsistence and cultural resources, and in many cases also reduces recreational use of the river.

Indicators: Levees / Flood prevention banks

Where there are large floodplains, many land owners construct flood prevention banks (levees, berms or dykes) in order to reclaim the land for utilisation. This is particularly apparent in agricultural areas and is an old traditional practice. However, levees canalise a river and separate the floodplain from the river, which in turn affects the sedimentation regime of the river and increases the flow velocity and flood peaks due to reduced attenuation. According to Heeg *et al*., (1989) apart from the primary effect of floodplain desiccation as a result of reduced floodplain inundation, there are also secondary effects such as inadequate flushing of floodplain pans leading to unnaturally-high salinity levels, reduced riparian habitat provision, reduced carbon storage, reduced sediment trapping but increased subsistence utilisation. Where historic levees occur, the river system would have adapted to the change in regime, however the construction of levees is now a listed activity in terms of the National Water Act, Act 36 of 1998. Naturally occurring levees are not common in South Africa; however manmade levees are common especially in agricultural areas. A levee also constitutes infilling/dumping/impeding the flow within a watercourse. A levee can be a simple earthen embankment or more formal for example stacked vehicle tyres. Levees are measured using Table 6-39.

Table 6-39 Description of levees or flood prevention banks

Measure	Description
None	No levee (flood prevention bank) on the site.
0-1m	Height of levee is less than 1metre
>1m	Height of levee is between 1 and 2 metres
>2m	Height of levee exceeds 2 metres

Indicator: Abstraction

There are two scales to abstraction, the first being abstraction for domestic use, e.g. within the allowances of Schedule 1 of the National Water Act, Act 36 of 1998 (NWA); and secondly abstraction that requires a water use licence in terms of section 21(a) of the NWA for the taking of water.

Schedule 1 of the NWA makes provision that:

(1) A person may, subject to this Act -

(a) take water for reasonable domestic use in that person's household, directly from any water resource to which that person has lawful access;

(b) take water for use on land owned or occupied by that person, for -

(i) reasonable domestic use;

(ii) small gardening not for commercial purposes; and

(iii) the watering of animals (excluding feedlots) which graze on that land within the grazing capacity of that land, from any water resource which is situated on or forms a boundary of that land, if the use is not excessive in relation to the capacity of the water resource and the needs of other users;

(d) in emergency situations, take water from any water resource for human consumption or firefighting; …

Note: Should a schedule 1 activity draw commercial gain, e.g. the sale of vegetables from a small garden, this would then be considered a NWA section 21(a) use requiring a water use license in terms of the NWA.

Without a flow-meter or other technical equipment, it is difficult for an official to measure the exact volume of abstraction. There are different scales of pumps or diversions which can indicate whether the abstraction is for domestic or commercial purposes. A domestic purpose (Schedule 1) abstraction pump infrastructure is usually smaller in size and capacity, whereas abstraction on a larger, commercial scale usually involves larger and more permanent infrastructure such as a pump house or a diversion weir and channel. However the scale of the infrastructure is not a solid rule, and the official should also take note of whether there are commercial activities taking place on the site e.g. nursery, golf course, if so, the abstraction is likely to be for commercial purposes and require a water use licence. The observation of abstraction on a site is described according to Table 6-40.

Table 6-40 Abstraction measure code

Observation	Description
None	No abstraction of river water
Domestic	Small scale abstraction – for domestic use, i.e. NWA Schedule 1, watering vegetable garden
Large	Large scale abstraction – permanent infrastructure or large abstractions e.g. for irrigation of a nursery or farmland purposes

Indicator: Impoundments

Impoundment structures not only reduce flow of water, but also the transportation of sediment which is a necessary element for ecosystem processes, e.g. providing substrate for vegetation and habitat for aquatic biota. Similarly impoundments can alter the temperature of the water, for example warmer water on the surface of an impoundment due to the long exposure to the sun and colder water at the bottom of the impoundment due to lack of exposure to the sun, which also affect ecosystems processes and diversity. Impoundment of flow through in-stream dams, weirs, and water features, may impact on downstream reaches of the watercourse by reducing the necessary flows and sediment loads, thereby altering the water temperature and influencing migration cues (Thirion, 2008). It may also impact on upstream reaches by altering the flood storage capacity of a reach and thereby causing more flooding or longer inundation after storm events. The USDA (1998:12) also points out that "if the barrier is sufficiently high, the impoundment may prevent the movement or migration of fish, deny access to important breeding and foraging habitats, and isolate populations of fish with other aquatic animals."

One of the threats to floodplains as a result of impoundments is due to the dams ability to trap sediment, thereby releasing water which is sediment starved, (Macfarlane et al., 2008). "The reduction in sediment load deprives floodplains downstream of the sediment required for floodplain construction and commonly leads to floodplain degradation" (Macfarlane et al., 2008:74). Impoundments do not necessarily need to be dams, they can also be small barriers that only operate as an impoundment at low flows, or collapsed or blocked structures e.g. accumulated flood debris trapped on obstacles in the river, blocked causeways, etc. The indicator for impoundments are described according to Table 6-41.

Table 6-41 Impoundment measure code

Observation	Description
None	None
Temporary	Small, temporary e.g. with sand bags
Low flow	Low flow only diversion (all high flows and floods overtop) e.g. low weir, causeway
Small, permanent	Small, permanent attenuation structures e.g. in-stream farm dam, Bruma Lake, Emmarentia dam, stormwater attenuation structures
Large, permanent	Large, permanent reservoirs e.g. permanent dams such as Berg River Dam, Midmar Dam, Vaal Dam, Vanderkloof Dam, etc.

Indicator: Culverts and bridges

Similarly to impoundments, culverts and bridges also affect the flow of water in a watercourse as well as disrupt the connectivity of the riverine zone. Ideally bridges should be single span or pier-support bridges to promote connectivity of the riverine zone under the bridge. However, single span bridges are more costly to construct than culvert bridges. Culverts concentrate the flow of water through the culverts, usually resulting in erosion on the downstream side of the culvert. In peak flows, where the opening of the culverts is not sufficient, the water can back-up upstream of the culvert causing damage to the river banks, and even over-topping the culvert. Flood debris also accumulates on the culvert edges which in turn affects the flow regime. Culverts and bridges are described according to Table 6-42.

Table 6-42 Culverts and bridges measure code

Observation	Description
None	No bridge or culverts or other obstacles
Bridge	Single span/pier bridge, with habitat continuation
Intermediate	Culverts with limited habitat continuation
Culvert/drift	Culvert /low level bridge / drift, no habitat continuation

Indicator: Flood Debris

Flood debris refers to the woody material, reeds and other solid waste that passes through a watercourse during a storm event. After a storm event, flood debris lines the banks of the watercourse indicating the height of the water level. However, large debris such as fallen trees may block a watercourse, causing debris to accumulate on obstacles in the watercourse e.g. other trees or culverts and bridge piers. The accumulation of flood debris in a river channel can alter the hydrological characteristic of the channel for example by acting as an impoundment. Naturally occurring fallen branches and large pieces of wood in a river provide habitat for breeding and resting of aquatic biodiversity. After major storm events, this debris may be washed downstream and accumulate against obstacles causing further impoundment and alteration of the hydrology at that point. The reduction in flow velocity due to the impoundment results in deposition of transported sediment. The river bed rises as a result of the accumulated debris and the river alters its course around the flood debris obstacle, severely impacting on the adjacent riparian zone and causing bank collapse. If there is no woody debris present at all this suggests that there is poor vegetation cover and structure

on the site or upstream of the site. The absence of woody debris reduces the habitat provision for aquatic fauna. The flood debris indicator is described according to Table 6-43.

Table 6-43 Accumulated flood debris measure code

Observation	Description
Naturally occurring	Debris naturally occurs in the river, i.e. fallen trees, branches, sticks. Usually dispersed not accumulated.
Scattered	Scattered woody and flood debris e.g. reeds and woody debris along the banks of the river after a flood, or a fallen branch in the river with no accumulated debris.
None	No woody debris.
Accumulated	Accumulated woody and flood debris obstacles e.g. fallen trees/branches blocking flow of water and accumulating other debris.

Criterion: Water Quality Indicators

Dallas and Day (2004) explain that water quality is the combined effect of the chemical constituents and physical attributes of a sample of water. Water quality is a term "used to describe the physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses and for the protection of the health and integrity of aquatic ecosystems. Many of these properties are controlled or influenced by constituents that are either dissolved or suspended in water" (DWAF, 1996:3). Water quality variables potentially affecting aquatic ecosystems may be physical or chemical. Water quality components may change as a result of either flow or non-flow related activities. Flow related impacts could result in water warming due to shallower water depths and decreased turbidity due to longer water retention times in the system allowing suspended sediments to settle out. Non-flow related impacts may possibly result from wastewater effluent discharges or irrigation return flows.

The enforcement officials do not necessarily take water quality samples; however the DWS water quality units may be tasked to take samples. The samples are compared to thresholds and the licence conditions of the site.

Indicator: Colour

Water that is colourless usually lacks pollutants that affect water colour. Suspended sediment will impart the same colour to water as the surrounding soil, for example the naturally occurring tannins in fynbos soils discolour the rivers in

the Cape to dark tea coloured brown. The presence of a colour that is different from the surrounding soil colour may indicate the presence of a chemical pollutant. Brightly coloured water usually indicates acid mine drainage or other chemical contaminants. The indicator for water quality colour is described using Table 6-44.

Table 6-44 Water quality: Colour measure code

Observation	Description
Colourless	Colourless
Tea	Tea coloured
Brown	Brown/muddy (soil)
Unnatural	Unnatural
Black	Black
Grey	Grey (raw sewage)
Green	Green (algal growth)

Indicator: Odour

Most water is either odourless or has a slight "earthy" odour. Odours such as petrol (hydrocarbon) fumes, solvents, sulphur or rotten eggs, sewage, or a sour smell may be *indicative* of chemical pollutants. The odour indicator is described using Table 6-45.

Table 6-45 Water quality: Odour measure code

Observation	Description
Earthy	Earthy smell
Hydrocarbon	Petrol / diesel / oil / Aviation fuel / paraffin / sour smell
Sewerage	Rotten egg / sewerage smell
Pesticide	Chemical or pesticide smell (algae)
None	No odour observed

Indicator: Clarity

Clarity refers to the amount of suspended material present in the water that causes the water to be dirty and limits the amount of light that can pass through the water. Over long periods of reduced sunlight, rooted and submerged plants will no longer emerge from the main body of a river. Likewise, clarity affects aquatic fauna and their ability to see food or predatory threats. The dirtier the water is, the more likely it is to contain suspended material – which is indicative of the occurrence of large hydrological related events. Some rivers may have a

naturally high turbidity due to high sediment suspension. Where chemicals have precipitated out, the water has a "milky" appearance and suggests chemical contamination. For the purpose of the site assessment, clarity is scored by observation. The clarity indicators are described using Table 6-46.

Table 6-46 Clarity: Observed measure code.

Observation	Description
Transparent	Completely transparent. No suspended material in the water.
Clearish	Some suspended material in water. Slightly turbid.
Cloudy	Opaque water, can see particulates in the water reducing visibility
Dirty	Milky appearance of the water. Some turbidity.
Poor clarity	Extremely muddy. High turbidity.
Not observed	Water clarity was not observed on site.

The indicator of measured clarity was removed from the checklist as it was deemed a health and safety issue. Many compliance officials cannot swim and therefore filling measuring vessels was deemed a safety issue.

Indicator: Water temperature

DWAF (1996:103) explains that temperature affects the rates of chemical reactions and also the metabolic rates of organisms. It is one of the major factors controlling the distribution of aquatic organisms. Natural variations in water temperature occur in response to seasonal cycles and organisms use these changes as cues for activities such as migration, emergence and spawning. Artificially-induced changes in water temperature e.g. discharged effluent that has been heated, can impact on individual organisms and on entire aquatic communities. Higher temperatures reduce the solubility of dissolved oxygen in water, decreasing its concentration and thus its availability to aquatic organisms. Elevated water temperatures increase metabolic rates, including respiration and thus oxygen demand, of aquatic organisms. Oxygen demand therefore increases leading to a decrease in dissolved oxygen supply. Unnaturally low temperatures, such as those induced by bottom releases of dam water, may induce fish mortalities in a river reach or suppress normal activities such as spawning. The toxicity of most substances, and the vulnerability of organisms to these substances, is intensified as water temperature increases.

Anthropogenic sources which result in changes in water temperature include:

- Discharge of heated industrial effluents.

- Discharge of heated effluents below power stations.
- Heated return-flows of irrigation water.
- Removal of riparian vegetation cover, and thereby an increase in the amount of solar radiation reaching the water.
- Inter-basin water transfers; and
- Discharge of water from impoundments.

Note: temperature will vary due to the season and whether the temperature is taken in open sunlight, in shade, in flowing or in stagnant water. The purpose of this indicator is to provide an indication if the water temperature is being excessively altered for example by industrial heated effluent or cooling agent. The temperature indicator is described using
Table 6-47.

Table 6-47 Temperature measure code

Observation	Description
Normal	Natural, approximately >21^{0}C and <27°C during summer months
Warm	Warm, warm to the touch
Cold	Cold, chill to the touch
Not tested	Temperature not tested on site.

Indicator: Foam

The presence of foam on the water surface may *indicate* the presence of industrial foaming agents or surfactants in industrial or commercial areas. This could also result from high phosphate content as a result of fertilizers in agricultural areas or Waste Water Treatment Works (WWTW) in urban areas. The soil type the river runs through, e.g. loamy soils, can also contribute to small patches of foam. The foam indicator is described using Table 6-48.

Table 6-48 Foam measure code

Observation	Description
None	No foam
Small	Small patches of foam / bubbles e.g. where water flows over rocks or obstacles
Large	Large quantities of foam / bubbles e.g. including in stagnant water and along river banks.
Not Observed	No observation made

Indicator: pH

According to Marlborough, rain water is naturally acidic at about 5.6pH whereas stream water usually ranges from a pH of 6.8 to a pH of 7.8; this range is considered to be an optimal range for most aquatic life. The natural pH of a river will vary from river to river, e.g. fynbos dominated river catchments have a naturally low pH down to pH 3. The natural pH range of a river is largely determined by the geology and soils of the area, for example limestone areas will result in rivers and streams having naturally higher pH levels and peat areas will have naturally low pH levels. The pH of a stream affects the organisms living there. Large fluctuations in pH outside of a river's natural pH range can lead to stresses on aquatic life in that river.

Low pH levels (below optimal) can result in fish kills by stressing their systems causing physical damage, which in turn can make them more vulnerable to disease. Similarly high pH particularly in combination with high water temperature, can increase the amount of un-ionized ammonia which is highly toxic to fish. Extreme rates of photosynthesis, whether natural or because of eutrophication, commonly result in very high pH values (>10) in standing waters during the night and lowered pH values during the day. In addition low pH also mobilises otherwise bound heavy metals, an increase in which can be toxic to aquatic life.

The pH indicator is measured using an HTH dipstick, but any method for measuring pH will apply. The pH indicator is described using Table 6-49.

Table 6-49 pH measure code

Observation	Description
Neutral	Neutral, 6.82 - 7.8
Acidic	Low, acidic, dipstick, <6.8, orange marker
Alkaline	High, alkaline, dipstick >7.8, pink marker
Not Tested	pH was not tested during the inspection

Indicator: Hydrocarbon oily sheen

An oily sheen is present if a film of iridescent colour is observed on the water surface. One can look for a rainbow effect that can appear to be floating on the surface of the water. Usually an oily sheen *indicates* the presence of oil, petrol, diesel or aviation fuel, also known as hydrocarbons. On rare occasions, and usually in the autumn, a noticeable but small oily sheen can be the result of the

decomposition of fallen leaves. Oily sheen can also be the result of iron rich groundwater seepage. The source of the sheen can be determined by disturbing the sheen with a stick or stone; if the sheen regroups fluidly then it is hydrocarbon based; if the sheen breaks up into irregular shaped pieces then it is natural in origin. The hydrocarbon oily sheen indicator is described using Table 6-50.

Table 6-50 Hydrocarbon oily sheen measure code

Observation	Description
None	No oily sheen
Small	Relatively small patches of sheen
Sheen	Large or regular occurrence of oily sheen
Not observed	No observation made on site.

Indicators: Nutrients

There are several types of nutrients that impact on watercourses, e.g. inorganic nitrogen and phosphorus. According to USDA (1998) the presence of some aquatic vegetation is normal, and water that has slight nutrient enrichment may support communities of algae, which provide a greenish colour to the water. However, streams with heavy loads of nutrients have thick coatings of algae attached to rocks and other submerged objects. Nutrient loads in the waterbody are indicated by the growth of algal and nuisance plants e.g. water hyacinth. The nutrient indicator is described using Table 6-51.

Table 6-51 Nutrient measure code

Observation	Description
None	Little or no visible algal or nuisance plant growth
Occasional	Occasional clumps of algal or nuisance plant growth observed
Excessive	Extensive algal or nuisance plant growth observed
Not observed	No observation made at the site.

Indicator: Oxygen availability

DWAF (1996:55) explains that decreased dissolved oxygen in aquatic ecosystems result in chronic and acute physiological and behavioural changes in aquatic biota. The sensitivity of many species, especially fish and invertebrates to changes in dissolved oxygen concentrations depends on the species, the life stages (eggs, larvae or adult), and behavioural changes (feeding and reproduction). Where possible, many species will avoid anoxic or oxygen-depleted zones. According to USDA (1998:12) “plant respiration and decomposition of dead vegetation

consume dissolved oxygen in the water. The lack of dissolved oxygen creates stress for all aquatic organisms and can cause fish kills." The oxygen indicator is described using Table 6-52.

Table 6-52 Oxygen measure code

Observation	Description
Oxygen available	Visually healthy ecosystem. Lots of living organisms. No indications of stressed organisms. Stream is well aerated at riffles and rapids.
Some anoxia	Fish gasping at the surface. Few living organisms.
Anoxic conditions	Dead fish present and some fish gasping at the surface.
Not observed	No observation made on site.

Indicator: Indication of life

Dead fish, lack of aquatic animal life, lack of insects are indicators of poor oxygen content in the waterbody, and is likely to be linked with toxic contamination of the water, poor pH or algal growth. The indication of life indicator is described using Table 6-53.

Table 6-53 Indication of life measure code

Observation	Description
Life	Indications of aquatic life, aquatic insects, fish, frogs, etc.
Dead	Dead fish, birds, or plants, no insects visible
None	No indication of aquatic life. Complete absence of aquatic organisms.
Not tested	No observation made

Criterion: Discharge quality

The indicators to describe discharge quality are similar to the indicators for water quality, but only limited to colour, odour, pH, temperature, foam, and hydrocarbon oily sheen. The scores are indicated in Table 6-54 to
Table 6-59.

Table 6-54 Discharge quality: Colour

Observation	Description
Colourless	Clear – Colourless
Tea	Clear – Tea coloured
Unnatural	Clear – but unnatural in nature or colour
Brown	Turbid – Brown/muddy (soil)

Black	Turbid – Black
Grey	Turbid – Grey, opaque, unnatural in colour (raw sewage)
Green	Turbid – Green (algal growth)

Table 6-55 Discharge quality: Odour

Observation	Description
Earthy	Earthy smell
Hydrocarbon	Petrol / diesel / oil / Aviation fuel / paraffin / sour smell
Sewerage	Rotten egg / sewerage smell
Pesticide	Chemical or pesticide smell (algae)
None	No odour observed

Table 6-56 Discharge quality: Temperature

Observation	Description
Normal	Natural, approximately >21^{0}C and <27°C during summer months
Warm	Warm, warm to the touch
Cold	Cold, chill to the touch
Not tested	Temperature not tested on site.

Table 6-57 Discharge quality: pH

Observation	Description
Neutral	Neutral, 6.82 - 7.8
Acidic	Low, acidic, dipstick, <6.8, orange marker; litmus paper red
Alkaline	High, alkaline, dipstick >7.8, pink marker; litmus paper blue
Not Tested	pH was not tested on site.

Table 6-58 Discharge quality: Foam

Observation	Description
None	No foam or bubbles
Small	Small patches of bubbles and/or foam
Large	Large quantities of bubbles and/or foam
Not Observed	No observation made

Table 6-59 Discharge quality: Hydrocarbon oily sheen

Observation	Description
None	No oily sheen
Small	Very small patches of sheen, patch less than area of hand
Sheen	Large or regular occurrence of oily sheen
Not observed	No observation made on site.

6.3.4.5 Step 3: Compiling the Site Inspection Checklist form

The next step in the tool development was to combine all the checklist indicators and measures, and information requirements together into a single useable form. The Site Inspection Checklist form (the form) comprises five sections.

Section 1: Record of Inspection

These are the details of the inspection, i.e. where the site is located, the case/file name, which inspector/s is/are conducting the site screening, the inspection number of site (e.g. initial inspection, follow up monitoring 1, follow up 2, etc.), the weather on the day of inspection and the weather on the previous two days prior to the inspection. The weather over the days prior to the site inspection may influence the conditions observed during the site inspection, for example, rainfall may alter the turbidity of the water clarity, colour and temperature, or very hot days may alter the oxygen content in the water leading to fish kills or algal blooms. It is thus important to record the weather on the days prior to the site inspection as well as the condition on the day of the site inspection. Section 1 of the form is illustrated in Figure 6-11.

SITE ASSESSMENT FORM

Section 1: Record of Insepction				
Site name:	**Emmerentia Dam**			
Site description:	Tributary of Braamfontein Spruit			
GPS Coordinates start of reach: *(WGS84, decimal degree format)*				
GPS Coordinates end of reach: *(WGS84, decimal degree format)*				
Date of Inspection:	19/03/2013			
Inspection number:	1 - initial inspection			
Inspector name:	Jack Black			
Weather on day of inspection?	Sunny and warm			
Weather 2 days prior?	Raining, overcast, cold			
Does the site include?	Bed only	Left bank and bed	Right bank and bed	Both banks X
Is the reach of river near the?	Source	Foothills X	Flat lands	Sea/estuary

Figure 6-11 Site Inspection Form Section 1: Record of Inspection

Section 2: Site Description

The Site Description provides a record of the description of the site, per bank (green columns) and the active channel (blue column) where relevant. If a zone does not have a coloured block for a particular indicator, then that zone is not relevant. For example, height of vertical banks has a green block for left and right flood banks, but no blue box for active channel, thus only the flood banks require a

measure of description. Similarly the channel substrate is only found in the active channel and not on the flood banks.

The site description, Figure 6-12, includes: the land use and % cover of land use on the site; the type of ground cover e.g. pervious, paved, etc., and its % cover; geomorphic characteristics such as height of the river banks and the description of the channel substrate; and the dominant types of riverine vegetation and % cover of each.

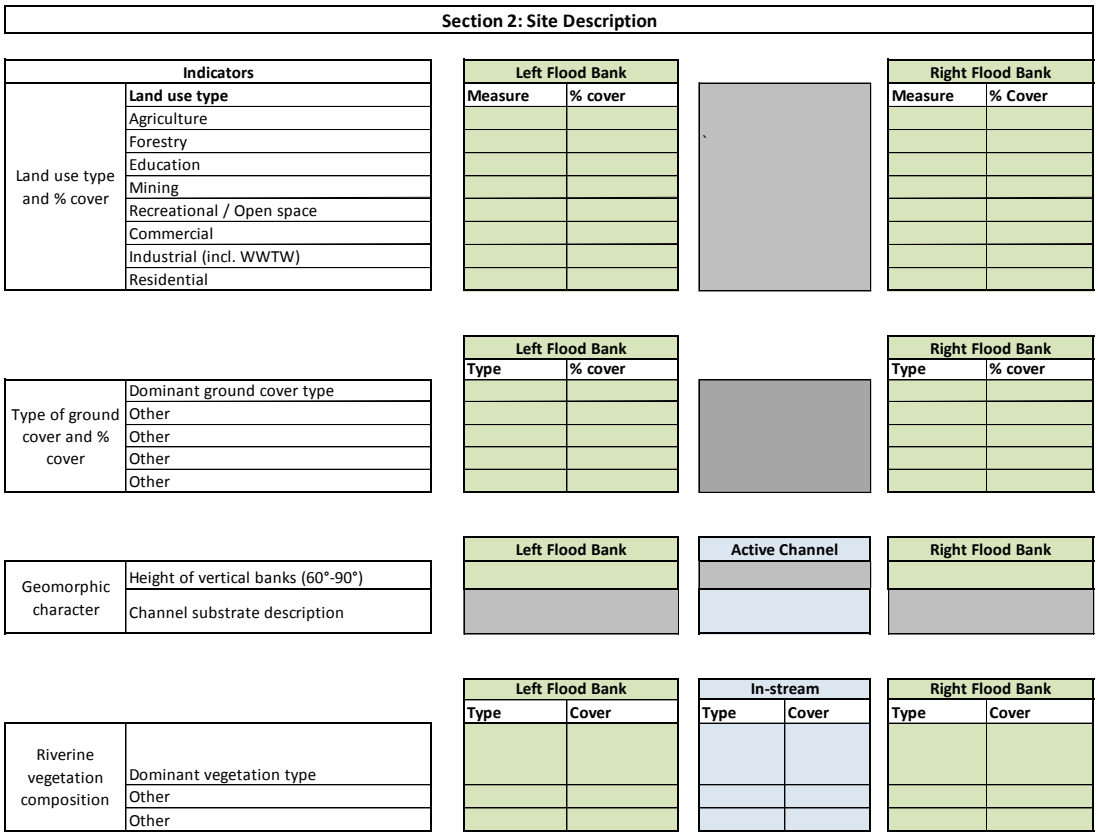


Figure 6-12 Site Inspection Form Section 2: Site Description

Section 3: Activities on the Site

The third section, Figure 6-13, refers to the listed activities that are observed or have taken place on the site at the time of inspection. The officials are required to indicate yes or no as to which activities, or evidence of which activities are observed during the site inspection.

Section 3: Activities on the site	
Which of the following activities are taking place on site?	**Yes / No**
Vegetation / Site clearing	
Excavation / erosion (dredging, removal, etc.)	
Infilling, impeding, encroachment (includes depositing, dumping, storage)	
Discharge	
Bank stabilising / channel straightening	
Abstraction/ stream flow reduction / transfers	
Impoundments (includes storage of water, dams, etc.)	
Diverting of stream flow (includes for irrigation)	
Structures (bridges, jetties, piers, storm water outlets, etc.)	
Canalising / levees (flood prevention-banks)	
Alien and/or invasive vegetation infestation	

Figure 6-13 Site Inspection Form Section 3: Activities on the site

Section 4: Site Inspection Checklist

Section 4,

Section 4: Site Inspection Checklist				
Indicators		**Left Flood Bank**	**Active Channel**	**Right Flood Bank**
Site character	**4.1 Erosion on site (out the channel)**			
	4.2 % vegetation is alien and/or invasive			
	4.3 Continuity of riverine zone			
	4.4 Dumping / rubble over 100m			
	4.5 Pieces of litter over 100m			
		Left Flood Bank	**Active Channel**	**Right Flood Bank**
Erosion and armouring	**4.6 Macro-channel bank erosion**			
	4.7 Extent of erosion of S-bend banks			
	4.8 Bank armouring			
	4.9 Active channel bed erosion			
		Left Flood Bank	**Active Channel**	**Right Flood Bank**
Hydrology	**4.10 State of discharge outlets**			
	4.11 Canalisation / channelling			
	4.12 Levees / Flood prevention bank			
	4.13 Abstraction from watercouse			
	4.14 Impoundments			
	4.15 Culverts / bridges			
	4.16 Flood debris			
			Active Channel	
In stream water quality	**4.17 Colour**			
	4.18 Odour			
	4.19 Clarity			
	4.20 Temperature			
	4.21 Foam			
	4.22 pH			
	4.23 Hydrocarbon oily sheen			
	4.24 Nutrients			
	4.25 Oxygen availability			
	4.26 Indication of life			
		Left Flood Bank		**Right Flood Bank**
If there is discharge from outlets	**4.27 Colour**			
	4.28 Odour			
	4.29 Foam			
	4.30 Hydrocarbon oily sheen			
	4.31 pH			
	4.32 Temperature			

Figure 6-14, of the form comprises the actual site inspection. The criteria are described based on the official's observations on the site. The official selects the best description from the provided measures for each of the indicators per left flood bank, active channel, and right flood bank as required. The provided measures are included on the field form for ease of reference, and are elaborated on in Section 6.3.4.4.2 The Site Inspection Checklist Indicators.

Section 5: Additional Information

Section 5 provides for any additional information such as the site layout diagram, and any additional notes such as number of samples collected, location of photos taken, reports/documentation collected, or other observations of the site not captured in sections 1-4 of the field form.

Section 4: Site Inspection Checklist				
Indicators		Left Flood Bank	Active Channel	Right Flood Bank
Site character	4.1 Erosion on site (out the channel)			
	4.2 % vegetation is alien and/or invasive			
	4.3 Continuity of riverine zone			
	4.4 Dumping / rubble over 100m			
	4.5 Pieces of litter over 100m			
		Left Flood Bank	Active Channel	Right Flood Bank
Erosion and armouring	4.6 Macro-channel bank erosion			
	4.7 Extent of erosion of S-bend banks			
	4.8 Bank armouring			
	4.9 Active channel bed erosion			
		Left Flood Bank	Active Channel	Right Flood Bank
Hydrology	4.10 State of discharge outlets			
	4.11 Canalisation / channelling			
	4.12 Levees / Flood prevention bank			
	4.13 Abstraction from watercouse			
	4.14 Impoundments			
	4.15 Culverts / bridges			
	4.16 Flood debris			
			Active Channel	
In stream water quality	4.17 Colour			
	4.18 Odour			
	4.19 Clarity			
	4.20 Temperature			
	4.21 Foam			
	4.22 pH			
	4.23 Hydrocarbon oily sheen			
	4.24 Nutrients			
	4.25 Oxygen availability			
	4.26 Indication of life			
		Left Flood Bank		Right Flood Bank
If there is discharge from outlets	4.27 Colour			
	4.28 Odour			
	4.29 Foam			
	4.30 Hydrocarbon oily sheen			
	4.31 pH			
	4.32 Temperature			

Figure 6-14 Site Inspection Form Section 4: Site Inspection

6.3.4.6 Comments

The indicators identified in this chapter provide a basic screening of the site and site characterisation, which provides more information about the state of the river than whether the activity is compliant or not. The detailed studies once identified and conducted by specialists, will provide more detailed information about the river health, and responses of ecosystems on the site. The Site Inspection Form provides an initial screening and indication of the impacts and response to the ecosystem functionality as a result of activities on the site.

6.3.4.7 Testing the tool

The Site Inspection Checklist was tested together with the Dashboard Tool in the Case Studies (see Chapter 7). Amendments were made to the descriptions and measures through an iterative process, as a result of comments and findings from the case studies.

6.4 Dashboard Tool (DT)

The purpose of the Dashboard Tool is to provide environmental enforcement officials with a visual indication of the potential impacts to the riverine functions as a result of activities on the site, and thereby "flag" riverine functions that may require rehabilitation. There are no output scores from the tool. The tool only provides a basic screening indication of the potential impact that activities may have on the river's potential to provide the various riverine functions, in an effort to guide the enforcement officials. The specialist studies will then provide a detailed assessment of the river. The specialist studies should use appropriate methodologies e.g. EcoClassification and reference sites when conducting their studies. The development and scoring system used in the Dashboard Tool is derived from the literature and existing assessment methodologies.

6.4.1 Tool objective

As identified in the preceding chapters, one of the critical challenges facing the implementation of the water regulatory framework is that the enforcement officials themselves are not necessarily aquatic ecologists, scientists or wetland specialists and thus fail to identify the actual ecological impacts occurring on site as a result of transgressions. These impacts are then not addressed or not adequately or

appropriately addressed in the enforcement process. Therefore the aim of the Dashboard tool is to highlight or flag to the enforcement official the potential ecological impacts or problems occurring on the site under inspection. The tool is not a quantitative evaluation or assessment of the health of the river, but rather a guide to enforcement officials to request more detailed studies by appropriate specialists. The specialists are then tasked with conducting detailed quantitative assessments of the river, using formal rigorous methods such as EcoClassification and reference sites.

As the officials do not necessarily have technical backgrounds, the process to identify and flag the issues that may be occurring on the site must not be technical or complex, as discussed in the previous section.

6.4.2 Tool Design

The tool design had two key challenges. Firstly how to "score" the impacts of a non-rigorous assessment; and secondly how to translate these "scores" into flags of potential impacts to riverine functions. The first challenge was resolved using a process of fuzzy synthetic evaluation; and the second challenge was resolved using a system of weighting matrices. These are described further in this section.

Fuzzy logic is a form of computing based on "degrees of truth" rather than the usual "true or false" (Programming Glossary). "It was designed to supplement the interpretation of measured uncertainties for real-world random phenomena. These uncertainties could originate with non-statistical characteristics in nature that refer to the absence of sharp boundaries in information" (Chang *et al.,* 2001:294). In the perspective of developing a tool for non-technical people using a non-rigorous assessment, applying fuzzy logic and in particular the technique of Fuzzy Synthetic Evaluation (FSE) provides the flexibility needed for the tool to measure the degrees of naturalness of the site without it being unconditional.

"By measuring biological condition and evaluating the result as a divergence from baseline biological integrity, we can thus focus on the most integrative, biological endpoint" (Karr, 1999:225). In other words, by measuring the divergence of indicators from naturalness of the site to provide ecosystem services we can identify on the most impacted riverine functions for rehabilitation. Rapport (1989)

in Norris and Thoms (1999:199) suggests that “health is commonly taken to be the absence of detectable symptoms of pathology. From this viewpoint it may only be necessary to define symptoms and their indicators.” The Dashboard Tool thus measures the disturbance i.e. degrees of truth or degradation, of the naturalness of the site according to the indicators.

Karr (1999:223) suggests that “at one end of a continuum of human influence on biological condition, severe disturbance eliminates all life [false]; at the other end of the gradient are pristine, or minimally disturbed living systems [True] (Figure 6-15, top). A parallel gradient, Figure 6-15 bottom, from integrity towards nothing alive, passes through healthy, or sustainable, conditions or activities. Below a threshold defined by specific criteria, the conditions or activities are no longer healthy or sustainable in terms of supporting living systems.” These changes, such as human activities in the watershed, alter the river’s biota and thus the entire biological context of the river, causing it to diverge from naturalness and reduce the potential to provide riverine functions.

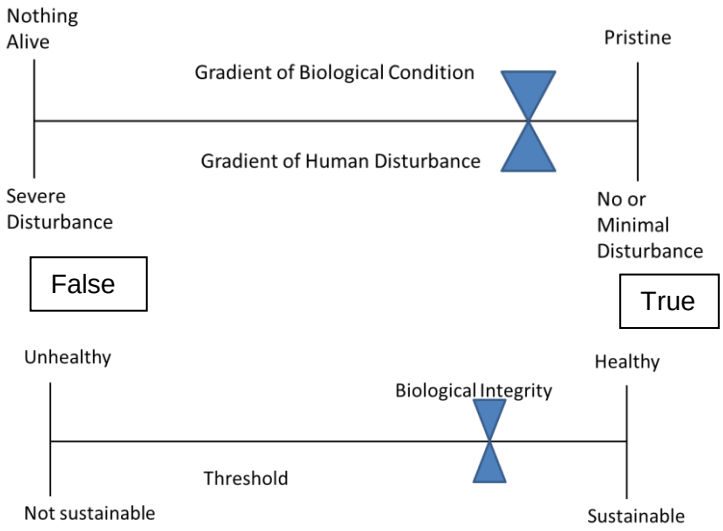


Figure 6-15 Continuum of human influence (Karr, 1999:223)

Therefore the Dashboard is based on Karr’s concept, where the potential to provide healthy ecosystem functions are set as the ideal state of naturalness or baseline (True), and potential impacts or disturbances are measured along the gradient (degrees of truth) away from the ideal, based on the indicators of the Site

Inspection Checklist (SIC). In other words, the Dashboard Tool (DT) indicates the reduced or increased ability of the watercourse to provided ecological functions at that point or site.

The ideal is set as the baseline. The ideal is the naturalness or **potential** to provide full riverine functions. However, each river has different characteristics, and these characteristics influence the amount or degree to which that river can **actually** naturally provide riverine functions. Determining these detailed characteristics and the natural ability to provide riverine functions requires detailed specialists studies, which come later in the enforcement process (i.e. after the initial site inspection by the enforcement officials). The SIC criteria and indicators provide an initial screening and description of the site. The DT then converts the official's observations into an indication of possible impacts to riverine function. This indication then flags the enforcement official to request detailed studies by specialists to determine the exact impact on the actual riverine function e.g. by rigorous assessment and comparing with reference conditions, and thus informing the rehabilitation plan.

It is not the intention of the tool to replace the more detailed ecological, specialist or other assessments of the river, but rather to guide enforcement officials to actually request the necessary ecological and other assessments, as part of identifying the impacts of contraventions and effectively rehabilitating such impacts.

The aim of the tool is to provide an easy to understand indication of impacts to river function. The tool provides no quantitative assessment of the site, as the tool is not a rigorous detailed assessment of the health of the watercourse on the site.

6.4.3 Developing the Tool

According to Change *et al.*, (2001:295) Fuzzy Synthetic Evaluation (FSE) ~~is~~ comprises three components, each of which describes or contains a variety of uncertainties with different scales. The three components are:

- an input sub-system;
- an output sub-system; and
- a classification mechanism.

The methodology for developing the Dashboard Tool was based on the following five steps:

Step1: Compile an input sub-system

Step 2: Compile a classification system

Step 3: Compile an output sub-system

Step 4: Test tool functionality

Step 5: Understand the outputs

The calculations in the Dashboard Tool (DT) are a “back-office” function of the tool, and do not require the user to carry out any calculations. The official completes the Site Inspection Checklist (SIC) on site and then when back in the office, captures it into the DT in the Impact Form (which is identical to the Field Form). This is completed by selecting the appropriate “answers” or descriptions from the drop-down lists that best describe the site for each of the indicators as observed on site. The official then reviews the produced graphs in the Dashboard. Mathematical algorithms behind the DT are setup as “back office” calculations in order to avoid any complex processing forming a “barrier to implementation” of the tool; as well as to speed up the processing of the field form into an output. The enforcement official is required to describe which activities are taking place on the site, by selecting the appropriate description to describe the indicators in the site inspection checklist.

6.4.3.1 STEP 1: Compile an input sub-system

The input sub-system uses the descriptions observed by the enforcement official in the site inspection checklist (SIC) and assigns a value of scale based on its degree of truth from naturalness, to each the descriptions.

The scoring is based on a 6-point scale, where a score of 0 refers to normative or ideal naturalness and a score of 5 refers to most impacted. A value is assigned to each of the description measures of the indicators from the SIC. The values for the measures are informed from the literature and derived from value-structures used in the existing tools e.g. FISCRWG, 2001, with regard to how the various points of degradation impacted the environment. Characteristics that are in a good state or good characteristic are assigned a value of 0 (True), i.e. close to pristine. Characteristics that are in a poor or degraded state are assigned a value of 5 (False), i.e. deviation from pristine. The descriptions in between True and

False are assigned values between 0 and 5 based on their degree of deviation from naturalness. Where a "no observation made" is scored, the weighting behind this generates no numerical value, but rather an "n/a" score. As Excel operates on numerical values, this "n/a" triggers an error in the calculations. The "n/a" is thus resented by a "0" but the value of the score is not included in the calculations. An ancillary script is run to check if the entries are numerical or "n/a" and then validates them in the calculations.

When the tool was tested for functionality, some of these assigned values were adjusted to ensure a balanced scale. Table 6-60 summarises the assigned values for each of the description measures of each of the indicators used in the DT. Note that not all of the indicators are used to inform the DT; this is discussed in previous section: The Site Inspection Checklist Indicators.

These scores are hidden in the Dashboard Tool calculations to avoid bias and score-tampering, as well as to avoid the need for the officials to conduct complex mathematical calculations. Although a numerical value is assigned to the descriptive measures of the indicators, the Tool does not provide a numerical value output of the site as the tool is not measuring the quantitative state of riverine function. The Tool uses a basic screening of impacts on the potential of the site to provide normative riverine function. This then guides the officials to identify where the problem areas are, and thereby identify the necessary specialist studies that need to be conducted and develop an appropriate rehabilitation plan.

6.4.3.2 STEP 2: Compile a classification system

Chang *et al., (2001:295)*, highlight that the classification mechanism is central to the process that represents a specific fuzzy reasoning basis. The classification is the computing component of the evaluation process. Chang *et al.*, continue to explain that the classification system is formed as a set of predetermined membership functions that imply the fuzziness at the boundary between each category designed for classification, and that the classification system is designed for both performing the reasoning functions and generating the outputs for later justification. In order to calculate the relationship between the description measures and riverine function, a system of matrices (reasoning functions) was used to calculate:

1. The relationship between the indicators to activities; and
2. The relationship between activities to riverine functions.

Table 6-60 Allocation of scale of values to the descriptive measures of the Site Inspection Checklist indicators.

		Scale of assigned values (Degree of truth or naturalness)					
	Indicator	**0 (Natural or True)**	**1**	**2**	**3**	**4**	**5 (Degraded or False)**
Site Description	**Ground cover**	Naturally vegetated	Kikuyu grass / manicured	Pervious	Compacted soil	Paved / impervious	Scale by % cover: 0-30% = 0.2 30-60% = 0.5 60-100% = 1
Site Character	**Site erosion**	None	Sheet	Rill	Gully		Donga
	Alien/ invasive Vegetation	no AIP		1-10%AIP	11 – 40% AIP	41 – 60% AIP	60 – 100% AIP
	Riparian zone	Continuous			Fragemented		None
	Dumping & rubble	None	0-10%	10-25%	25-50%	>50%	
	Litter	None	10 pieces		10-50 pieces		>50 pieces
Erosion and armouring	**Macro-Channel bank erosion**	None	>5%		>20%		>50%
	Erosion of S-bend bank	None		<10%	11-50%		>50% of macro
	Bank armouring	Vegetated	Toe	Occassional		Armoured	Exposed soil Engineered
	Bed erosion	None		Some incision			Deep incision
Hydrology	**Discharge outlet**	None		Good			Poor
	Canalisation	Natural		Occassional	Straightened	Deeply eroded	
	Levees / flood prevention	None	0-1m	>1m			>2m
	Abstraction	None		Domestic			Large
	Impoundments	None	Temporary	Low flow	Small, permanent		Large, permanent
	Culverts / bridges	None		Bridge	Intermediate	Culvert / drift	
	Flood debris	Scattered		None	Accumulated		
In-stream water quality	**Colour**	Colourless Tea	Brown	Unnatural			Grey Black Green
	Odour	Earthy None					Sewerage Pesticide Hydrocarbon
	Clarity	Transparent	Clearish	Cloudy		Dirty	Poor clarity
	Temperature	Normal					Cold Warm
	Foam	None		Small			Large
	pH	Neutral					Alkaline Acidic
	Hydrocarbon oily sheen	None	Small				Sheen
	Nutrients	None	Occassional				Excessive
	Oxygen availability	Oxygen available	Some anoxia				Anoxic conditions
	Indication of life	Life			None observed		Dead
Discharge quality	**Colour**	Colourless Tea	Brown	Unatural			Grey Black Green
	Odour	Earthy None					Sewerage Pesticide Hydrocarbon
	Foam	None		Small			Large
	Hydrocarbon oily sheen	None		Small			Sheen
	pH	Neutral					Alkaline Acidic
	Temperature	Normal					Cold Warm

Matrix 1: Relationship of indicators to activities

A matrix indicating the relation between indicators and the various activities was compiled. The relationship is based on the reliability of the indicator, as well as the contribution of the indicator as an impact of the activity. The reliability of the indicator may be affected by *inter alia*:

- As the site is not compared to reference conditions in the SIC, the description of specific indicators e.g. pH or clarity, may be described as degraded, but this may actually be the natural state of the river, i.e. a high sediment suspension river contributing to poor clarity or a fynbos vegetation dominated river contributing to acidic pH conditions.
- Scale of impact. Where the officials are required to estimate the scale or size of the indicator, they may be influenced by personal subjectivity (this is noted in the case studies in Chapter 7) and therefore influence the reliability of the indicator as a direct comparison of the impact of activities.

Therefore the indicators are not necessarily measured as a direct impact of activities but rather several indicators are used to measure the impact of an activity in order to provide some verification of the impact. The activity is scored out of 100 and each contributing indicator is scored as a percentage of that based on its reliability and contributing scale of impact. When determining the value of contribution of each of the indicators, the relationship of the different indicators to the particular activities and to each other was considered. This first weighting matrix of the relationship between the indicators as impacts of activities is illustrated in Table 6-61. The matrix is automatically populated with the assigned values from each of the indicator measures from the completed Impact Form. The scores of the matrix are then summed to give a total score per activity per left bank, active channel and right bank. The matrix was refined during Step 4 functionality testing of the tool.

Table 6-61 Matrix 1: Relationship of indicators to activities (illustration only includes one bank and the active channel)

	Matrix 1: Relationship of indicators to activities / Activities	Flood Zone / bank											Active Channel										
		Alien / invasive vegetation infestation	Vegetation / site clearing	Excavation /erosion	Infilling / encroachment / impeding	Discharge	Bank stabilising	Abstraction	Impoundments	Diverting	Structures	Canalising / levess	Alien / invasive vegetation infestation	Vegetation / site clearing	Excavation /erosion	Infilling / encroachment / impeding	Discharge	Bank stabilising	Abstraction	Impoundments	Diverting	Structures	Canalising / levess
Site	Ground cover		80%	20%			10%																
	Erosion on site			10%																			
	Alien / invasive vegetation	100%											100%										
	Riparian zone		20%				10%							20%				20%					20%
	Dumping & rubble				30%				10%	20%		10%				60%				10%	20%		10%
	Litter					10%											10%						
Geomorph.	Macro channel			30%			20%					30%											
	Erosion S bends			30%			10%																
	Bank Armouring				20%		30%					10%											
	Bed erosion														80%			80%					30%
Hydrology	Discharge outlet					10%	5%																
	Canalisation / chanelling				20%		10%			35%		30%										20%		30%
	Levees				20%		5%			20%	10%	10%												
	Abstraction																		100%		10%		
	Impoundments				5%				80%	10%	10%					20%				80%	20%	10%	
	Culverts / bridges				5%				10%	10%	80%	10%				10%				10%	10%	90%	10%
	Flood debris			10%						5%					20%	10%					20%		
Water Quality	Colour																5%						
	Odour																10%						
	Clarity																10%						
	Temperature													80%			5%						
	Foam																10%						
	pH																20%						
	Hydrocarbon oily sheen																5%						
	Nutrients																10%						
	Oxygen																5%						
	Indication of life																10%						
Discharge	Colour					10%																	
	Odour					20%																	
	Foam					10%																	
	Hydrocarbon oily sheen					10%																	
	pH					20%																	
	Temperature					10%																	
	Total Score	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*N/A*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*

Matrix 2: Relationship of activities to riverine functions

The second matrix, indicated in Table 6-62, is calculated based on whether a particular activity has an impact to a specific riverine function. This was derived from the literature and existing tools. The values of the relationship are either positive (+) or negative (-) based on whether the activity would have a positive or negative impact on the potential of the river to provide a particular riverine function. The numerical value is based on the potential severity of impact the activity could have on the riverine functions. The numerical values determined for each activity per riverine function are independent of each other, i.e. there is no cumulative weighting score per activity, or cumulative weighting score per function. The numerical value is scored out of 100, i.e. a percentage influence.

For example: Impoundments will help to attenuate flood flows predominantly in the active river channel and to a lesser extent in the flood zones; this is a positive impact. Therefore the impoundment's impact on the attenuation function is scored as +50 in the active channel and +30 in the flood zones. However impoundments also result in the loss of biodiversity and habitat provision especially in the active channel; this is a negative impact. Therefore impoundment's impact on the habitat function is scored as -50.

The matrix is automatically populated with the values from matrix 1. The matrix was refined during Step 4 functionality testing of the tool.

The final value produced through this second matrix is used to populate the output sub-system. The results do not provide a numerical value of the riverine health but rather an indication of disturbance away from the ideal or naturalness; where the ideal would be the potential to provide riverine function. The output indicates each activity's impact on the riverine functions at the site. The impact can be positive or negative.

Table 6-62 Matrix 2: Relationship of activities to riverine functions

Matrix 2: Relationship of activities to riverine functions Activities / Riverine functions		Alien /invasive vegetation infestation	Vegetation / Site clearing (creation of lawns)	Excavation and erosion	Infilling, impeding and encroachment	Discharge	Bank stabilising	Abstraction	Impoundments (and decreased sediment loads)	Diverting	Structures Bridges, jetties, etc.)	Canalising, levees and channel modification
Left Flood zone	Flood attenuation	20	-20	-20	-15	0	-10	0	30	0	10	-20
	Sediment trapping	20	-20	-20	-15	0	-10	0	30	0	10	-20
	Habitat provision	-20	-20	-20	-20	0	-10	0	-20	-10	-10	-20
	Carbon storage	-20	-20	-10	-10	0	-10	0	10	0	0	-10
	Aesthetic/recreational use	-20	20	-10	10	0	10	0	20	10	10	0
	Subsistence/cultural use	-40	-40	-10	-10	20	0	0	-20	-10	10	-10
Active Channel	Flood attenuation	20	0	-20	-10	0	-10	0	50	0	10	-20
	Sediment trapping	20	0	-20	-10	0	-10	0	30	0	10	-20
	Water Quality	-10	0	-10	-10	-100	0	-10	-10	0	0	0
	Aquatic habitat provision	-20	0	-20	-20	-20	-10	-10	-50	-10	-10	-20
	Aesthetic/recreational use	-10	10	-10	-10	0	10	-10	20	10	20	10
	Subsistence/cultural use	-10	-10	-10	-10	-40	-10	-20	40	-10	-10	-10
Right Flood Zone	Flood attenuation	20	-20	-20	-15	0	-10	0	30	0	10	-20
	Sediment trapping	20	-20	-20	-15	0	-10	0	30	0	10	-20
	Habitat provision	-20	-20	-20	-20	0	-10	0	-20	-10	-10	-20
	Carbon storage	-20	-20	-10	-10	0	-10	0	10	0	0	-10
	Aesthetic/recreational use	-20	20	-10	10	0	10	0	20	10	10	0
	Subsistence/cultural use	-40	-40	-10	-10	20	0	0	-20	-10	10	-10

6.4.3.3 STEP 3: Compile an output sub-system

The output sub-system is based on a series of graphs, called the Dashboard. The Dashboard graphs illustrate the potential impacts to riverine functions. The graphs do not provide a quantitative output as the system is based in fuzzy logic and is not a rigorous method for determining a quantitative value of the site. Using the values calculated through the classification matrices, the impacts to riverine functions by activities are represented in stacked graphs. The x-axis indicates the riverine functions according to left flood zone, activities channel or right flood zone. The y-axis indicates the extent of potential impacts, either positive or negative. The extent of the stacked graphs per function indicates to the enforcement official the potential impacts occurring on the site. The impacts are illustrated as deviation away from baseline, where baseline is the ideal naturalness of riverine functions. The enforcement official then requests detailed studies by appropriate specialists to determine the exact extent or scale of the impacts and which in turn informs the objective and actions of the rehabilitation plan. Further, the results of the comprehensive specialist studies should be captured into the River Health Database for future cases and to develop a database of river characterisation.

The Baseline

The output values from the classification system matrices are visually compared to a "baseline". The baseline is a normative ideal; it is not a precise calculated value. For each of the riverine functions listed in the tool, i.e. flood attenuation, sediment trapping, habitat provisions, water quality, recreational/aesthetic and subsistence/cultural, the full capability of that function is assumed as the baseline, i.e. the ideal naturalness potential of the river to provide that function. As each river across the country has different characteristics, its individual capability to provide riverine functions will vary. At this point in time, these character-based capabilities are not known for every reach of every river. Therefore for the purpose of this research, the baseline is assumed to be the full ideal potential capability for each river function. The comparison of the SIC results, is then illustrated as the positive or negative impact as a result of the activities affecting the site, on the ability of that river reach to provide the full capability of the particular river function.

The graphs

The Dashboard provides two sets of graphs. The top set of radar graphs is a summary of the negative impacts per riverine function per component of river reach assessed, i.e. left flood bank, active channel and right flood bank. The bottom, colour-stacked bar graph is the key output graph. This graph indicates the potential impacts to the riverine functions. It is important to note that the Dashboard does not provide a quantitative value of impacts on the potential capability of the river to provide riverine functions on the site. The tool provides a basic screening indication of the riverine functions being affected by the activities on the site. For a numerical or quantitative value, rigorous detailed studies will need to be conducted by appropriate specialists to provide a rating on the state of the river health for the particular reach and site.

Summary graphs

The summary graphs are presented for each component of the riverine zone, in other words there is a summary graph for the Left Flood Bank, the Active Channel and the Right Flood Bank. Figure 6-17 illustrates a specific summary graph. The dashed line of the radial graph indicates the "baseline" or no impact to the riverine functions. The blue line indicates the extent of impact to the riverine functions on the site. The summary graph only indicates the negative impacts. Where the blue line is close to the dashed line of the radial graph there is little or no impact to that particular riverine function. The further inwards the blue line is, i.e. away from the dashed line, the greater the negative impact to the riverine function. For example, in Figure 6-17 water quality is touching the baseline therefore there is minimal impact, however habitat provision is furthest away therefore there is significant potential impact to the habitat provision function.

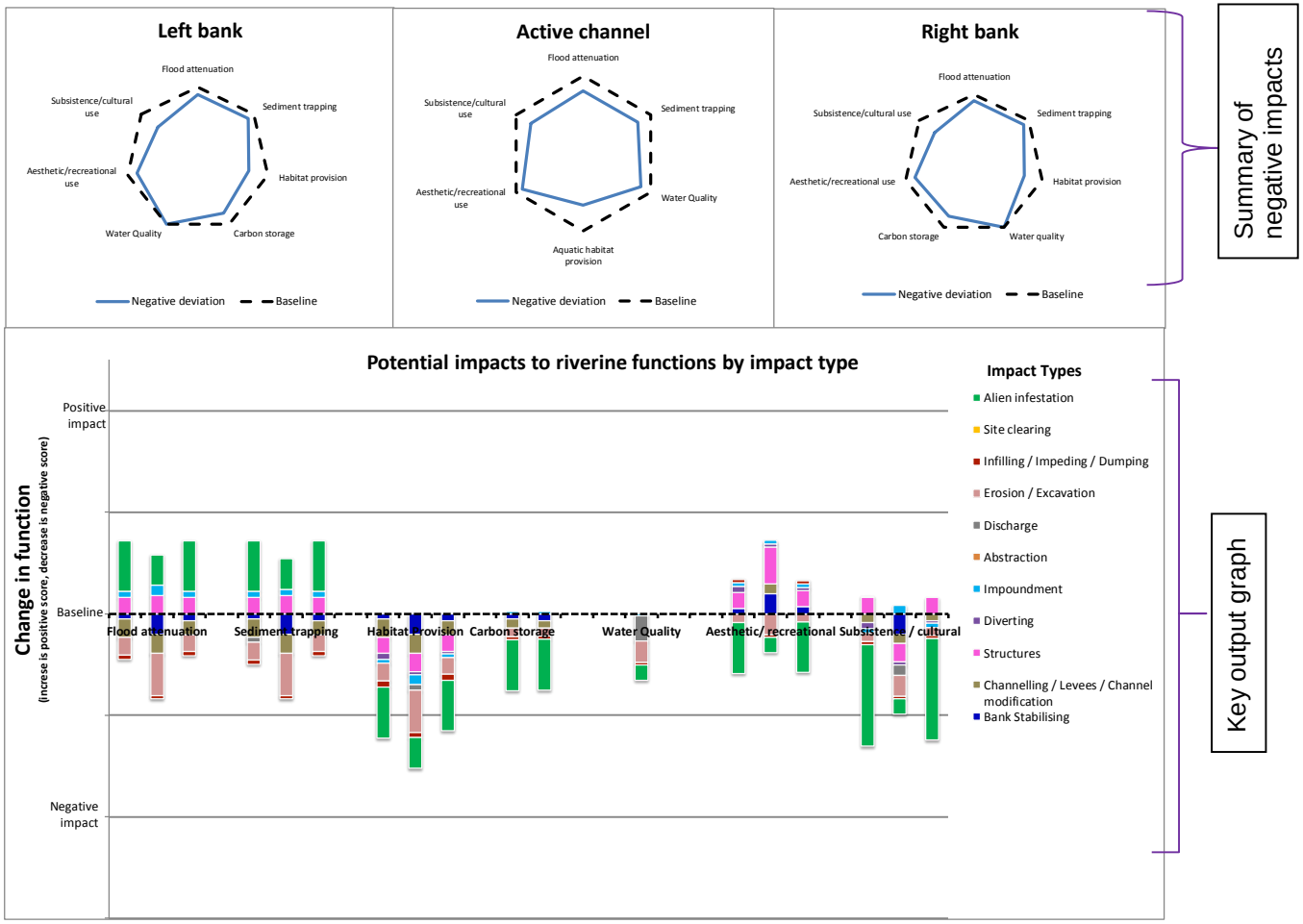


Figure 6-16 The Dashboard set of graphs

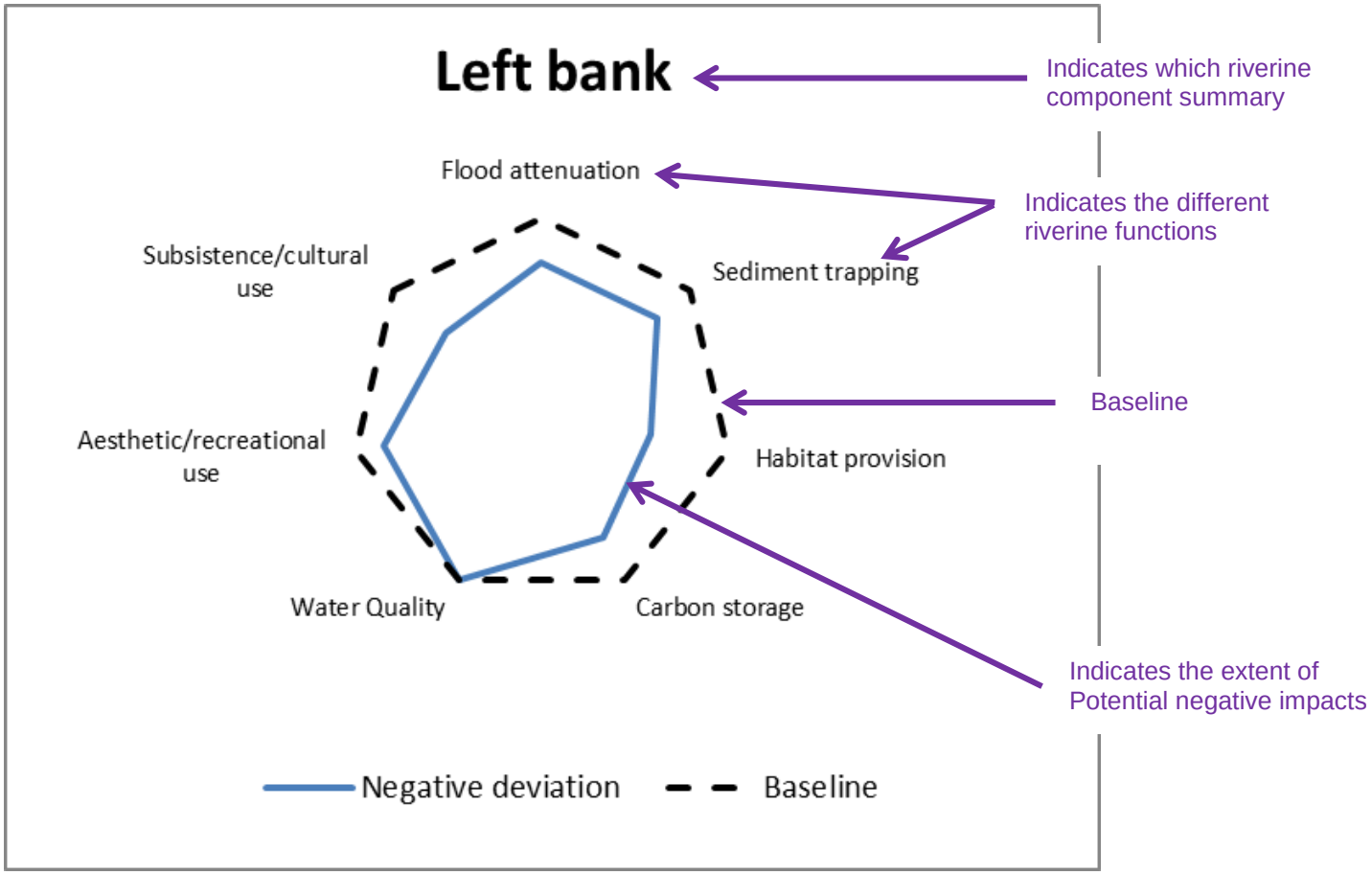


Figure 6-17 Illustrating a summary graph for the left bank.

Key output graph

Figure 6-18 illustrates the different components of the key output graph.

1. The key output graph is composed of seven groups of coloured stacked bar graphs. Each one of the seven groups represents one of the riverine functions. Each group includes three stacked bar graphs, one per left bank, active channel and right bank. For example the first group illustrates Flood attenuation, the second group illustrates sediment trapping, and the third group illustrates habitat provision, and so on. These function graphs are not a comparison to each other, but an indication of the impacts to that function, positive and negative, from the "baseline".

2. Each of the riverine function groups of graphs is composed of three stacked bar graphs. These three stacked bar graphs indicate the component of the riverine zone. For example, the left bar stack illustrates the left flood bank, the centre bar stack illustrates the active channel, and the right bar stack illustrates the right flood bank. Where there is no impact to a zone, there is no bar stack, for example carbon storage only affects the river banks, so there is no bar stack for the active channel.

Similarly, if there is no discharge on a particular bank on the site, there is no bar stack for the river bank in the water quality function.

3. The coloured stacks indicate the different activities that are contributing to the potential impacts on the riverine functions. For example, in Figure 6-18 Illustrating the key output graph, the green bars indicate alien infestation, the pink bars indicate erosion or excavation, and the brown bars indicate channelling/levees/channel modification.

4. The "baseline" indicates the ideal potential to provide the river function. The stacked graphs indicate the change away from ideal as a result of the indicators and activities illustrated in the stacked graph. Some activities will have positive impacts, e.g. above the baseline, and some will have negative impacts e.g. below the baseline. The total length e.g. both positive and negative impacts, of the stacked bar should be considered, when determining which functions have been most impacted by activities on the site. Rehabilitation activities should focus on the activities causing negative impacts on the site.

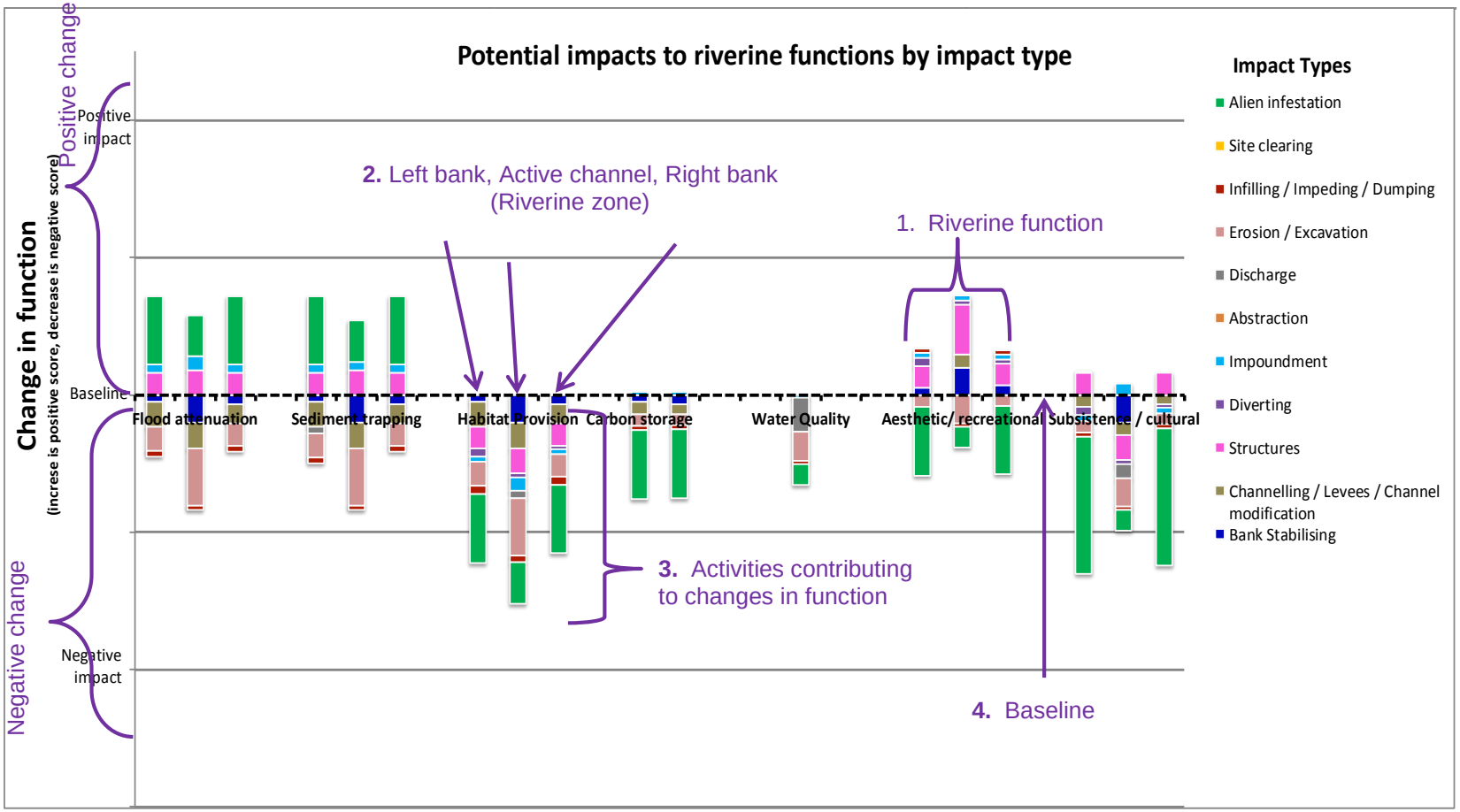


Figure 6-18 Illustrating the key output graph

Of particular concern are the negative impacts to riverine functions. The stacked graphs that are the furthest/longest below the baseline indicate the most potential negative change in the ability to prove the riverine function. In the Figure 6-18, habitat provision, water quality, and subsistence/cultural are the most negatively impacted functions, followed by sediment trapping, flood attenuation, and carbon storage especially on the left river bank. Aesthetic/recreational has the least negative impact to provide function. This means that rehabilitation objectives of this site should focus on rehabilitating habitat provision as a priority. **Note:** not all contraventions are the cause of the negative impacts; these negative impacts should still be addressed as "Duty of Care" in the enforcement process.

The next step would be to instruct the landowner or transgressor to conduct detailed quality or health assessments for these particular functions. These assessments should include the river health assessment or EcoClassification methodologies.

6.4.3.4 STEP 4: Testing tool functionality

The indicators, the assignment of values to the measures (Step 1), the matrices (Step 2) and the Dashboard graphs (Step 3) were tested through desk-top simulations by the author and Mr Mark Rountree (Fluvial Geomorphologist expert in the Water Research Commission panel of experts) to test the formulation and calibration of the different sub-systems of the tool. During the desktop simulations rivers of different sizes, characteristics and different impact issues were devised (based on rivers around South Africa and cases that both the author and the specialist had worked on e.g. mountain stream and fully canalised rivers). The results of the simulations were then compared with each other to check if appropriate issues were being identified, or if particular functions or indicators dominated the process. Adjustments were made, and iterations were run again.

Where necessary the relationship matrices or the scale assigned measure values were adjusted and the process was repeated. Finally a workable version of the tool was then field tested with various officials to further test the parameters and to test for other elements of scientific rigour such as objectivity, robustness, repeatability. The field testing with the officials is captured in the case studies in Chapter 7.

Addressing Objectivity:

When determining the measures of the indicators a coarse-scale approach was used. As the officials have varying backgrounds, varying experience and interpretations of the indicators, it was decided that a fine-scale of measures would lead to a greater variability in the resultant graphs which would reduce the repeatability of a particular site or case. Subjective interpretation of the observations on the site will still take place. The Site Inspection Checklist is based on a structure similar to other existing river assessment methodologies, where the "best-fit" description is selected from a predetermined list of characteristics. This limits the scope of subjectivity to the selection of a best-fit description. The assigned value for each of the activities is based on the sum of several indicator scores, again reducing subjectivity to the selection of descriptions for each indicator. These indicator scores are grouped per activity based on the relevance and contribution of information the indicator has to the particular activity, as well as per flood zone or active channel. Some subjectivity is still inherent as each official has a different understanding and interpretation of observations made of the site, the activities and impacts, as well as the indicators in the Site Inspection Checklist Form.

6.4.3.5 STEP 5: Using the outputs

Using the information illustrated through the Dashboard graphs, in particular the key output graph, the enforcement official is then guided as to what additional studies are required, and/or what specialists should be involved in compiling the rehabilitation plan including what issues the rehabilitation plan should aim to address.

The next step in the enforcement process, after conducting the site inspection, is for the enforcement official to draft the warning notice. As highlighted in Chapter 4, no new information may be added to the administrative notice between the warning notice and the final administrative notice; hence the importance in ensuring the enforcement officials request the appropriate detailed studies and specialist inputs in the warning letter, and hence the need for Dashboard Tool.

Informing the administrative notices

Using the results from the Dashboard, the official can then direct the rehabilitation plan to specifically target the remedying of impacts to the potential to provide riverine functions.

The request for a Rehabilitation Plan should include three aspects:

i. Any necessary specialist/detailed studies, and the resultant impacts to be rehabilitated;
ii. Environmental Management Plan / Programme;
iii. Monitoring Programme.

For example, using the information illustrated in Figure 6-18 the administrative notice should include:

Submit a rehabilitation plan within 30 days from receipt of this notice for approval by this Department. The rehabilitation plan should address the following issues:

i. Impacts to habitat function – a detailed habitat integrity assessment should be carried out in accordance with requirements of the EcoClassification Module G: Index of Habitat Integrity (Kleynhans et al., 2009) and should be compiled by an appropriate accredited or professionally registered specialist or ecologist.

ii. Impacts to subsistence/cultural function – a detailed assessment of the resource economics should be carried out to determine the subsistence value and cultural significance of the resource affected by the site and should be compiled by an appropriate accredited or professionally registered resource economist or resource anthropologist.

iii. Impacts to flood attenuation and sediment trapping function – a detailed hydro-geomorphological assessment should be carried out in accordance with requirements of the EcoClassification: Geomorphological driver assessment index (Kleynhans et al., 2009) and should be compiled by an appropriate accredited or professionally registered hydrologist, geomorphologist or sedimentologist.

iv. Environmental management plan - must recognize the potential impacts of activities on the site, provide mitigation for these impacts, as well as allocate responsibility for implementing the mitigation. The

EMP should include best practice methodologies for site management, e.g. bunding of stockpiled soil; no toilets or storage of substances within the buffer of- or the riparian zone; delineate the riparian zone and clearly indicate that it is a sensitive environment.

v. *Monitoring plan – detailing the parameters to be measured (including how, when, how often, etc.), the timing of monitoring and responsibility of monitoring activities, to determine progress of the rehabilitation activities to the rehabilitation objectives and if necessary compliance actions.*

Specialist studies

To determine from the Dashboard Tool which specialist studies are required, the official determines which functions have been the most negatively impacted. For example in Figure 6-18, habitat provision has negative impacts to both the channel banks and the active channel, the subsistence/cultural function has also been negatively. The flood attenuation and sediment trapping functions have also been impacted, but to a lesser extent that aforementioned functions. This is noted by observing which functions have negative stacked-bars (i.e. below the baseline). Specialist studies should thus focus on the habitat provision and subsistence/cultural functions, as well as the flood attenuation and sediment trapping function. With regard to particular activities, discharge, alien infestation, erosion and infilling are contributing towards the negative impacts on the riverine functions. This is observed by noting which activities are the most common in the negative bar stacks.

"The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river" (Kleynhans and Louw, 2008:A1-1). This is necessary in order to determine suitable and appropriate rehabilitation objectives and activities. Table 6-63 provides a suggestion to the types of specialists and assessment methodologies that are available, according to riverine functions. These specialist studies can be applied according to which function(s) have been identified in the Dashboard as

requiring further investigation. This list is a suggestion not prescriptive, to enable flexibility in case by case contexts.

Table 6-63 Riverine function and potential specialist and assessment methodologies.

Riverine Function	**Specialist**	**Suggested Assessment Methodology**
Flood attenuation	Hydrologist	Hydrology
Sediment trapping	Geomorphologist / sedimentologist	Geomorphological driver assessment index
Habitat provision	Ecologist	Index of Habitat Integrity
Carbon storage	Botanist	Riparian Vegetation Response Assessment index
Water quality	Water Quality specialist	Physico-chemical driver assessment index
Subsistence / cultural	Resource-economist / Resource anthropologist	Resource assessment / cultural assessment

The aesthetic/recreational function are directly related to the habitat provision and the flood attenuation functions in particular, therefore any remedial work to these functions will affect these secondary functions as well. With regard to the subsistence/cultural function in particular, if the watercourse is known to be used for cultural or subsistence activities then a specific study should be conducted, however if there is no subsistence/cultural utilisation of the river then this function can be ignored. However it is critical to first formally establish that there is no subsistence use or cultural use that is being impacted by the site before ignoring the function.

Habitat Integrity (Habitat Provision Function)

Habitat provision is the most common riverine function to be impacted in urban rivers as a change in each system driver (hydrology, water quality, etc.) will always result in a change to habitat attributes. “The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region” (Kleynhans 1995 in Kleynhans *et*

al., 2009:G1:v). Aquatic physical habitat refers to the environment for the in-stream and riverine zone biota created by the interaction of the physical structure of the channel (the geomorphology) and the flow regime (discharge pattern over time). Table 6-64 summarises the various component and metrics (aspects) that affect habitat integrity.

Table 6-64 Summary of the Index of Habitat Integrity components and metrics

IN-STREAM HABITAT INTEGRITY ASSESSMENT		**RIPARIAN ZONE HABITAT INTEGRITY**	
Component	**Metric**	**Component**	**Metric**
Hydrological modification	Base (low) flows	Hydrological modification	Base flow
	Zero (no) flows		Zero flow
	Floods		Moderate floods and freshes
			Large floods
Physico-chemical modification	pH	Bank structure modification	Marginal
	Inorganic salts		Non-marginal
	Nutrients	Riparian zone connectivity	Lateral
	Water temperature		Longitudinal
	Water clarity		
	Oxygen concentration		
	Toxics		
Bed modification	Sedimentation		
	Benthic growth. (Algal growth)		
Bank modification	Marginal characteristics (vegetation and abiotic (e.g., undercut banks)		
	Non-marginal characteristics (vegetation and abiotic)		
Connectivity modification	Longitudinal		
	Lateral		

Where any of the metrics in Table 6-64 have been or are likely to be affected by the contravention, then a detailed habitat assessment is required in order to determine the state/health of the habitat integrity on the site. The assessment should be in accordance with the requirements of the EcoClassification Module G: Index of Habitat Integrity (Kleynhans, C.J. *et al.,* 2009) and should be compiled by an appropriate accredited or professionally registered specialist or ecologist. As a guideline, a habitat assessment will also provide information about the other drivers and responses, and can be used as a minimum requirement for specialist studies, but this should be reviewed on a case by case basis.

Water Quality (Water Quality Function)

Where there are serious water quality-related impacts on the site e.g. fish and bird deaths, strong smelling/odorous water, unnatural water colour, excessive algal blooms, etc., a detailed water quality analysis must be conducted. This includes *inter alia* an assessment of Total Dissolved Solids (TDS), e.coli, pH, nutrients, heavy metals, dissolve oxygen, and water clarity. Most of these attributes can be tested with apparatus by the officials themselves (provided that they comply with both health and safety requirements and chain of evidence requirements), however where laboratory testing is required, e.g. heavy metals, nutrients, e.coli, the samples must be taken according to the appropriate sample methodologies, laboratories must be accredited, and a chain of evidence must be attached to the samples at all times. The samples must be compared to appropriated thresholds.

Hydrology / geomorphology (Flood attenuation and Sediment Trapping Functions)

Where contravening activities have resulted in, or themselves are, activities causing impacts to the flow regime (including the functions of flood attenuation and/or sediment trapping) of the water course e.g. impoundments, major abstractions, bridges/culverts, weirs, significant impediments or diversion of flow, channel modifications, etc., a detailed hydrological assessment should by conducted for the site (including upstream and downstream impacts). Changes in the hydrological regime of the watercourse will impact on the erosion/sediment/deposition regime as well as the flooding patterns of the watercourse. Hydrological studies should be carried out by qualified or professionally registered hydrologists. Where erosion and sedimentation/deposition are the critical issues, then an accredited or professionally registered sedimentologist or geomorphologist should conduct the analysis.

Resource-economist /Resource Anthropologist (Subsistence / Cultural Functions)

Where contraventions have impacted on a site that is known to support subsistence or cultural practices, then a detailed assessment of this subsistence or cultural practices is needed. The subsistence based resource value derived from the practices need to be determined. The specialist studies should also

include an ecologist and Index of Habitat Integrity assessment, as habitat provision and subsistence practices are closely linked.

Where specialist studies are identified they should be conducted by the relevant accredited or professionally registered specialists. The detailed studies need to compare the site reach to a reference condition, clearly outline the key issues, and make clear recommendations for rehabilitation, including setting objectives and identifying measures (indicators) of progress. All results should be recorded as a baseline against which to monitor progress (improvement). The Specialists need to answer the following questions in their reports:

- Describe the impact of the contravention: Has the contravention resulted in an impact to the river corridor (riparian area and in-stream)? Explain how/what the impact (and cumulative impact if relevant) has been. What is the footprint/extent of the impact? What is the duration of the impact e.g. temporary, permanent, etc.? How has the contravention/impact affected safety (Public Safety), water quality, hydrology, geomorphology, biodiversity on the site and the adjacent properties? Refer to NEMA sections 23(2)(b), 24(4)(a)(iv) and 24G(1)(i).
- Should directed remedial activities seek to **Restore**, **Rehabilitate** or **Remediate** the river corridor? (Restore refers to returning the river to a pristine state; rehabilitate refers to repairing specific functions but not returning the entire site to a pristine state; and remediate refers to maintaining the status quo and preventing further degradation). What should the objectives of the “rehabilitation” be? What measures/indicators should be used to monitor progress of the rehabilitation?

Based on the results and recommendations of the specialist’s studies, a rehabilitation plan should be compiled setting clear objectives for rehabilitation, including appropriate timeframes and measures (indicators) of improvement. A compliance notice or directive can then be issued instructing the implementation of the rehabilitation plan as per the specialist studies.

Where a person cannot afford to conduct the specialist studies, the enforcing Institution should conduct the specialist studies and remedial works, in terms of sections 28(7), 31N(2)(b) of the National Environmental Management Act (Act 107

of 1998)(NEMA), or sections 19(4), 20(6)(b), 53(2)(a) of the National Water Act (Act 36 of 1998)(NWA).

Information and data collected through the specialist assessments should be captured into the River Health Programme database for future monitoring and reference.

Environmental Management Plan (EMP)

The Environmental Management Plan, like formal Environmental Authorisations, must identify the potential impacts of all activities on the site, provide mitigation for these impacts, as well as allocate responsibility for implementing the mitigation. The EMP is an extension of the Environmental Authorisation and in the case of compliance and enforcement will be an extension of the administrative notice, e.g. Compliance Notice or Directive. The aim of the EMP is to promote environmental awareness and best environmental practice for all activities on site, i.e. not limited to listed activities.

Firstly the riparian zone should be delineated according to the DWAF (2008b) guideline, and mapped spatially using the GPS co-ordinates of the riparian-terrestrial boundary. The map should also include the 32m buffer around the riparian zone. The boundary of the riparian area and the buffer area should be clearly demarcated on site e.g. by coloured markers, fencing, or signage. The EMP should indicate which activities should not be carried out within the riparian area and within the buffer area e.g. storage and disposal of waste and temporary toilet facilities.

Examples of other additional EMP activities should include *inter alia*:

- Removal or management of alien and invasive vegetation according to the class of plant species.
- Rubble and site waste to be collected in clearly marked skips or litter bins around the site. Implement site management fines for littering/dumping. Install litter traps on storm water runoff infrastructure. Erect “no dumping/no littering” signs. Waste such as plastic, glass and tins, etc., should be recycled wherever possible. Remove dumping/solid waste to an approved landfill site (pink slips to prove formal dumping, or detailed motivation of recycling).

- Improved storm water retention and/or filtration on site prior to discharge (SUD).
- Erect sediment screens around stockpiles.
- Regular clearing of storm water drains, riparian areas and in-stream channels of debris, sediment and solid waste washed from site.
- Storage of hydrocarbons and other substances must be in accordance with their materials datasheets or South African National Standards (SANS).
- Maintenance of equipment must be in a bunded or secured area. Spills must immediately be cleaned up and contaminated soil and waste must be disposed of by appropriate means.

Monitoring Plan

According to FISCRWG (2001:9-29) designing the rehabilitation plan is not the end of the project. The remedial effort is not considered complete once the rehabilitation plan has been compiled or implemented, but that there should be ongoing monitoring, evaluation, and adaptive management. The purpose of monitoring rehabilitation activities is to gather data that will help determine the success of the rehabilitation effort. FISCRWG (2001) suggests that monitoring of rehabilitation activities should be guided by predetermined criteria and checklists and allow for the recording of results in regular monitoring reports. The technical analysis in a monitoring report should reflect remedial objectives and should identify and discuss options to address deficiencies, successes or alternatives.

The National Research Council (NRC) (1990), based on a thorough review of freshwater monitoring plans, some of which have been in place for over 30 years, recommended the following factors to ensure a sound monitoring plan:

- Clear, meaningful monitoring plan goals and objectives that provide the basis for scientific investigation;
- Flexible plans that allow modifications where changes in conditions or new information suggests the need;
- Useful and accessible monitoring information available to all interested parties.

The Monitoring aspect of the Rehabilitation Plan should set out the monitoring requirements, such as parameters to be measured (including how they will be measured, how often, threshold to measure against), timing of monitoring and responsibilities of monitoring activities. The monitoring plan does not need to be

complex or consist of expensive measures and assessments. It must be practical and provide some indication of the progress of attaining the rehabilitation objectives.

6.5 Findings and Conclusions

The previous chapters (chapters 3, 4 and 5) illustrated the need for a tool to guide enforcement officials in determining rehabilitation objectives. The Site Inspection Checklist and Dashboard Tools that have been developed were successfully tested in the field, these are discussed in Chapter 7: Case Studies. It was considered whether the socio-economic functions included in the Dashboard were necessary in the Tool; as the activities in urban rivers are usually to improve these functions, it was decided to leave them in the Dashboard Tool.

Comments received back from the officials as well as from the case studies suggested minor adjustments in the Tools, mainly regarding terminology. This has been accommodated both in the Guideline Document (Braid, 2014), as well as in the structure of the Site Inspection Checklist, e.g. the measure options are now also included on the paper version of the Form, negating the need for the officials to carry the detailed descriptions with them on site. In testing of the tools in the Case Studies, the selection of indicators used were slightly adjusted or dropped, based on the results and comments from the officials. Where indicators were dropped from the checklist this was usually due to complexity of measuring the indicator.

In general the comments and feedback received from the teams of officials that tested the tools were highly positive, and that the Tools will be very useful to the officials.

Future development of the Tools could more rigorously test the value-allocations of the indicators, as well as the matrices of relationships between the activities to indicators and between the activities to functions, by comparing the site to a database of reference conditions once such a database is established. However for the purpose of this research, the testing of the Tool has confirmed its usability as its intended objective of initial screening of potential impacts to riverine functions on the site.

6.5.1 Legislation Search Tool (LST)

The LST database currently only captures the national environmental legislation. However provincial/ geographic specific legislation and regulations may also still be applicable as well as the Municipal by-laws. These were purposefully excluded from the scope of the initial tool development. However future development of the tool should include this detail as well.

The legislation is regularly being updated, and the listed activities identified in the different statutes, especially the NEMA, are regularly being amended. This will require the continued maintenance of the database to ensure that it is kept up-to-date with any amendments in the legislation. At the time of developing the tool, it was recommended to the Department of Environmental Affairs to take ownership of this maintenance. This has not been confirmed to date.

6.5.2 Site Inspection Checklist (SIC)

When considering the criteria and indicators to be included in the SIC, aquatic invertebrates were initially considered as well as diatoms, however due to the complexity of assessing the invertebrates and the time and cost in analysing diatoms, it was decided to remove these criteria from the Site Inspection Checklist, but that they should rather be available as specialist studies should they be required. Furthermore, the in-stream sampling required for the mini-SASS or macro-invertebrate assessment posed Health and Safety issues. It is rather recommended that these studies form part of the detailed specialist studies, conducted by accredited specialists.

The indicators and measures used in the SIC were drawn from existing assessment methodologies and easily observable indications on a site. A Guideline Document (Braid, 2014) for the enforcement officials has also been developed, and explains the different indicators and includes pictures to illustrate the difference in measures. These indicators and measures were discussed with various specialists of the WRC specialist team such as water quality specialist, botanist, aquatic ecologist and fluvial geomorphologist, and adjusted appropriately.

The SIC provides a detailed site inspection report, which can be easily understood by various officials, including those not having seen the site. This is particularly important, where there is significant staff-turnover, to ensure continuity of the rehabilitation objective.

6.5.3 Dashboard Tool

The values assigned to the measures, and the various matrices of relationships, i.e. of the indicators to activities and activities to riverine functions, were derived from the literature and existing methodologies. These were adjusted based on the outcomes of the case studies and testing. The Tool was designed to provide an initial screening as to the impacts on the potential of the river to provide riverine functions on the site, and thus identify which detailed studies and specialists need to be involved. The more fine-tuned quantitative assessment would be conducted by appropriate specialists and result in detailed and appropriate rehabilitation plans. This tool successfully provides that indication.

7 CASE STUDIES

Case studies were used in development and refinement of the Site Inspection Checklist (SIC) indicators and the adjusting of the Dashboard assigned values and matrices. The case studies presented in this report outline this development and refinement process. The case studies presented in this chapter were selected to illustrate that the tools were tested for objectivity, robustness, sensitivity, replicability and accuracy. Several trials were conducted by the author, and desktop-simulations were conducted with a specialist from the Water Research Commission project[19] to develop the tool into a useable format for testing in the field with officials. These case studies are samples of the field testing carried out in the field with officials. The initial trials were conducted on the tools to develop them into a workable version to test with the officials. This included testing the format of the Dashboard Tool. The tool initially indicated the impacts per function as separate result graphs per function. However, as the graphs are not quantitative, it was difficult to determine the relative impact across the functions. Therefore all the functions were included into one graph. This also made it easier for the case files of the officials, in that there was one page of results. In the process of testing, some of the indicators were dropped[20], including building orientation, vegetation composition and structure, substrate embeddedness and measured water clarity, due to complexity of the indicator and its scoring e.g. vegetation composition and structure or the lack of equipment or willingness of officials to take measurements near the water. It was important to field test the tools with the target audience in order to ensure the tools and the guideline document[21] were responsive to their needs, as the target audience. The case studies reported in this chapter were conducted with enforcement officials from various institutions. Only the Status Quo case study of the Bryanston Bicycle Park was not conducted with enforcement officials. A feedback session was held with the officials after completion of the case study testing to review the officials experience and site inspection observations.

The recurring test in the case studies was for objectivity. Each person has an individual perception or interpretation of the observations they make, and in

[19] See Braid, S. (2014)

[20] While these are important indicators in a detailed ecosystem health assessment, their complexity for the non-technical enforcement officials resulted in the indicators being ignored during the site observations. It was therefore decided to remove them. These indicators will still be assessed by the specialists in the detailed studies.

[21] See Braid, S. (2014)

particular of the scale or extent of their observations. It is important to test for objectivity in the tools in order to ensure that the results are not biased by subjectivity.

The replicability was tested in the case studies by using groups of various officials to assess the same site. Assessing the site on different days may influence the result due to differing conditions between assessment days. Therefore replicability was tested through group testing.

The training or background of the officials in the testing is an inherent variable in the process and tools. The tools have been tested across a variety of physical watercourses and desktop-simulations, in order to test the robustness of the tools.

The tools provide an indication of impacts on the potential of the watercourse on the site to provide ideal riverine functions. The exact extent that the site can provide riverine function will be determined by the specialist and detailed studies once the enforcement official has requested such studies and inputs. Therefore there tools are based on a coarse scale structure in order to accommodate the officials capabilities. The tools indicate which functions are potentially being impacted. By catering for subjectivity and robustness, the results of the tool will be fairly accurate. The Status Quo case study in Chapter 5 also compared other existing river assessment methodologies on the site, and the SIC and DT tools were also tested on the same site in the same day. The results of the assessments corroborate each other.

The 4 case studies included in this chapter illustrate how the tools were tested, where adjustments were necessary and highlight variability in officials' observations.

7.1 Case Study 1: Testing objectivity of the SIC and Dashboard: Western Cape

On Monday 22 April 2013, a workshop was held with officials from the Western Cape Regional office of the Department of Water and Sanitation, the City of Cape Town Metropolitan Municipality, Drakenstein Municipality and CapeNature. At the workshop the Site Inspection Checklist and Dashboard Tool were presented and explained in detail to the officials. The officials then selected sites where they could test the tool. The sites selected would be tested by at least two of the enforcement officials. This was done to test the objectivity of completing the site

inspection checklist and therefore the results of the Dashboard Tool. The following case studies present the results from the various sites and discuss the outcomes of the results.

7.1.1 Site 1: Macassar Low Level Bridge

This site was assessed by two different officials in order to assess the objectivity of the Site Inspection Checklist and the output graphs from the Dashboard.

7.1.2 Site location

The site is located upstream of a small bridge over the Kuils River, in Macassar in the Western Cape and illustrated in Figure 7-1 and Figure 7-2. The upper catchment flows through residential, commercial and industrial land uses. Upstream of the site the river flows through informal settlements and then through a Palmiet wetland system before reaching the site, which is surrounded by low density residential and agricultural land use. At the downstream boundary of the site is a low-level crossing with culverts. The site assessment was conducted in April 2013.



Figure 7-1 Macassar: Upstream showing right bank (Author: 2013)



Figure 7-2 Macassar: Upstream showing left bank (Author: 2013)

7.1.3 Activities

The activities on the site include the construction of a wall along the right river bank within the riparian zone and a culvert bridge across the river.

7.1.4 Results

A site assessment was completed on the same day to ensure the same testing conditions by the two different enforcement officials, having differing tertiary education. The first official had 15 years of experience while the second official only had 2 years of experience. This difference in background influenced the selection of answers to describe the site in the Site Inspection Checklist Form; this is noted in the level of detail captured between the two forms. In sample one (by official 1) most of the indicators were answered, whereas in sample 2 (official 2) many of the indicators were left as unobserved. The result is indicated in the Dashboard by contribution of activities to the impacts on the site, e.g. in sample 1 there are many contributing activities while in sample 2 there are fewer contributing activities due to the fewer indicators being answered. However, despite the difference in the "completeness" of the Site Inspection Checklist, the trends in the results of the Dashboards still indicate the same functions as being impacted, e.g. Water Quality, Habitat Provision and Subsistence/Cultural but the extent or scale of the impacts differs. This difference in experience and background has been accommodated by simplifying the terminology in the Site

Inspection Checklist Form, as well as providing more explanation of the terminology and indicators in the Guideline Document.

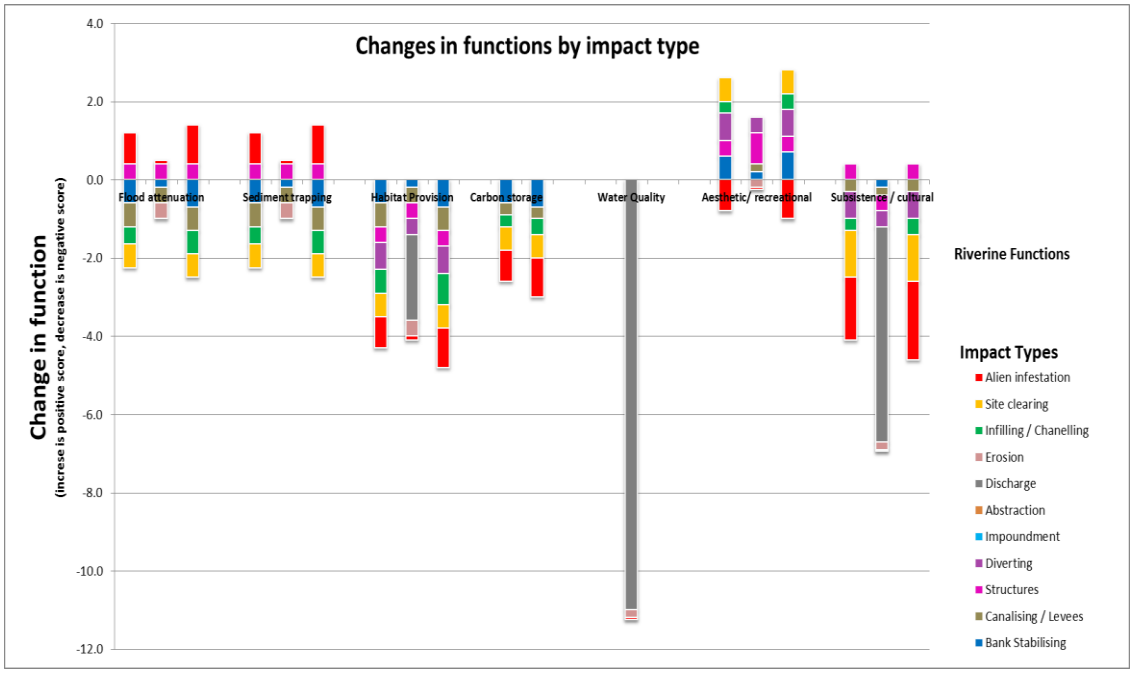


Figure 7-3 Official 1 - Macassar site assessment Dashboard sample 1

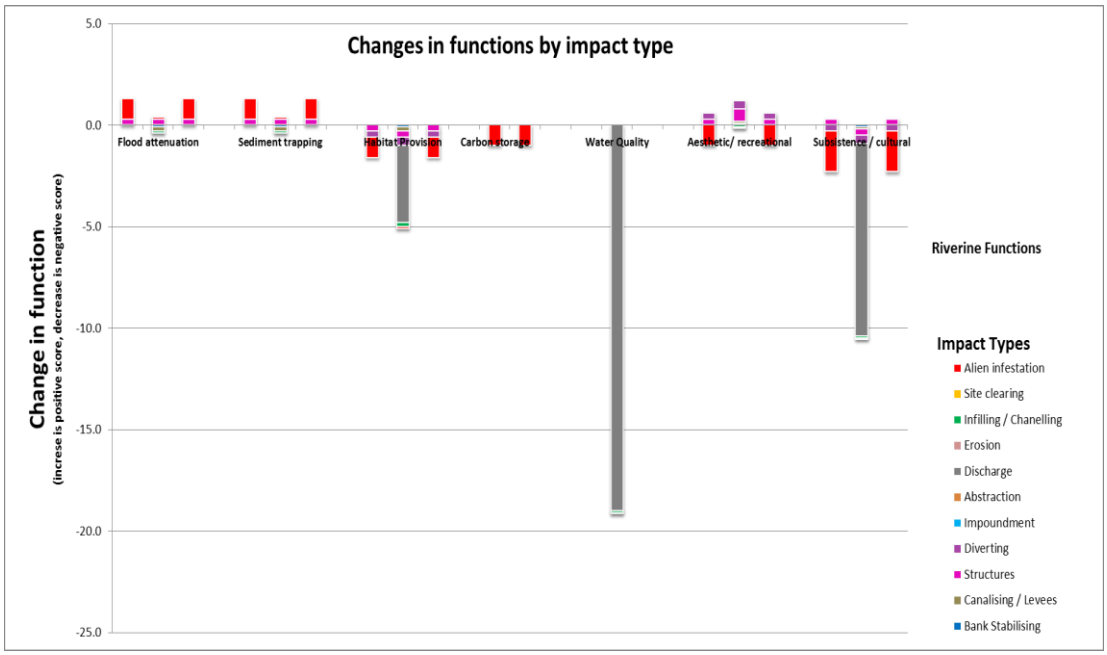


Figure 7-4 Official 2 - Macassar site assessment Dashboard sample 1

At the time, water quality had the most indicators in the tool and each indicator of water quality contributed significantly in the activity-function relationship matrix; therefore the results were biased towards water quality as more information was contributing towards this impact score. After this site assessment the indicator-activity relationship matrix was added to the Dashboard calculations in order to balance out the volume of indicators and their scope of contribution to the activity score. The number of indicators was not reduced, but the weighting or amount of the "contribution" per indicator was adjusted. Furthermore, the scale on the vertical axis of the dashboard was fixed as a qualitative scale rather than a numerical scale. The updated Dashboard is presented in Figure 7-5 and Figure 7-6.

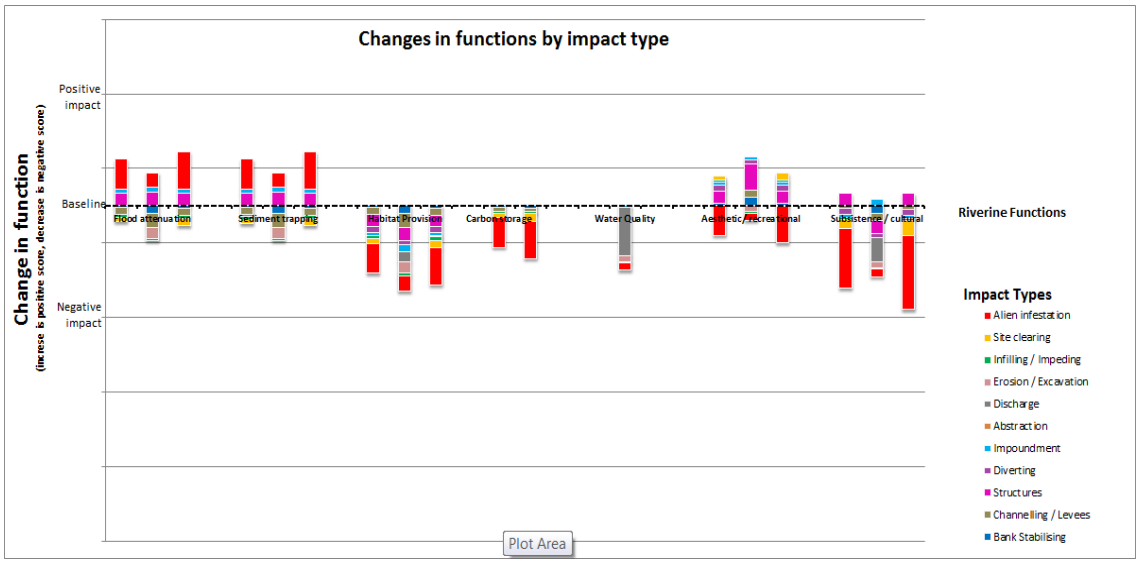


Figure 7-5 Official 1 - Macassar site assessment Dashboard sample 2

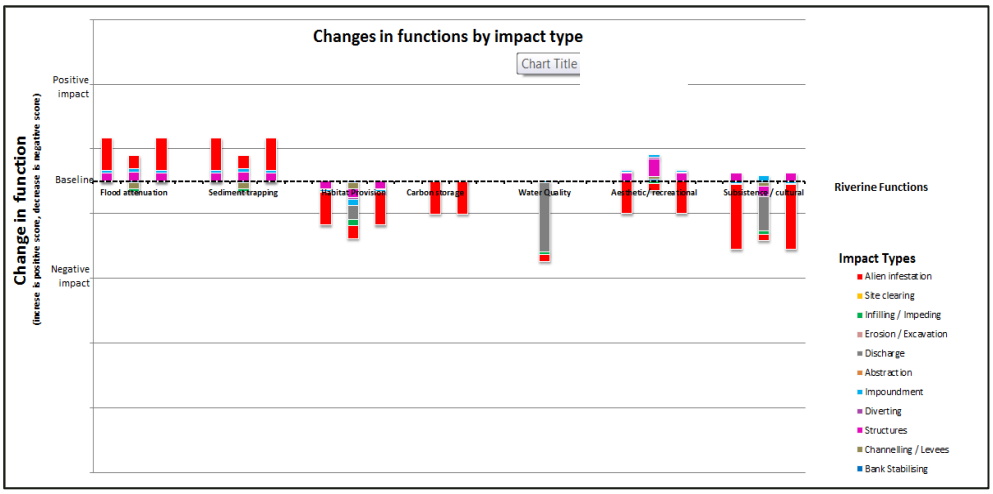


Figure 7-6 Official 2 - Macassar site assessment Dashboard sample 2

In the updated version of the Dashboard, after the activity-indicator weighting has been added to the dashboard calculations, the similarity in the trends between the two samples is more noticeable. This indicates that the Tool accommodates experience and training subjectivity of the officials.

7.2 Site 2: Liesbeek River

This case study was used to test the objectivity of the Site Inspection Checklist Form. The same site was assessed by two different officials and the author. The EcoClassification of the Lower Liesbeek River was used as a control assessment.



Figure 7-7 Liesbeek River: Right bank - stormwater outlet depicted (Author: 2013)



Figure 7-8 Liesbeek River: Left bank (Author: 2013)



Figure 7-9 Liesbeek River: Discharge into the river with oily sheen (Author: 2013)

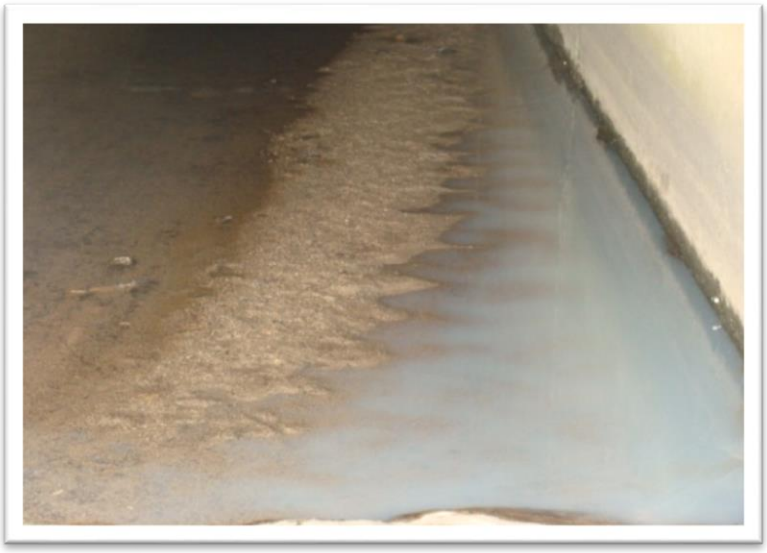


Figure 7-10 Liesbeek River: Milky discharge in stormwater outlet (Author: 2013)

7.2.1 Site location

The site is located on the lower sections of the Liesbeek River catchment. Land uses in the catchment in the vicinity of the site include residential, light industrial, commercial and recreational. Upstream of the site is a low-flow weir. The site includes a stormwater outlet. The site assessment was conducted in June 2013.

7.2.2 Activities

There was a pollution discharge into the river from the stormwater outlet located on the river-right bank in the riparian zone. The stormwater outlet and discharge are illustrated in Figure 7-7 to Figure 7-10.

7.2.3 Results

The updated version of the Dashboard calculations, with the activity-indicator weighting included, was used to derive the results presented in Figure 7-11 to Figure 7-13.

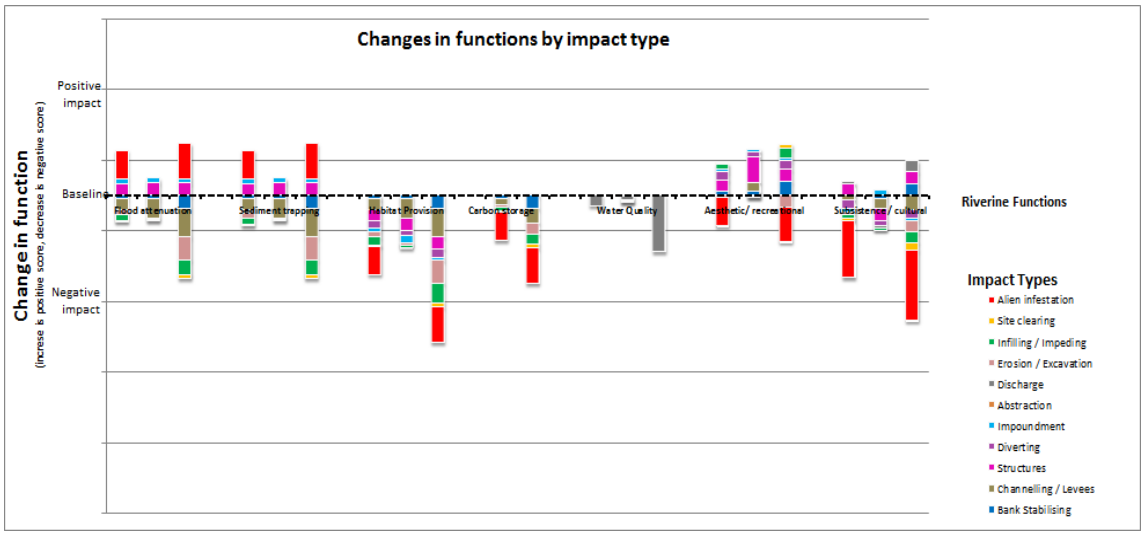


Figure 7-11 Official 1 - Liesbeek River discharge site assessment Dashboard

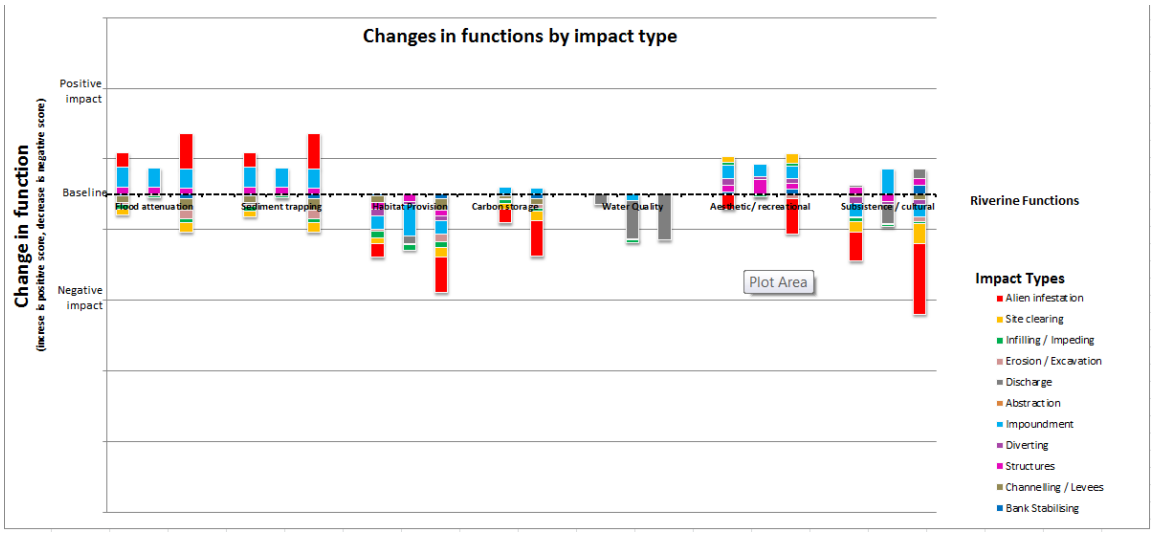


Figure 7-12 Official 2 - Liesbeek River discharge site assessment Dashboard

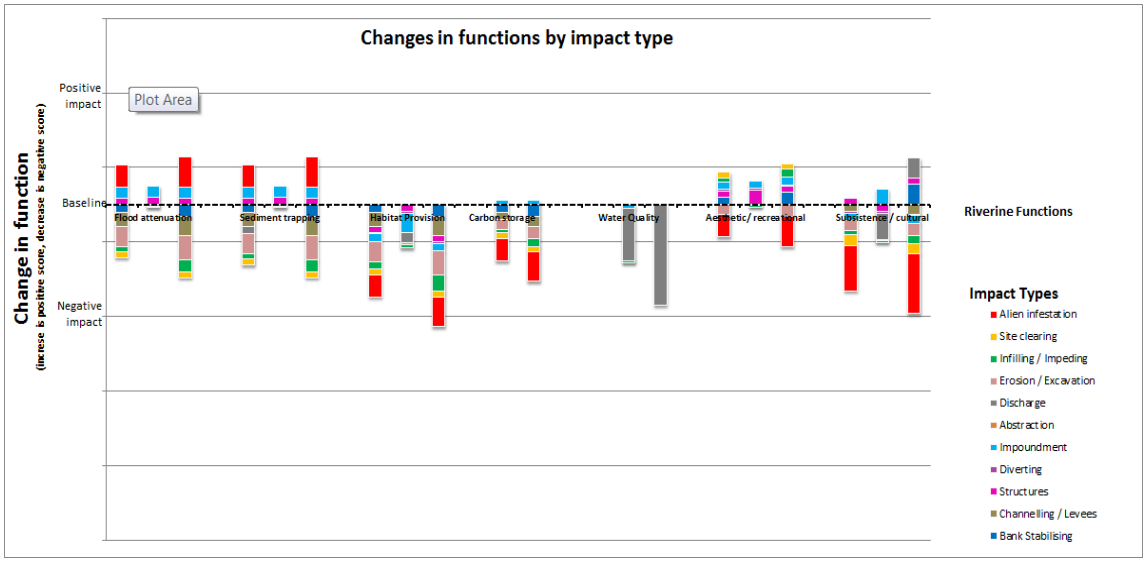


Figure 7-13 Author's sample - Liesbeek River discharge site assessment Dashboard

7.2.3.1 Tool results

There is no quantitative value-based score on the vertical axis of the Dashboard as it is not based on a rigorous detailed assessment. The Dashboard provides an indication of how the potential capability to provide riverine functions is impacted by the activities on the site. Visual inspection of the graph set indicates that the trends of the Dashboard graphs are similar. All three sets of results identified the functions of Habitat Provision, Flood Attenuation and Sediment Trapping as being impacted. In terms of water quality, the discharge on the right river bank was clearly identified as contributing a negative impact. Similarly, the invasive alien vegetation, erosion and channelling on the site were also identified as contributing negatively to the riverine functions on the site.

The extent of the impacts between the official's observations do vary; this is affected by subjective interpretation of scale / or extent of the impact e.g. height of channel banks, extent of erosion, etc. The size of the coloured bars in the graphs does not need to be exactly identical between the results, given the inevitable subjective interpretation by each official completing the Site Inspection Checklist as to the scale of the % coverage of the activity or indicator on the site. This subjectivity was mitigated by slightly adjusting the assigned value of indicators where measures of the indicators relate to scale or extent of the indicator, as well as the contribution of such scale indicators in the indicator-activity relationship matrix.

Furthermore, this version of the tool was based on observing the river looking upstream, i.e. looking upstream versus downstream the identification of left bank and right bank alters. There was confusion as to which bank was left and right bank. The methodology was changed to reflect observing **downstream**, i.e. with the flow of water the bank to the left, is **left bank**.

7.2.3.2 Control results

The EcoClassification for the Lower Liesbeek River was used as a control for this case study. The EcoClassification was conducted in 2005; although it precedes the case study testing the results are still relevant and applicable. The results of the EcoClassification are presented in Table 7-1.

Table 7-1 Summary of results of the EcoClassification assessment of Lieesbeek river (RHP, 2005)

	Ecological Indicators	**Score**
	Index of Habitat Integrity (IH)	Fair to Poor
	Fish Assemblage Integrity Index (FAII)	Fair
	South African Scoring System (SASS)	Poor
	Riparian Vegetation Index (VAI)	Poor
	Water Quality	Fair
	Desired Health	**Fair**

The EcoClassification (2005:31) noted the following major impacts in the Lower Liesbeek River:

- **Alien vegetation:** most of the indigenous riparian vegetation has been removed and replaced by invading alien plants (kikuyu, poplars, wattle).
- **Alien Fish:** The lower Liesbeek River is dominated by alien fish (carp, catfish, tilapia). Competition for food or habitat and predation has caused near disappearance of indigenous Cape galaxias.
- **Urban development:** Most of the rivers flow through densely populated urban areas and have been canalised with a resultant loss of goods and services (ability to process and dilute waste). Poor water quality in the

middle and lower reaches results from wastewater discharges, stormwater runoff and litter disposal. This reduces ecosystem functioning and poses a risk to human health.

Based on its assessments the EcoClassification (2005:31) identified the following management actions:

- Control littering and rubble dumping along river reaches in densely urbanised areas.
- Clear alien vegetation and encourage, where possible, landscaping with indigenous plants.
- Improve monitoring and management of stormwater runoff and wastewater discharges/spills from urban areas.
- Involve communities in the rehabilitation of riverine habitat and river health initiatives.
- Discourage new canalisation and where possible remove concrete lining of canals to rehabilitate riverine habitat for aquatic life.
- Support the Integrated Aquatic Weed Control Programme which manages the removal of nuisance aquatic plants.

These management actions are generic and not site specific to the case study site, but they still apply for the purpose of testing the tools.

As the EcoClassification was conducted several years prior to the case study, a Stream Visual Assessment Protocol was also carried out as a control for the Liesbeek river site inspection.

A stream visual assessment was conducted on the case study site, the results are included Table 7-2

Table 7-2 Completed Stream Visual Assessment Protocol for Liesbeek river site inspection

Owners name	City of Cape Town		**Evaluator's name**		S. Braid			**Date**	June 2013	
Stream name	Lower Liesbeek River, Cape Town				**Waterbody ID number**		Case study, site 2			
Reach location	Site located downstream of N2 highway, and weir. Site includes stormwater outlet									
Ecoregion	Fynbos		**Drainage area**				**Gradient**			
Applicable reference site	Diep River, in Diep river Cape Town									
Landuse within drainage	**Row crop**		**hayland**		**Grazing/ pasture**		**forest**	20%	**residential**	60 %

(%):											
confined animal feeding operations	n/a		**Canopy cover**	10%		**Industrial**	10%		**Other**		
Weather conditions today	Windy and sunny			**Past 2-5 days**	Windy and sunny						
Active channel width	6m	**Dominant substrate:** boulder		gravel		sand	**X**	Silt		mud	

Assessment Scores	Score		Score
Channel condition	3	Pools	7
Hydrologic alteration	7	Invertebrate habitat	5
Riparian zone	3	Score only if applicable	
Bank stability	3	Canopy cover	1
Water appearance	3	Manure presence	0
Nutrient enrichment	7	Salinity	n/a
Barriers to fish movement	3	Riffle embeddedness	3
Instream fish cover	3	Macro-invertebrates observed (optional)	2

Overall score (Total divided by number of indicators scored)	= 50 ÷ 14 = **3.57**	<6.0	**Poor**
		6.1 – 7.4	Fair
		7.5 – 8.9	Good
		> 9.0	Excellent

The Stream Visual Assessment Protocol rated the site as POOR with a score of 3.57.

7.2.3.3 Comparative results

In terms of the output results of the inspections and Dashboard compared to the EcoClassification and Stream Visual Assessment:

> The Dashboard indicated that habitat provision, flood attenuation, sediment trapping and subsistence/cultural were the functions that were being impacted the most. In particular the main activities contributing to the potential impairment of the riverine functions was alien vegetation, channelling, erosion and infilling. Generally the impacts on the site are having a negative effect on the ability of the watercourse at the site to provide riverine functions.

The EcoClassification identified alien vegetation, loss of fish habitat (food, habitat predation) and canalising of the watercourse as major impacts. The ecological indicators found the river to be in a Fair-Poor state and set a desired health for the river of Fair.

The Stream Visual Assessment found the site to be Poor. The following assessment indicators scored low: channel condition, riparian zone, bank stability, water appearance, barriers to fish movement, instream fish cover, canopy cover, riffle embeddedness and macroinvertebrates observed.

Findings: the results of the Dashboard tool do not differ from the findings of the EcoClassification and the Stream Visual Assessment.

7.3 Case Study 2: Testing objectivity of the SIC and Dashboard: Gauteng

A workshop was held with enforcement officials from various Gauteng-based institutions on 19 June 2013. The group comprised officials from the Department of Water and Sanitation: Gauteng Regional Office and the City of Johannesburg Metropolitan Municipality. The capability of team included an aquatic ecologist, hydrologist and general, i.e. no specific background in environmental management. The workshop included a brief explanation of how to complete the Site Inspection Checklist Form but little training was provided. The officials were tasked with assessing a tributary of the Braamfontein Spruit as a practical to test objectivity of the tool amongst a group of officials and uniformity of the tool a different characteristic river[22]. Figure 7-14 illustrates some of the officials conducting their site observations in the field. Many of the officials worked in pairs, and 10 Site Inspection Forms were submitted at the end of the exercise. The officials used printed copies of the Site Inspection Form and a copy of the descriptions. The assessments were carried out on the same day at the same time to ensure the same testing conditions.

7.3.1 Site location

The river reach assessed is located downstream of the Emmarentia dam in Johannesburg, approximately 100m in length. Figure 7-15 illustrates a portion of the site. The land use surrounding the site includes medium-density residential, open manicured park and recreational uses.

[22] Different river characteristics to the previous case study.



Figure 7-14 Enforcement officials in Gauteng completing the Site Inspection Form on a tributary to the Braamfontein Spruit (Author: 2013)

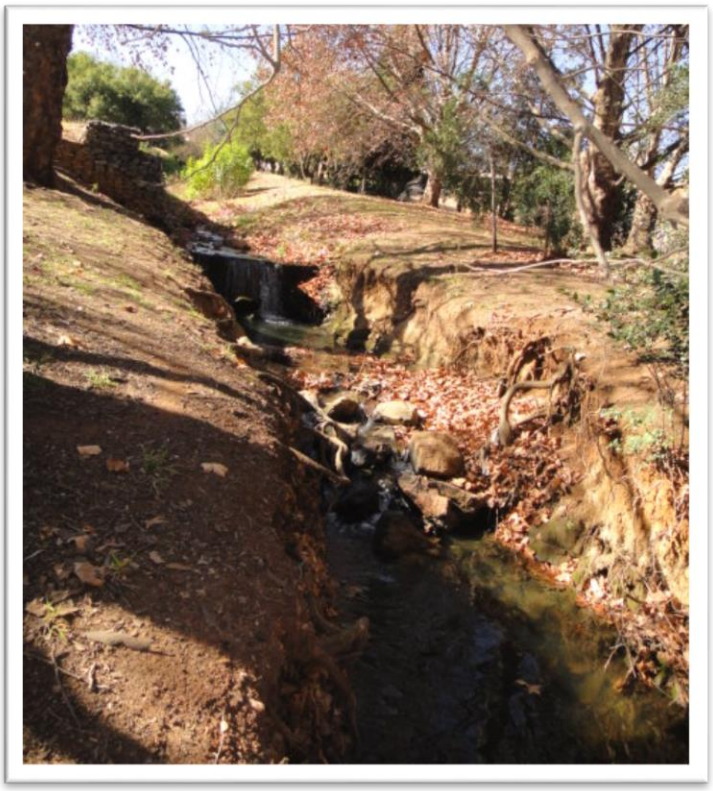


Figure 7-15 Tributary to the Braamfontein Spruit (Author: 2013)

7.3.2 Activities

Activities on the site included the installation of gabion baskets for bank stabilisation and the erection of a pedestrian bridge across the river, which had subsequently collapsed into the river causing a low flow impoundment. The site surrounding the river reach is landscaped park area. The riparian vegetation has been cleared. The river channel is incised and the active channel banks are eroded.

7.3.3 Results

The Dashboard results of the ten samples and the control sample are presented in Figures 7.16 to 7.26.

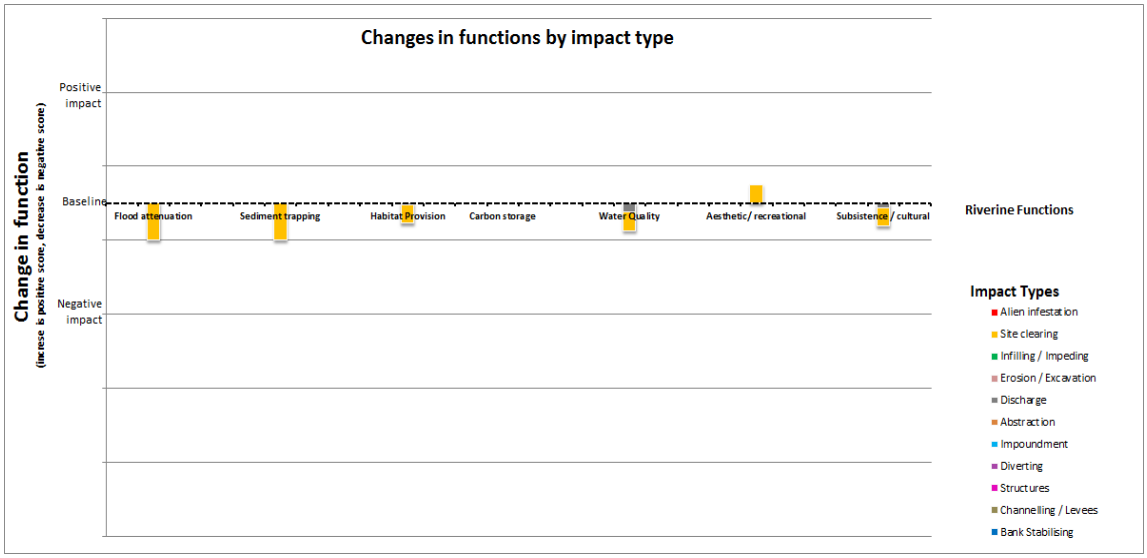


Figure 7-16 Sample 1 - Braamfontein Spruit site inspection Dashboard. Sample is incomplete

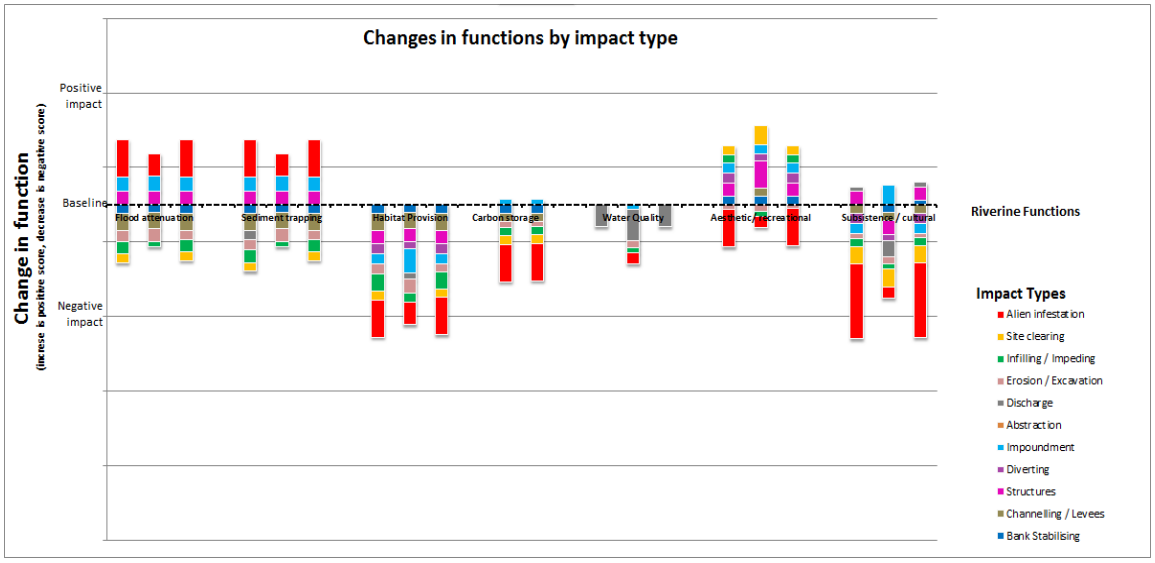


Figure 7-17 Sample 2 - Braamfontein Spruit site inspection Dashboard

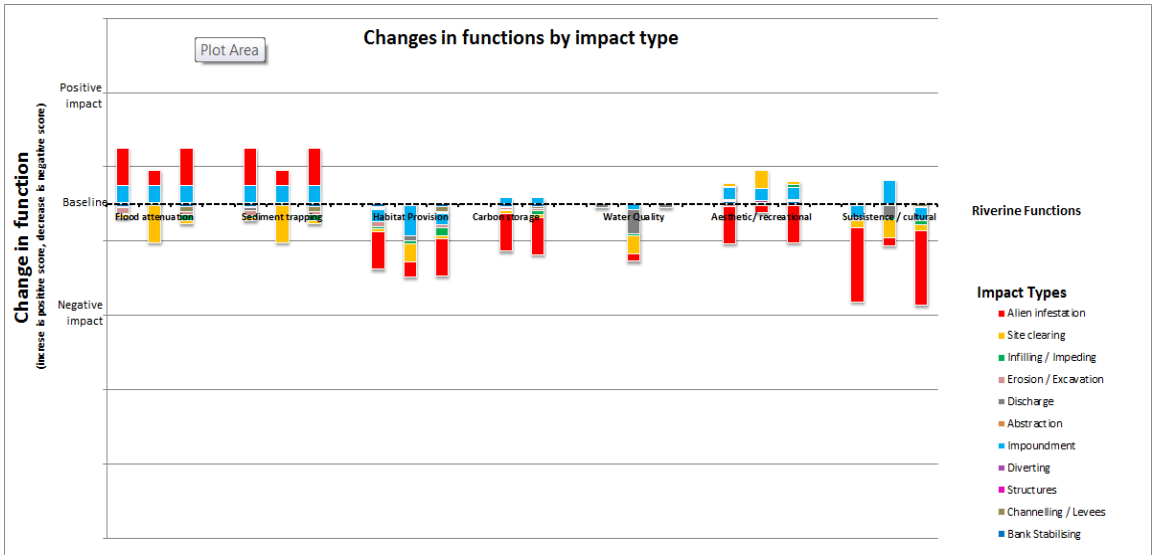


Figure 7-18 Sample 3 - Braamfontein Spruit site inspection Dashboard

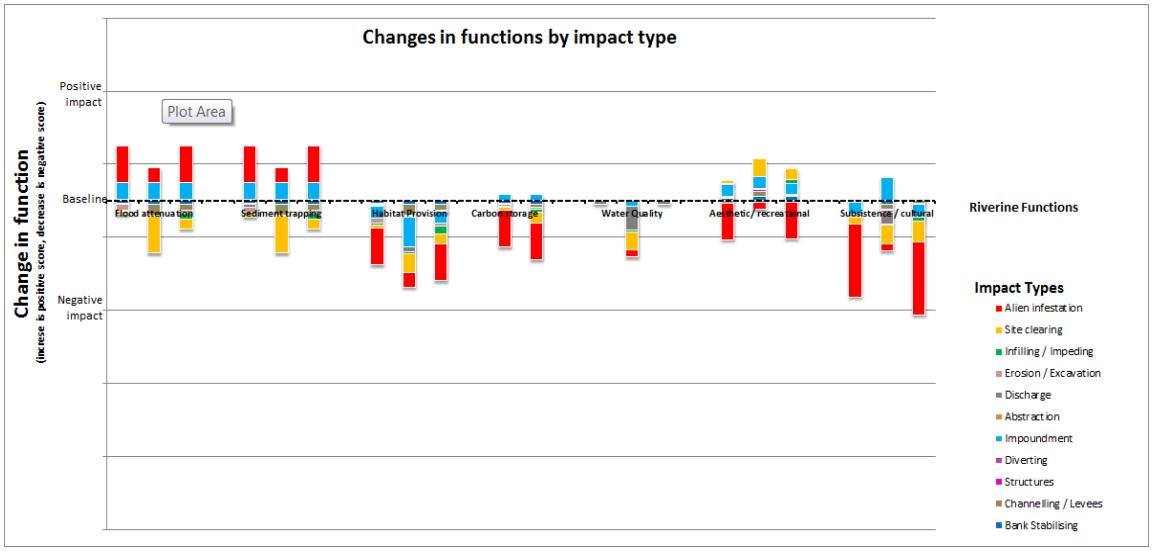


Figure 7-19 Sample 4 - Braamfontein Spruit site inspection Dashboard

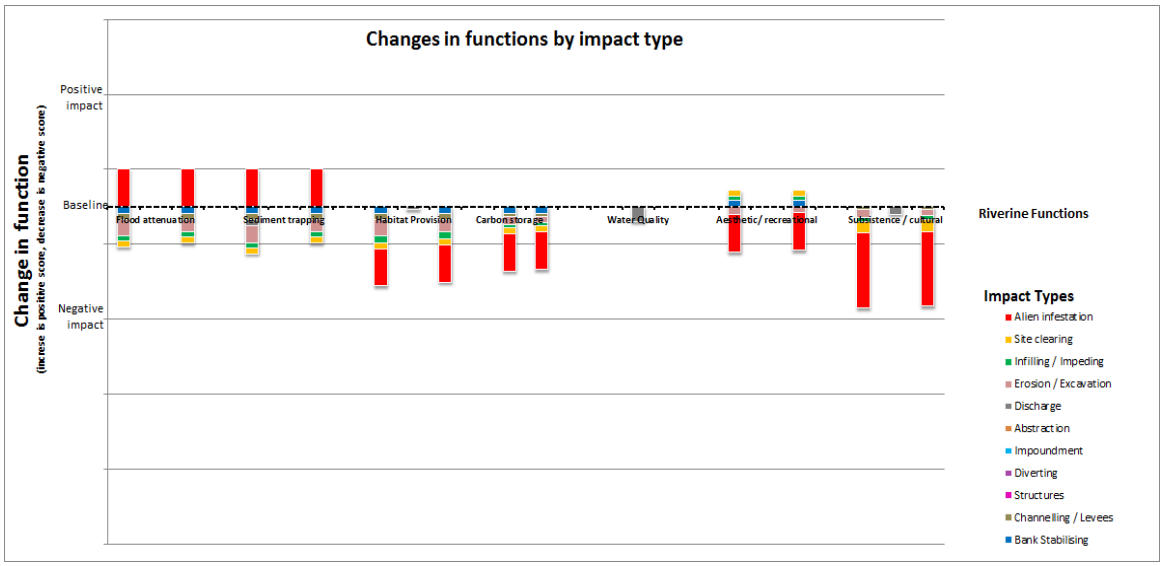


Figure 7-20 Sample 5 - Braamfontein Spruit site inspection Dashboard

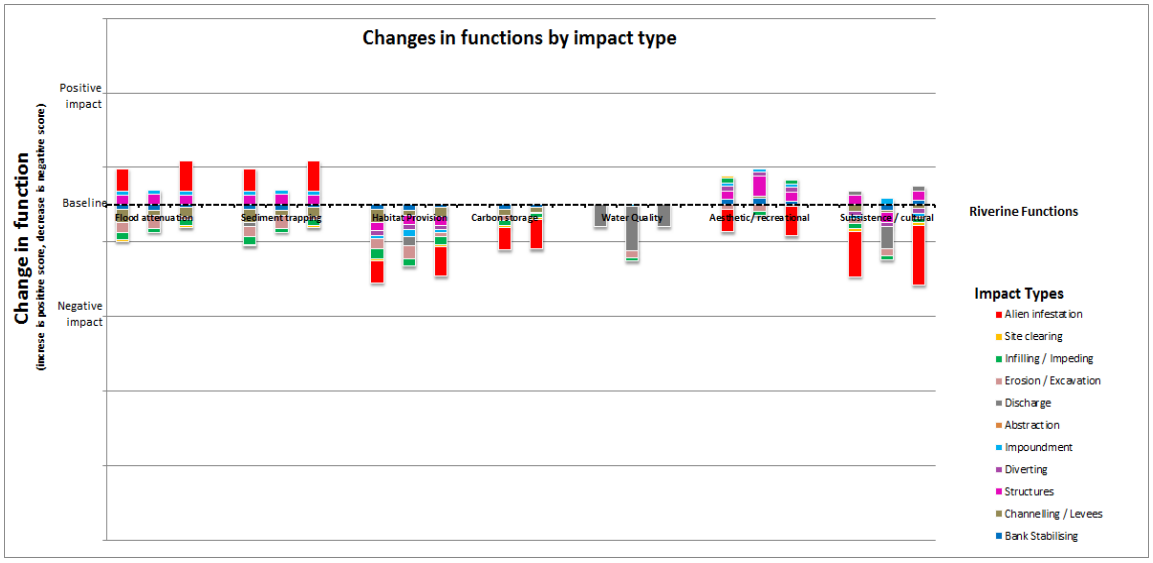


Figure 7-21 Sample 6- Braamfontein Spruit site inspection Dashboard

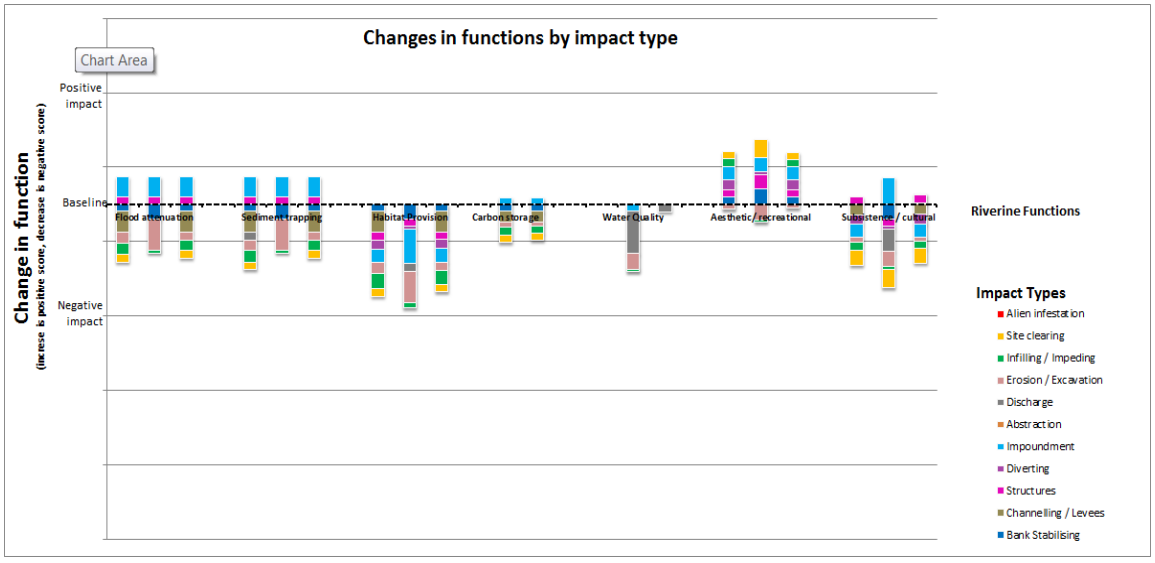


Figure 7-22 Sample 7 - Braamfontein Spruit site inspection Dashboard

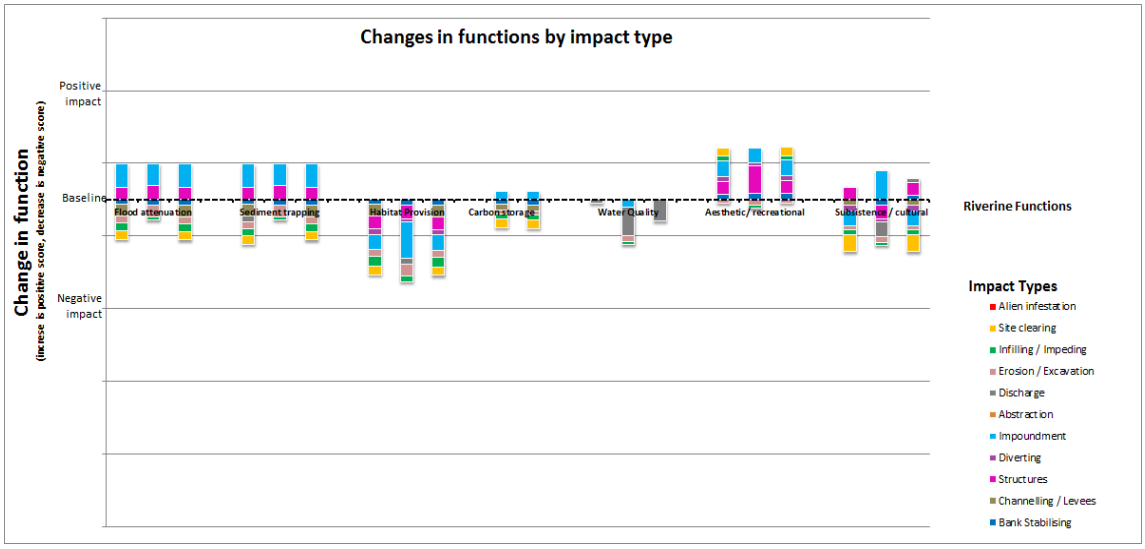


Figure 7-23 Sample 8 - Braamfontein Spruit site inspection Dashboard

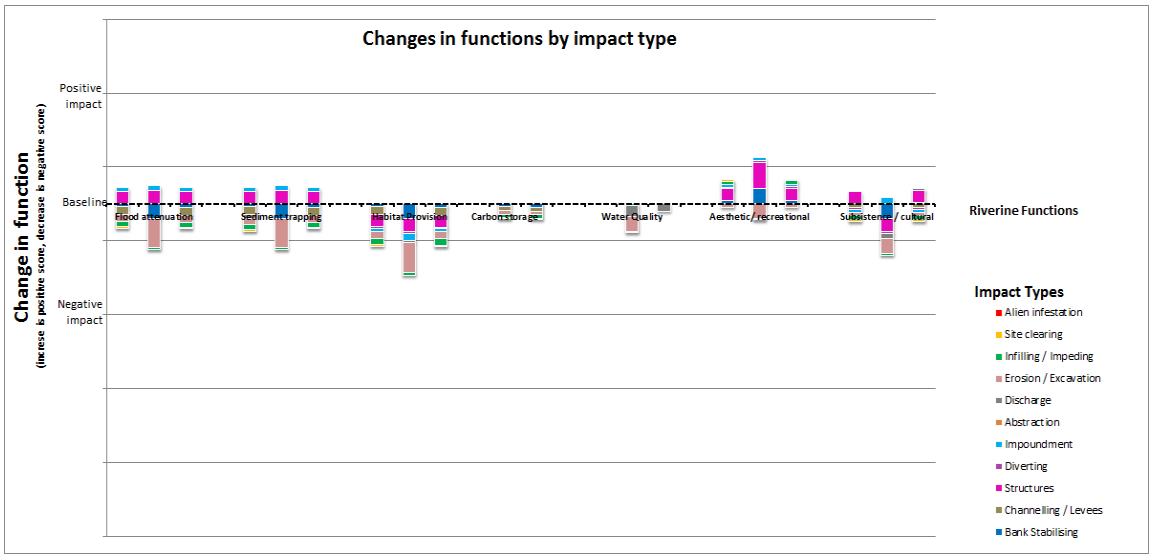


Figure 7-24 Sample 9 - Braamfontein Spruit inspection Dashboard

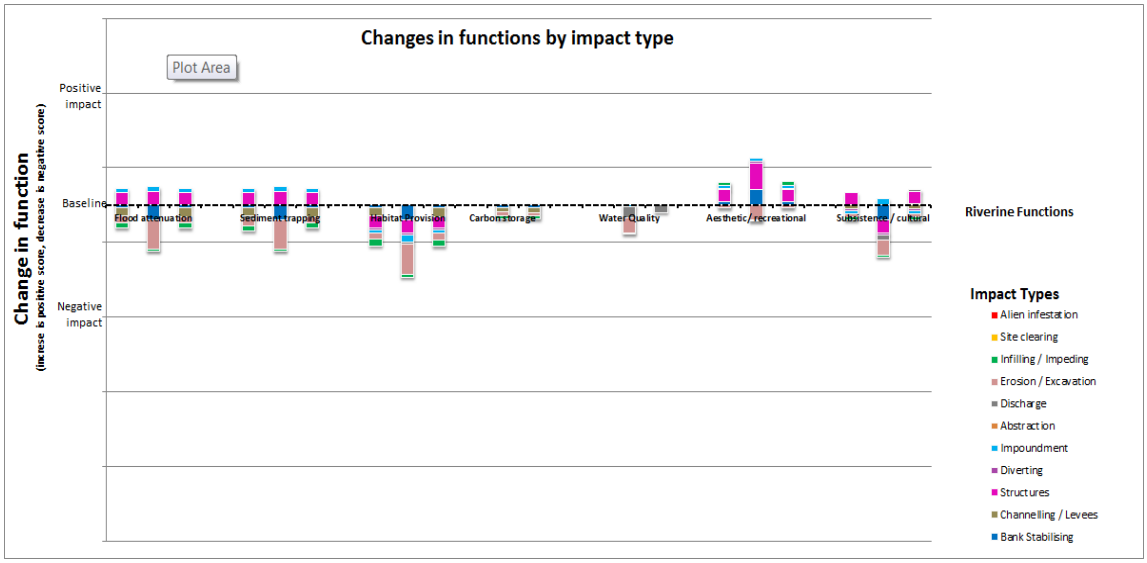


Figure 7-25 Sample 10 - Braamfontein Spruit site inspection Dashboard

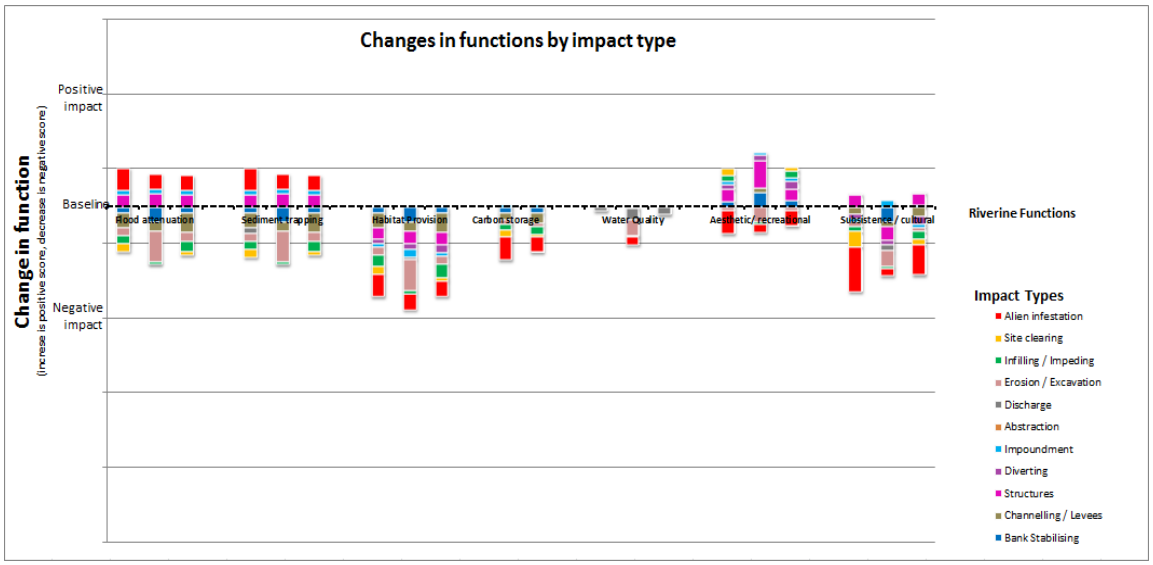


Figure 7-26 Control sample - Braamfontein Spruit site inspection Dashboard

The findings of the Braamfontein Spruit assessment include:

i) Excluding the incomplete sample, 9 sets of results were reviewed. There are two groups of trends in the results. Group 1 trend includes samples 2 – 6, and Group 2 trend includes samples 7-10.

   a. Group 1 samples trend: There is variation between the banks and channel with regard to positive impacts, in particular noted in the flood attenuation and sediment trapping. The dominant impacts are from alien vegetation, site clearing and impoundment. The

main negative impacts are to habitat provision resultant subsistence and cultural functions, secondly to carbon storage and water quality.

b. Group 2 samples trend: there is more uniformity across the banks and channel with regard to positive impacts, in particular on flood attenuation and sediment trapping. Within this group there is a further split in trends. Samples 7 & 8 indicate the banks are more impacted, whereas samples 9 & 10 indicate the channel as being more impacted. The range of extent of impacts is smaller from the latter 2 samples than for samples 7 & 8. The dominant activities for the Group 2 trend are impoundment, diverting, erosion, channelling and discharge. There is very little to no indication of alien vegetation in this group of samples. The main negative impacts are to habitat provision and resultant impact to subsistence and cultural functions, and secondly to flood attenuation, sediment trapping and water quality.

The Dashboard provides an indication of impact to potential of the watercourse to provide riverine functions. Both trends identify habitat provision as the main function begin impacted. The variation between carbon storage in Group 1 and Flood attenuation and sediment trapping in group 2, is the extent of inclusion of erosion indicators completed in the assessments. This highlights the requirement that officials need to understand erosion impacts and processes.

ii) There is some variation, mainly due to the completion of the form, i.e. indicators being left blank with no answer, or yes/no scoring instead of selecting an appropriate description. These then limited the amount of information going into the tool, and thus the resultant Dashboard graphs provide limited output indications. In particular forms that were missing more than 50% information were marked as incomplete sample.

iii) In order to understand the outputs between the samples in more detail and understand the differences in the results, the observations in the checklists were captured into a series of bar graphs. A graph was produced for each indicator that contributes to the Dashboard calculations. The graph indicates the number of officials that selected which description measure for each indicator. This enables the detailed

analysis of the non-quantitative data of the Dashboard results. The specific indicators and measures can be reviewed to determine where there is variation in the selected measures. These bar graphs are included in Figure 7-27 The measures are represented on the x-axis as the assigned values in the Dashboard tool, i.e. 0 represents most natural description and 5 represents most degraded description, and numerical values in between represent degrees of truth from natural.

The y-axis indicates the number of officials that selected the particular measure. The selected descriptions for the different riverine components are represented by the blue stack indicating left bank, red stack indicates the right bank and green stack represents active channel.

Where the officials left indicators blank, the indicators could be interpreted as a “no response” or “none” (0 value). For the purpose of the testing it was interpreted as “no response” (n/a value). In the electronic version of the form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a score. Repeated use of the toll will use increase the official’s ability to complete all the indicators on the form.

Figure 7-27 Series of bar graphs indicating the observations per indicator of the Emmarentia site inspection.



The variability of the scoring was located in the following indicators:

Indicator	Variance in observations
Ground cover:	The variation is due to officials not distinguishing between naturally vegetated (0 value) and kikuyu i.e. manicured (1 value). This will be resolved when officials complete the Inspection form electronically. Also some observations did not include an extent of cover of ground cover which reduced the contributing value of ground cover in the indicator-activity matrix.
Erosion on site:	This was noted as either "yes" or "erosion" and did not distinguish the type of erosion on site. This was captured as "n/a" in the Dashboard. This will be resolved when officials complete the form electronically; they will have to select a specific option from a drop down menu. 2 officials indicated gully erosion (3 value) on the banks, this however was the deep incision erosion of the river. The explanation of gully erosion and incision erosion was expanded in more detail in the Guideline document in order to avoid confusion.
Alien vegetation:	Where the measure was observed these varied between 60-100% (5 value) and 11-40% (3 value), which is influenced by the officials' ability to identify alien vegetation. Some left the indicator blank. The blank indicator could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). This is an indication of the inability to identify alien vegetation.
Continuity of Riparian zone	This varied extensively from y/n and blank observations (captured as "n/a") to none (5 value), fragmented (3 value), and continuous (0 value). Although the site was all in recreational park area the riparian zone on the river banks had been cleared of riparian vegetation. The river channel was interrupted by the failed gabions, head-cut erosion and collapsed pedestrian bridge. The discrepancy in observations is

	based on the official's subjective understanding of a fragmented riparian corridor. The Guideline document has elaborated more and illustrated with photographs the difference between a fragmented and continuous corridor.
Dumping	Most indicated there was none (0 value) or left the indicator blank (n/a value). The material from the failed gabions had been removed from the channel and dumped on the river bank; this was observed by the 2 officials as dumping. The blank indicator could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Litter	Most indicated none (0 value). Those that walked the extent of the site noted 0-10 (1 value) pieces of litter. Where the indicator was blank this was captured as "n/a". The blank indicator could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Macro-channel erosion	Most of the group either indicated 20% (3 value) then >5% (1 value), which is relative to interpretation of scale or measurement. 1 person observed none (0 value) which is an indication of poor understanding of erosion. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it

	was ignored or if it was a 0 score. The variation of measure selected is subject to the official's interpretation of scale or extent of the erosion.
Erosion in S-bends	Where this indicator was completed most of the group observed 11-50% (3 value). Similar to macro-channel erosion, this is subjective to interpretation of scale. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Armouring	This indicator had the most variation in selected measures. These observations varied from natural/vegetated (0 value), exposed soil (5 value), armoured (4 value), occasional (2 value) and toe armouring (1 value). The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score. The "exposed soil" state of the river banks was confused as "natural". There were gabions on a section of the river, and part of the gabions had failed.
Bed erosion	The observations varied. Mainly the wrong descriptions were applied. There was deep incision from the erosion in the river channel. One official noted there was no bed erosion showing a poor understanding of erosion. The discrepancy in the measure of observations was due to subjectivity of the officials' interpretation of "some" versus "deep" incision. It is difficult to attach a quantitative reference to this indicator as all rivers in the country vary and a

	specified quantitative measure could not be applied uniformly. Therefore this indicator is open to subjectivity of the official's observation and interpretation of "deep" versus "some" incision.
State of discharge outlet	This varied based on whether the officials went to observe the discharge outlets or not, if not then they did not observe that there as an outlet. There was a discharge outlet and it was in good condition, i.e. no erosion or sedimentation around the structure and there was no discharge at time of inspection.
Canalising	This observation varied between natural (0 value), blank (n/a value), occasional (2 value) and deeply eroded (4 value). This is limited by the officials understanding of erosion processes and channelization of the watercourse. The site has excessive erosion and down cutting in the river channel resulting in the river being naturally channelized. The guideline document has elaborated more on the difference between the measures.
Levees	Most officials noted no levees or flood bank protection walls. One pair noted a 1m levee, which refers to the height of the gabion structure above the river bank. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Abstraction	Most officials note no abstraction. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was

	a 0 score.
Impoundment	Most officials noted a low flow (2 value) or no impoundment (0 value). The collapsed pedestrian bridge into the river is acting as a low flow impoundment. The blank indicators could be interpreted as a “no response” or “none” (0 value). For the purpose of the testing it was interpreted as “no response” (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Culvert/bridge	The observations varied between a drift (4 value), none (0 value), intermediate (3 value), blank (n/a value) or bridge (2 value). This is linked to scale. As the pedestrian bridge had collapsed across the river it was no longer a bridge but rather a drift across the river. The discrepancy in observations was related to the official’s subjective interpretation of the state of the bridge. The blank indicators could be interpreted as a “no response” or “none” (0 value). For the purpose of the testing it was interpreted as “no response” (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Flood debris	This observation varied between blank (n/a value), none (2 value) or scattered (0 value). Flood debris is not usually intentionally observed by officials, and this resulted in many not recording it in the assessment. The blank indicators could be interpreted as a “no response” or “none” (0 value). For the purpose of the testing it was interpreted as “no response” (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.

Water quality: Colour	Observed colour varied between colourless (0 value), tea (0 value), blank (n/a). These are each scored the same, so the description measurement accommodates the subjectivity into the description and scoring.
Water quality: Odour	Some observations noted no odour (0 value) or not observed (n/a value). The not observed indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none. Some officials noted sewerage (5 value). There was an overflowing manhole in the vicinity of the site contributing to a strong sewerage smell, but the water in the watercourse had no odour.
Water quality: Clarity	This was observed as clearish (1 value) or transparent (0 value). There is a subtle difference which is subject to the officials' interpretation. Reading the list of descriptions will assist in resolving this variation.
Water quality: Temperature	Noted as normal (0 value) or cold (5 value) or blank (n/a value). This is linked back to previous experience of officials, where measuring water temperature, pH, etc., are not regularly carried out by environmental officials but rather water control officers. Officials feeling the water for the first time noted it as cold. The inspection was conducted on a cold winter day which could influence the observation of the water being cold. Section 1 of the Site Inspection Form includes a description of the weather on the day of, and previous 2 days to inspection to record any variables that may influence the measure of indicators such as temperature and turbidity.
Water quality: Foam	Most officials noted no foam present (0 value). The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value).

	In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score. One official noted small foam (2 value). This is linked to the official observing the water in the river. The natural bubbling of the water in its course was noted as small foam. Reading the indicator description will help clarify the measures of description.
Water quality: **pH**	All official's selected the same description. HTH dipsticks were used to indicate the general pH of the water.
Water quality: Hydrocarbon oily sheen	Most of the officials observed no hydrocarbon oily sheen on the water surface. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Water quality: **Nutrients**	Most officials noted there was no nutrients (0 value). Two officials noted there was occasional nutrients (1 value); this was observed in the stagnant water around the reeds. This observation was made by officials that walked the extent of the site and observed the water of the watercourse. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.
Water quality: **Oxygen availability**	Most officials noted that there was oxygen availability. Some officials left this indicator as blank.
Water quality:	Most officials observed this indicator as "none

occurrence of life	observed" (3 value), blank (n/a value) and 1 official observed life. The officials did not consider the invertebrates at the site as an indication of life. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.

iv) One of the biggest contributors to the discrepancy in the results was that many indicators were left blank. The blank indicators could be interpreted as a "no response" (n/a value) or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a actually a 0-value score.

v) The selected measures, where extent or scale/size of impact are concerned had variances due to the official's subjective interpretation of the extent or scale of the impact. This subjectivity is inherent. As a means of mitigation, the indicators are grouped into activities and then the output is a function of the activity-function relationship. This enables several indicators to contribute towards an activity in order to prevent one indicator contributing solely to the output. This system of matrices provides some mitigation against the subjectivity inherent in observations of scale.

vi) A theme that was identified as lacking understanding was erosion. This resulted in the officials' ignoring the indicator despite it being a key issue to identify impacts to the watercourse. It is highly recommended that an introductory course on erosion processes be included in the enforcement training programme. Erosion (processes and impacts) are not limited to contraventions affecting water courses.

vii) Another contributor to variation in officials' observations is the ability to identify alien and invasive vegetation. It is strongly recommended that a

basic course in alien and invasive vegetation identification and management be included in the enforcement training programme. Alien and invasive vegetation infestation is not limited to cases involving water courses, but given the water scarce nature of the country, enforcement mechanisms can and should be used to eradicate or sustainably manage such infestations.

viii) Many of the officials did not walk the extent of the site to make observations, but rather stood in the middle and only noted what they observed from that point. This resulted in them missing key observations such as the discharge outlet, the nutrient accumulation in the lower part of the reach and observations of life i.e. frogs and crabs.

ix) The results of the case study and of the Dashboard Tool demonstrated that the tool is also relevant to the Gauteng officials, and applicable to other river characteristics.

7.4 Case Study 3: Testing with and without training, to test objectivity of the SIC and Dashboard

The aim of this case study was to test the subjectivity in the tool with mixed qualification persons, as well as with and without training. The group, involved in the testing were members of the Cape Wetlands Forum and included an ecologist, fish specialist, environmental manager, general members of the public (lay persons) and the author.

7.4.1 Site location

This case study involved two sites. The first site was located upstream on a wine estate in Lourensford. This is referred to as the Lourensford site. The participants were explained each indicator as the site inspection was conducted. The participant has to select the measure of observation.

The second site assessed was located downstream, at Radloff Park. This second site was assessed by some of the previous group and new participants with no training or explanation. This site is referred to as the Radloff site.

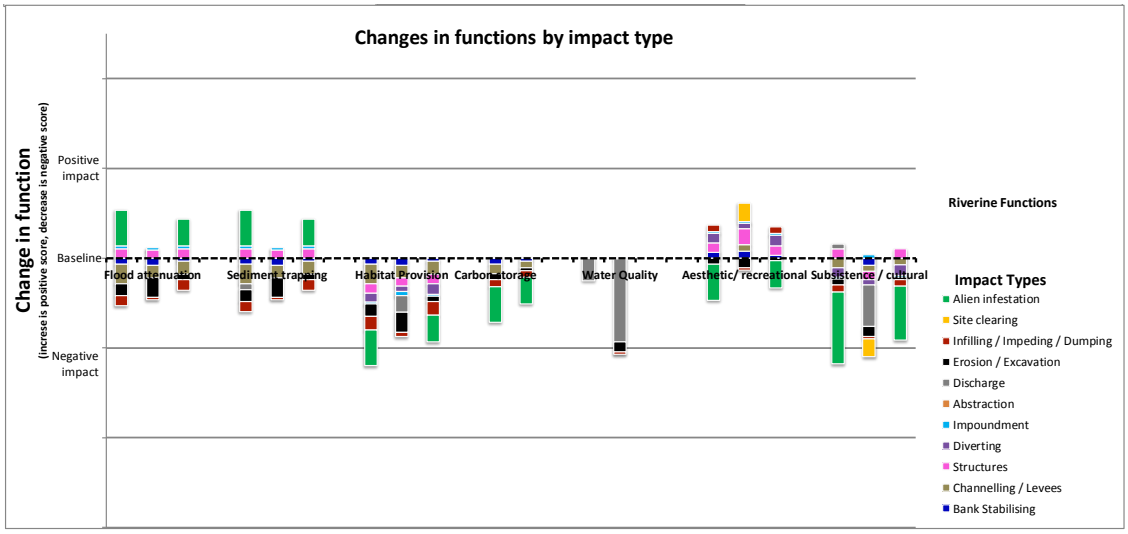
7.4.2 Activities

Lourensford site: The site included a discharge point, site clearing, levee, alien invasive vegetation and a bridge across the river.

Radloff Park site: The site included site clearing, alien invasive vegetation and debris from a recent flood.

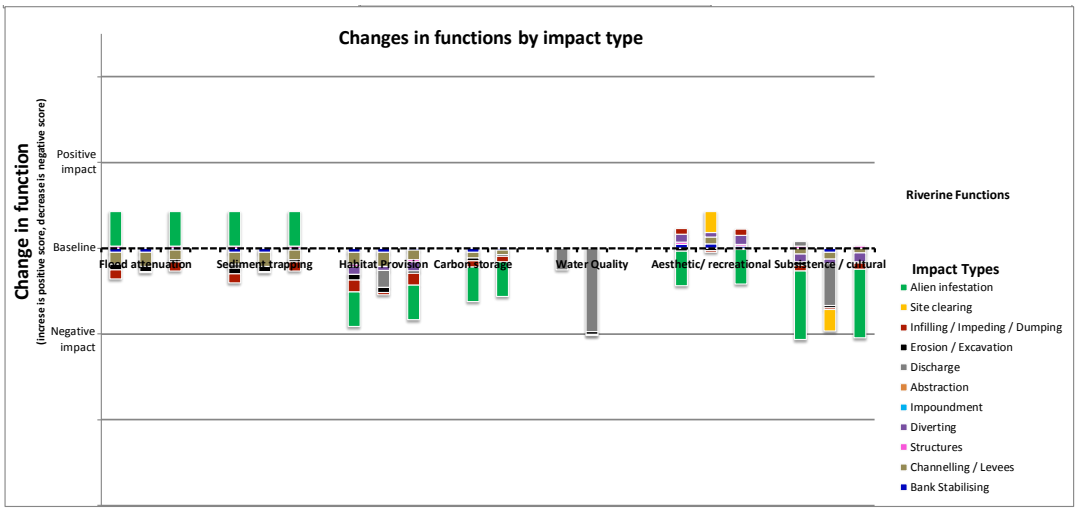
7.4.3 Results: Lourensford Site with training

The Dashboard graphs of the testing team are provided in Figure 7-28 to



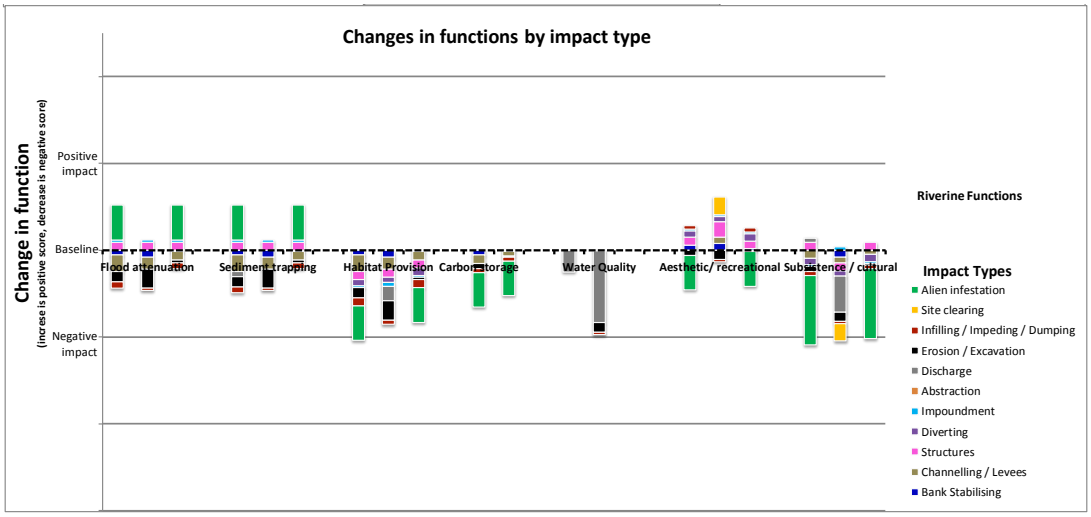
Lourens river, Lourensford Farm

Figure 7-34:



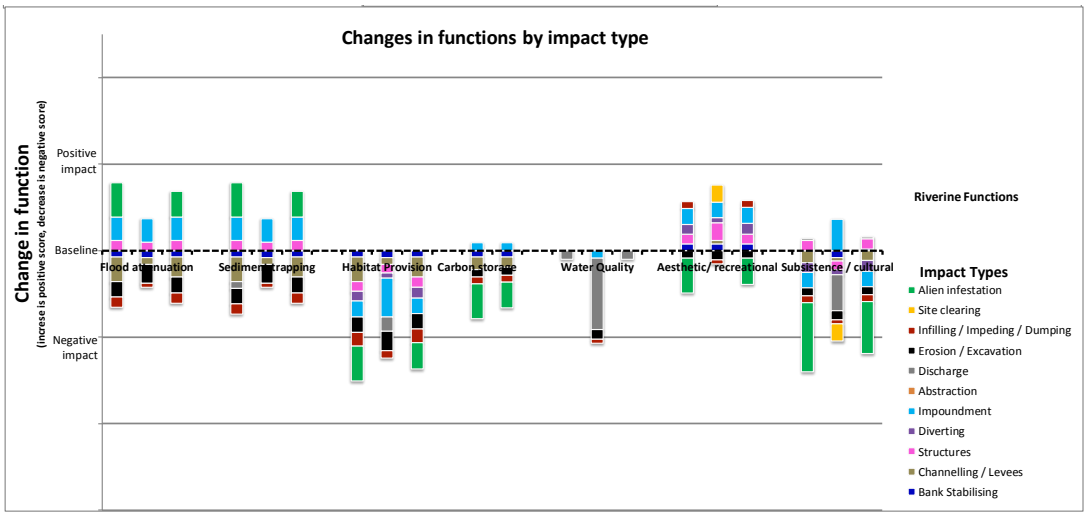
Lourens river, Lourensford Farm

Figure 7-28 Sample 1 - Lourensford Farm site inspection dashboard



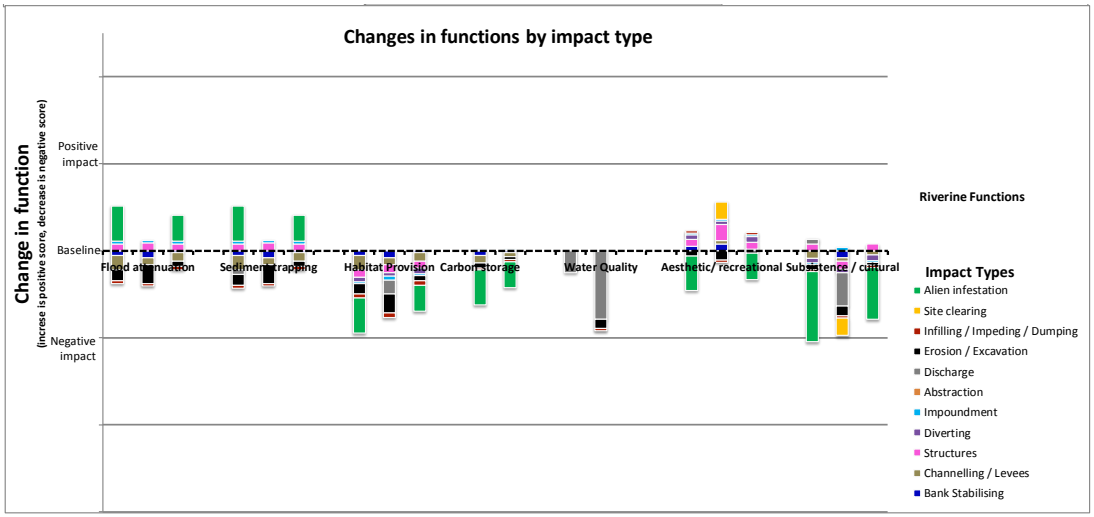
Lourens river, Lourensford Farm

Figure 7-29 Sample 2 - Lourensford Farm site inspection dashboard



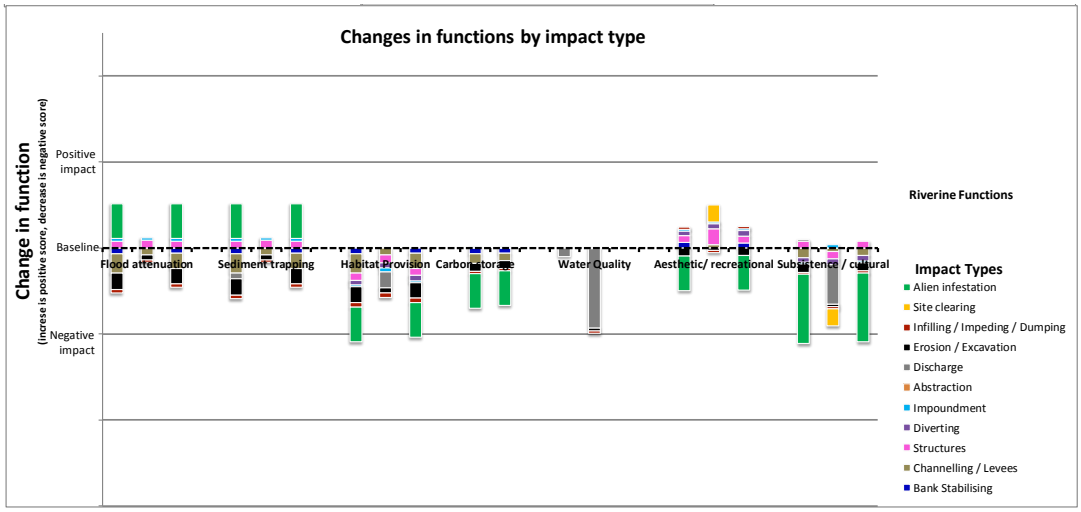
Lourens river, Lourensford Farm

Figure 7-30 Sample 3 - Lourensford Farm site inspection dashboard



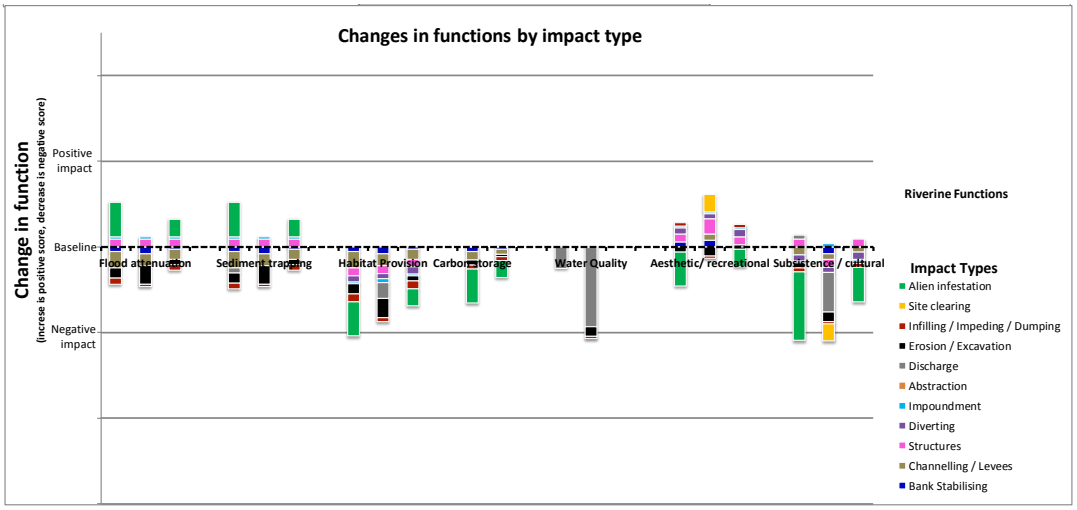
Lourens river, Lourensford Farm

Figure 7-31 Sample 4 - Lourensford Farm site inspection dashboard



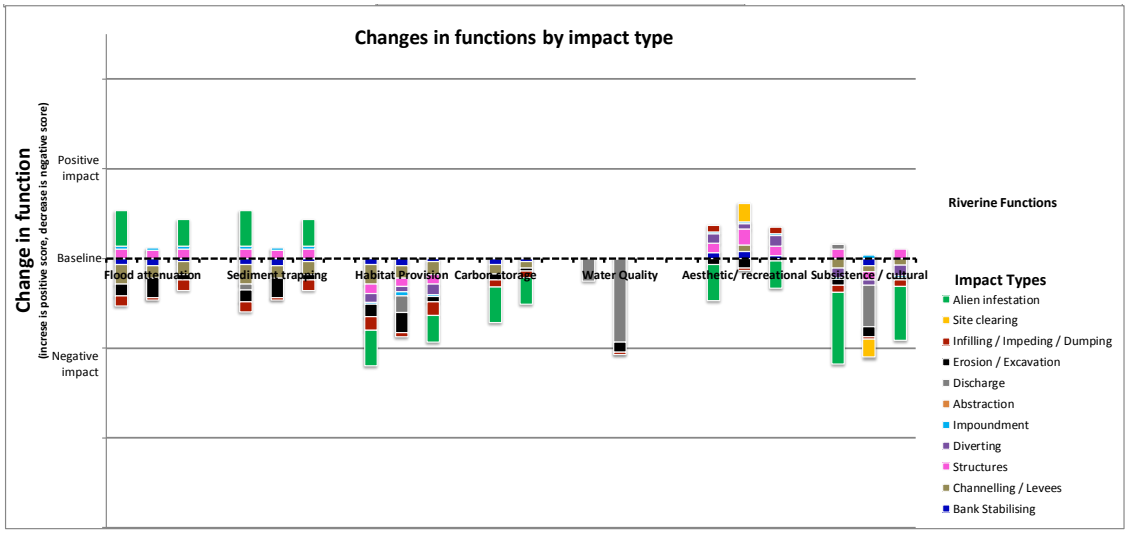
Lourens river, Lourensford Farm

Figure 7-32 Sample 5 - Lourensford Farm site inspection dashboard



Lourens river, Lourensford Farm

Figure 7-33 Sample 6 - Lourensford Farm site inspection dashboard



Lourens river, Lourensford Farm

Figure 7-34 Sample 7 - Lourensford Farm site inspection dashboard

In order to understand the outputs between the samples in more detail and understand the differences in the results, the observations in the checklists were captured into a series of bar graphs. A graph was produced for each indicator that contributes to the Dashboard calculations. The graph indicates the number of officials that selected which description measure for each indicator. This enables the detailed analysis of the non-quantitative data of the Dashboard results. The specific indicators and measures can be reviewed to determine where there is variation in the selected measures. These bar graphs are included in Figure 7-35. The measures are represented on the x-axis as the assigned values in the

Dashboard tool, i.e. 0 represents most natural description and 5 represents most degraded description, and numerical values in between represent degrees of truth from natural. The y-axis indicates the number of officials that selected the particular measure. The selected descriptions for the different riverine components are represented by the blue stack indicating left bank, red stack indicates right bank and green stack represents active channel.

The variability of the scoring was located in the following indicators:

Indicator	Variance in observations
Erosion on site	Most indicated none (0 value), some indicated sheet (1 value) or rill (2 value) erosion. This is based on observation while walking on the site, whether the erosion on the site was observed. There was sheet erosion on the site.
Alien vegetation	The variance was limited to the extent/scale of alien vegetation on the right bank. The selection of measures was 41-60% (4 value), 11-40% (3 value) and 1-10% (2 value). This can be attributed to the person's ability to recognise alien vegetation, and therefore the measure of coverage of infestation. The participants agreed there was alien infestation the discrepancy was in the extent of the site affected by it.
Macro-channel bank erosion	This varied on both banks. This particular indicator highlights a person's subjective understanding of the river channel and the extent/scale of erosion in the watercourse. This indicator contributed the biggest cause for variation in the results.
Bed erosion	Some forms were marked blank (n/a value) or none (0 value), and some indicated there was some incision (2 value). Again this can be attributed to a person's understanding of erosion processes in a river and observations.
State of discharge outlets	1 participant marked the discharge outlet on the right bank instead of the left bank, resulting in a variation of results in the right bank graphs. For the left bank graphs, all the participants agreed there was a discharge outlet, however their interpretation of the state of it varied between poor (5 value) and good (2 value). The guidelines have elaborated to include pictures and issues that deem an outlet in a poor state. The state of the outlet on the site was of a poor condition, with the discharge undercutting the outlet structure.

Levees / flood protection banks	This indicator also had significant variance in its observations, with measures across the spectrum. The majority of the participants observed the levees under the vegetation, the discrepancy was in the height of the levee banks. The height of the bank was subjective to a person's ability to determine height or scale. The levees were 1-2m.
Water quality: Foam	1 participant noted no foam (0 value) in the watercourse, the rest of the participants noted some foam (2 value). This variance in observation was noted by the 1 participant not walking around the site for the inspection.
Water quality: Nutrients	Most of the team observed no evidence (0 value) of nutrients in the water. Two team members observed evidence of occasional nutrients (1 value). The nutrients noted were natural brown rock algae.
Water quality: Occurrence of life	Most of the participants observed no signs (3 value) of life during the inspection and 2 participants noted some life. The weather conditions on the day i.e. raining, may have been a contributing factor.

Figure 7-35 Series of bar graphs indicating the observations per indicator of the Lourensford inspection.



i) The indicators of ground cover type, riparian zone continuity, % dumping, pieces of litter, erosion S-bends, canalisation, abstraction, impoundments, flood debris, water quality: colour, water quality: odour, water quality: clarity, water quality: temperature, Water quality: pH, water quality:

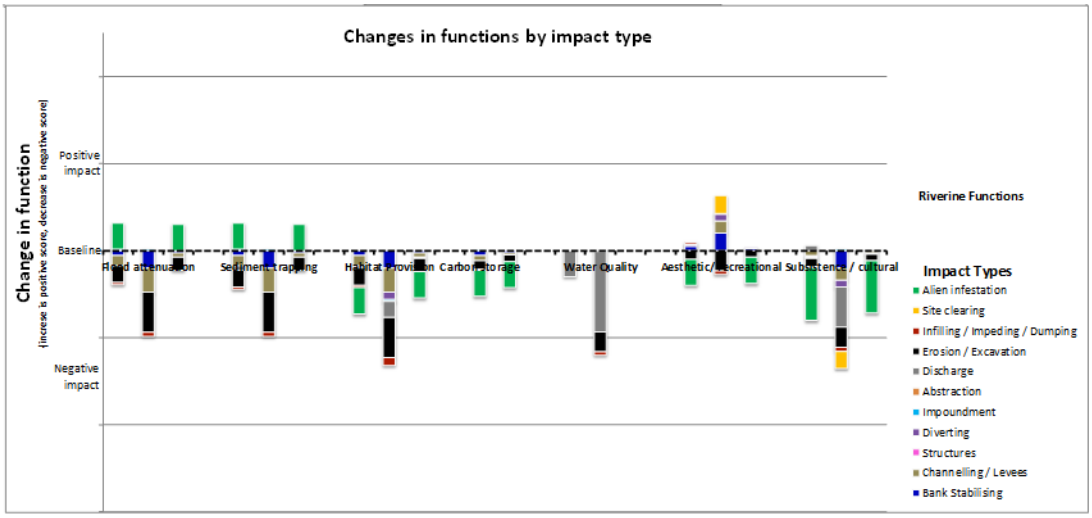
hydrocarbon oily sheen, and water quality: oxygen availability all had uniform observations.

ii) The discrepancy in the indicators of bank armouring and bridges/culverts is attributed to some of the participants leaving the indicator blank. The blank indicators could be interpreted as a "no response" (n/a value) or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a actually a 0-value score.

iii) All the Dashboard indicated the main functions being negatively impacted were habitat provision, water quality and subsistence/cultural. The extent of impact to function varied slightly between the Dashboards, this is as a result of the variance in scale of impacts observed by the test team, i.e. extent of macro-channel bank erosion, extent of alien vegetation infestation, height of flood prevent bank. The Dashboard does not provide a quantitative output therefore the subjectivity in observing scale does not affect a numerical score of the site. The extent of impact may vary between officials' observations, but the point of the tool is to identify which functions are being impacted. The trend of the outputs of the Dashboards were similar and therefore the same issues and recommendations could be made from each of the results.

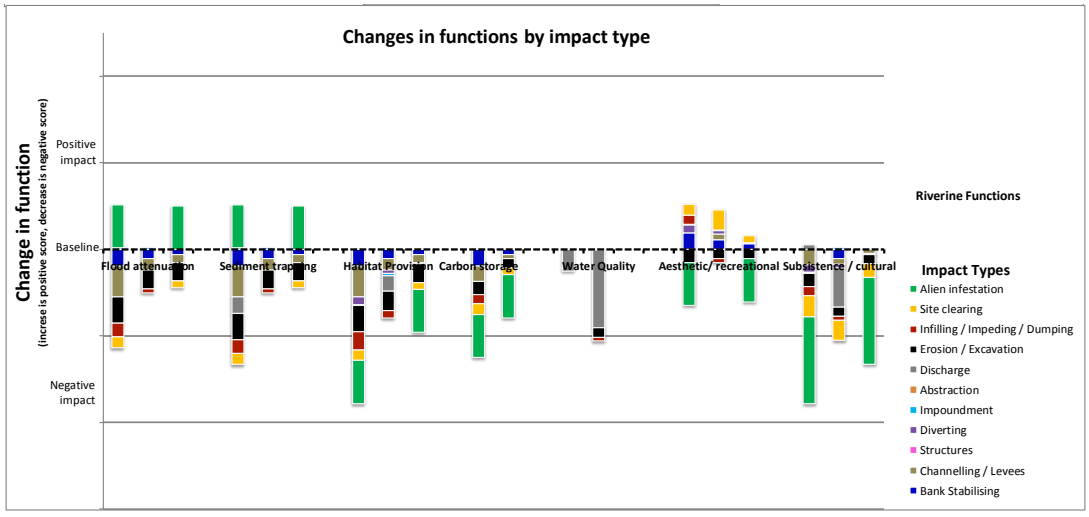
7.4.4 Results: Radloff Park Site without training

The dashboard graphs of the case study samples are provided in Figure 7-36 to



Radloff Park

Figure 7-41.



Radloff Park

Figure 7-36 Sample 1 - Radloff Park site inspection dashboard

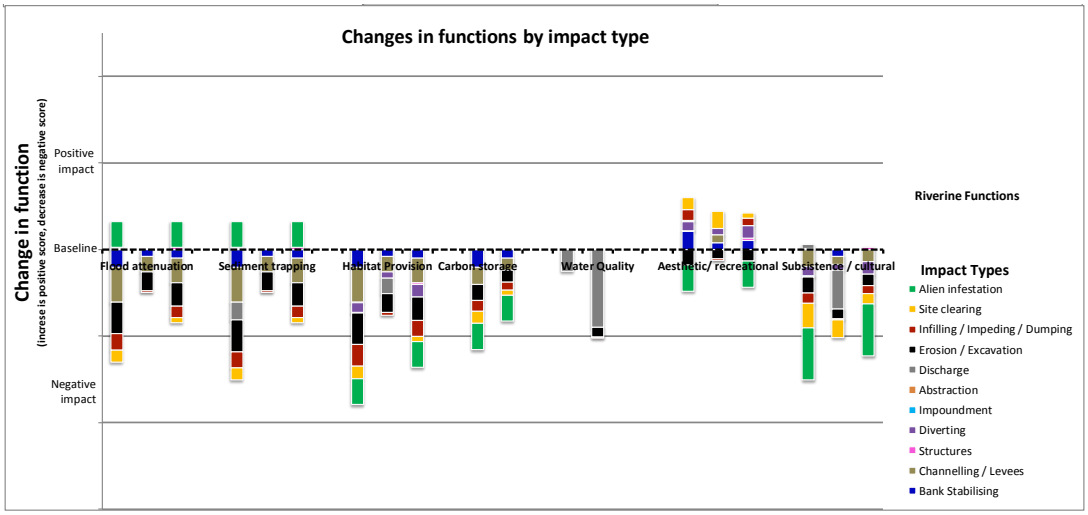


Figure 7-37 Sample 2 - Radloff Park site inspection dashboard

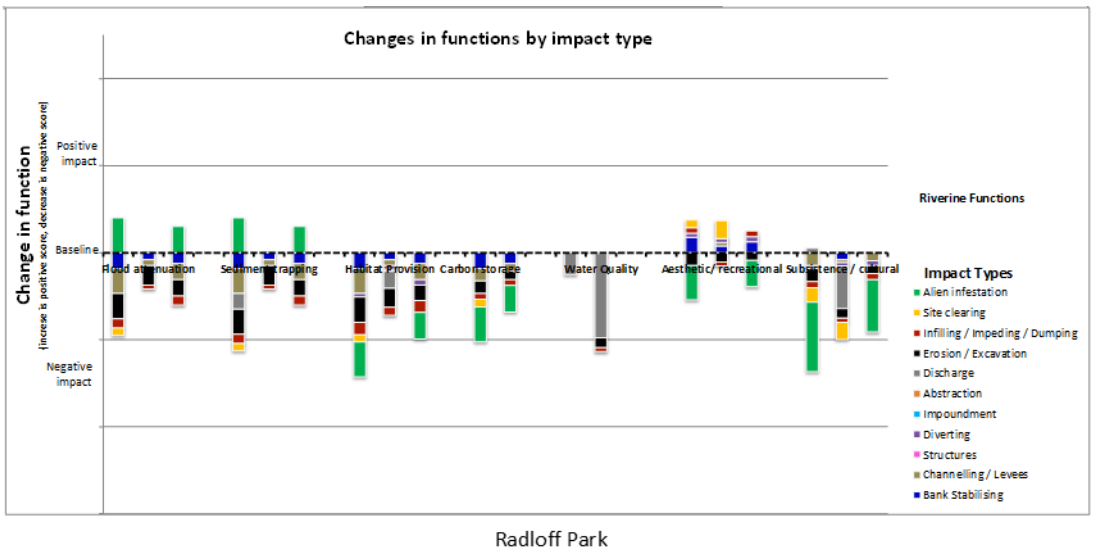


Figure 7-38 Sample 3 - Radloff Park site inspection dashboard

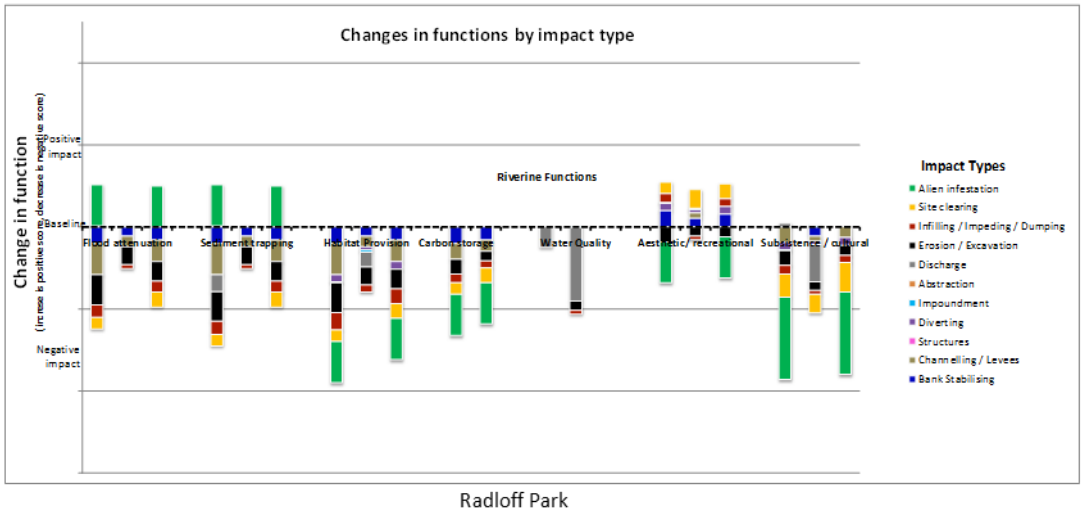


Figure 7-39 Sample 4 - Radloff Park site inspection t dashboard

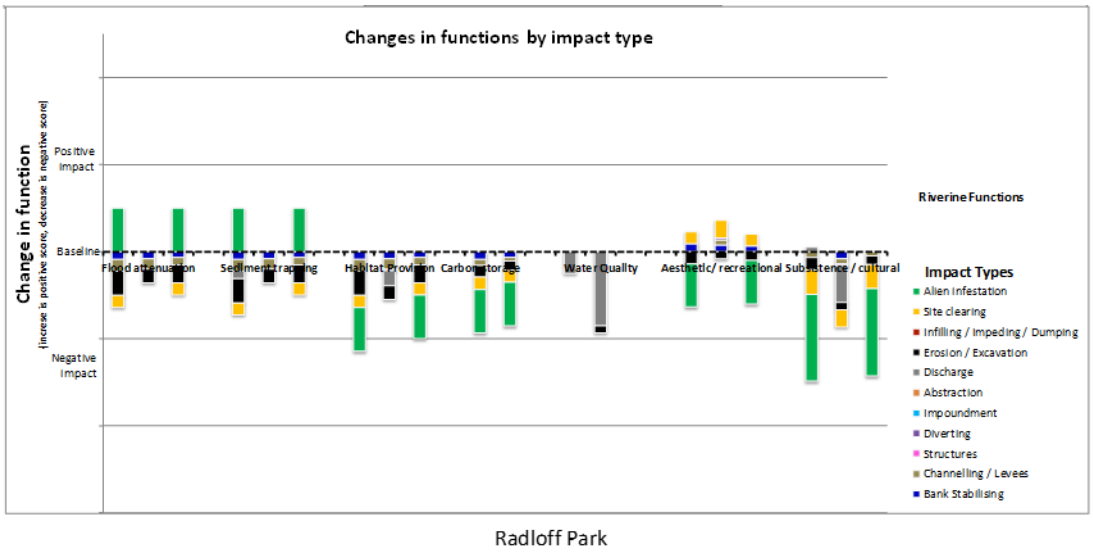


Figure 7-40 Sample 5 - Radloff Park site inspection dashboard

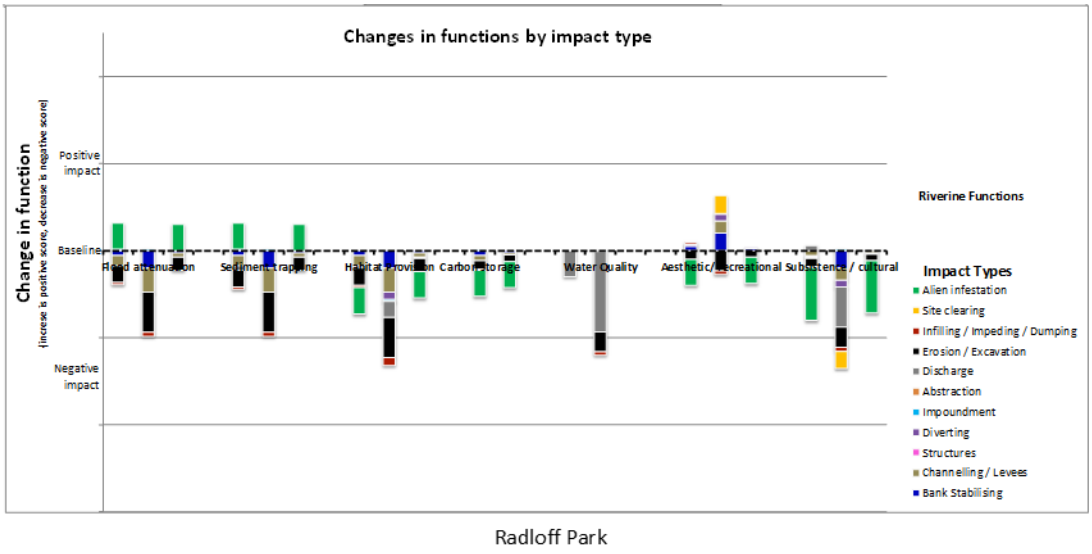


Figure 7-41 Sample 6 - Radloff Park site inspection dashboard

The findings from the second site of Radloff Park, include:

i) In most of the indicators, the observations and scoring were generally regular. There was one participant (without training) that tended to vary in their observations, usually linked to scale of impact, refer sample 6. Scale of impact will remain a subjective interpretation, as the measure of scale will vary between sites. This subjectivity is accommodated in the tool by the relationship matrices.

ii) The trend line of the first 4 Dashboard graphs are similar. These four participants were part of the first site inspection and training (Lourensford site). There is variation in sample 5 and more so in sample 6, both of which had not received training.

iii) The observation measures for the indicator of water quality: odour varied between none (0 value) and bank. The blank indicators could be interpreted as a “no response” or “none” (0 value). For the purpose of the testing it was interpreted as “no response” (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score.

In order to understand the outputs between the samples in more detail and understand the differences in the results, the observations in the checklists were captured into a series of bar graphs. A graph was produced for each indicator that

contributes to the Dashboard calculations. The graph indicates the number of officials that selected which description measure for each indicator. This enables the detailed analysis of the non-quantitative data of the Dashboard results. The specific indicators and measures can be reviewed to determine where there is variation in the selected measures. These bar graphs are included in Figure 7-42. The measures are represented on the x-axis as the assigned values in the Dashboard tool, i.e. 0 represents most natural description and 5 represents most degraded description, and numerical values in between represent degrees of truth from natural. The y-axis indicates the number of officials that selected the particular measure. The selected descriptions for the different riverine components are represented by the blue stack indicating left bank, red stack indicates the right bank and green stack represents active channel.

Figure 7-42 Series of bar graphs indicating the observations per indicator of the Radloff site inspection.



The variability of the scoring was located in the following indicators:

Indicator	Variance in observations
Groundcover	The main difference was as a result of not a distinguishing between vegetated (0 value) and kikuyu grass (1 value). There was sections of compacted exposed soil (3 value) as well. All three descriptions are accurate, the variation is in the interpretation of extent/cover of each of the ground cover types.
Erosion on site	Most of the participants recorded rill erosion on site. One participant recorded gully erosion on the right bank and one recorded none on the right bank. This discrepancy in interpretation of scale of erosion is subjective to the participant's scale understanding of erosion.
Alien vegetation	All the participants observed there was infestation of alien or invasive vegetation. The extent of cover of the infestation varied due to subjective interpretation of scale. This is also linked to a person's ability to identify alien and invasive vegetation. The Guideline document includes a section on species identification in order provide reference material in the field.
Continuity of riverine zone	There was some variability as to whether the riparian zone was fragmented or continuous. The challenge arose from the break in vegetation with compacted soil. The guidelines document has elaborated with photos of continuous and fragmented riverine zones.
Dumping and rubble	This was variable on the left bank between 0-10% over 100m (1 value) and none (0 value). This was influenced by extent of observation carried out on the site. Dumping in the channel and right bank are observed uniformly.
Pieces of litter	The right bank and active channel were observed uniformly. There was 1 participant that observed 0-10pieces of litter (1 value).
Macro-channel erosion	All the participants agreed there was some macro channel erosion, however the extent of the erosion was variable. This is linked to ability to interpret scale or

	measurement by observation.
Extent of S-bend erosion	All the participants noted there was erosion in the S-bends or cut banks. The variation arose with the extent of the erosion. Again this is linked to subjective interpretation of scale.
Bank armouring	The observations were split between exposed soil (5 value) and blank (n/a value). This will be rectified when officials complete the site form electronically. The observation of none was linked to officials only looking for formal bank armouring e.g. concrete walls or armourflexing.
Active channel (Bed) erosion	Most noted some, one noted deep channel erosion. This is linked to ability to interpret scale. At the time of inspection the river was in spate and the extent of bed erosion was not clear.
Canalisation	This varied between deep erosion (4 value), occasional erosion (2 value) and blank (n/a). The variation was linked to team members understanding that erosion can cause canalisation and not just formal engineered canalisation.
Levees / flood protection banks	Majority of the participants left this indicator blank. The blank indicators could be interpreted as a "no response" or "none" (0 value). For the purpose of the testing it was interpreted as "no response" (n/a value). In the electronic form the officials will be required to select a description, even if it is none, this will clarify whether a blank description is because it was ignored or if it was a 0 score. One team member observed a flood bank on either side of the river.
Flood debris	Majority of the participants observed no flood debris. One participant noted the debris as being scattered.
Water Quality: Colour	There was variation in the interpretation of the colour between brown, tea and milky. The water was still highly turbid from the flood resulting in subjective interpretation of the colour. Both brown and milky were suitable descriptions. The colour milky has been

	changed to prevent confusion with turbidity.
Water quality: Clarity	Most participants noted the clarity as cloudy (2 value), one noted it as clearish (1 value). This is linked to experience in observing / measuring clarity of water. All participants noted that the water was turbid, the extent of turbidity was subject to the participants' personal scale of reference.
Water quality: Foam	The variation in observation was based on the participants walking the extent of the site. Those that did walk the extent noted some foam, those that did not, did not observe the foam.
Water quality: Occurrence of life	Most participants observed no occurrence of life. This may be influenced by the weather and river in spate. Only 1 participant observed life.

iv) The indicators of discharge outlets, abstraction, impoundments, culverts/bridges, water quality: temperature, water quality: pH, water quality: hydrocarbon oily sheen, water quality nutrients, and water quality: oxygen availability were each scored uniformly by all the participants.

v) There was reduced variability in the scoring after the training. The Guideline Document that has been produced (Braid, 2014) will assist in this regard for officials that have not yet been on training.

7.5 Case Study 4: Status Quo – Bryanston Bicycle Park

Case study 4 refers to the Bryanston Bicycle Park, which was described in Chapter 5. Chapter 6, Phase 1, Step 3 of the comparative review of existing riverine assessment tools included testing the selected tools on the case study site of the Bryanston Bicycle Park. To complete the comparison of river assessment tools the Site Inspection Checklist and Dashboard Tool were also assessed on the Bryanston Bicycle Park Site, on the same day as the other methodologies in order to ensure the same testing conditions.

7.5.1 Site Inspection Checklist and Dashboard Result

The most significant impact on the site was a result of the erosion due to the increasing stormwater runoff and the widening of the stream channel. However these impacts were “lost” in the enforcement process as the process focused on the legal box-ticking. As an example of how the tool could have guided the process better, a Site Inspection Form was completed at the site of the severe gully erosion, downstream of the N2 culvert and the Dashboard graph, Figure 7-43, was produced for the site.

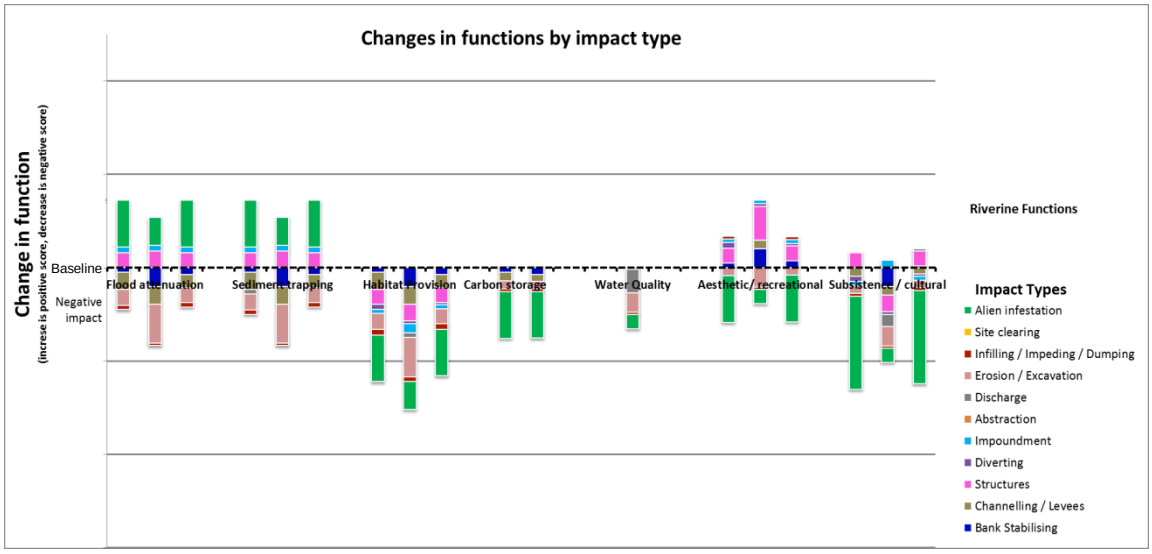


Figure 7-43 Dashboard of Bicycle Park erosion gully

Based on the graphs in the Dashboard, the function of Habitat Provision has been the most impacted function followed by flood attenuation, and sediment trapping. The socio-economic function of subsistence/cultural functions have also been impacted on the site. The site is not used for subsistence or cultural practices, but it is used for social and recreational use. The main activities contributing to the negative impacts are alien vegetation infestation and erosion, channelling and structures (in this case the structure is the stormwater culvert under the N2 highway not the wooden bridges). Removal of the wooden bridges or receiving authorisation for the bridges will not remediate these functions. However addressing the erosion on site would remediate these functions. Identifying the negative impact on habitat provision as the objective of the rehabilitation, would have guided the Bicycle Park and its specialists more constructively in developing the rehabilitation plan, rather than just the legalising of the activities. The legal aspect of the bridges and excavation could still have been dealt with, but would not have been the focus of the rehabilitation plan. This outcome is supported by the specialist, who highlighted that: “The channel incision in the river, caused by

erosion, was the major problem on the site. The wooden bridges were not contributing to the site degradation. Rehabilitation activities should include addressing flood attenuation" (Rountree pers comm.).

By comparison with the results of the other river assessment methodologies (refer Appendix A):

- The River Habitat Assessment (Quinn, 2003) classed the site as **Fair and requiring major rehabilitation**.
- The EcoClassification of the catchment has an Ecostatus of **Poor**, especially as a result of increased urban runoff, altered natural vegetation and poor water quality from sewerage.
- River Habitat Survey, the site only scored **23 points** for habitat provision.
- Stream Visual Assessment Protocol indicated that the site was **Poor.**

In comparison with these assessments the results of the Site Inspection Checklist and Dashboard Tool are in keeping with the results and findings. The site is in poor state; in particular habitat provision has been negatively impacted. The site requires major rehabilitation, especially from runoff erosion.

7.6 Conclusions

"Selecting indicator answers is subjective, but it provides the necessary consistency for comparisons" (EA, 1998:14). Objectivity was specifically tested throughout the case studies. Where applicable, subjectivity was catered for in alterations to the tools as a result of the case study testing, for example incorporating the indicator-activities matrix. The main opportunity for subjectivity that still remains in the tool, but is mitigated through the matrices systems, is a person's interpretation of extent or scale of the indicator on the site. There is no measure of extent that can be applied uniformly across all case sites. The measure of extent of indicators is based on a basic observation, i.e. a little bit, a quarter of the site, half the site, or more than half the site. This simple measure can be applied to any assessment site.

In testing of the tools, it was identified that two specific courses: that of basic erosion (processes and impacts), and alien vegetation identification and management should be carried out amongst enforcement officials.

Future development of the tool can develop more fine-scale refinement of the tools by comparing completed checklists with a database of reference conditions.

However for the objective of providing the enforcement officials with guidance towards identifying appropriate rehabilitation needs on case sites, the Site Inspection Checklist and Dashboard tool adequately meet this objective. Furthermore, the tools can be applied to all river-related sites and are not limited to enforcement sites specifically.

8 SUMMARY, CONCLUSION AND RECOMMENDATIONS

8.1 Summary

Chapter 1 of this research outlined the motivation, context, and structure of the research. The specific problem statement of the research was to determine whether the South African water resources management regulatory governance framework is achieving its constitutional responsibilities in respect of Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996. If not, then to identify how to make enforcement-driven rehabilitation of water resources more appropriate to achieving its constitutional responsibilities.

The specific aims of the study were to:

1. Review the concepts of the environmental right, sustainability, Integrated Water Resources Management (IWRM), riverine function, good governance, and enforcement-driven rehabilitation;
2. Conduct a critical evaluation of the water resources management regulatory framework and identify operational challenges to implementation of the regulatory framework;
3. Propose recommendations to address the operational challenges; and,
4. Use applied research to identify or develop pragmatic (practical, user-friendly) tools to assist enforcement officials to set appropriate rehabilitation objectives in the compliance and enforcement process.

Chapter 2 introduced key concepts that formed the theoretical foundations for this thesis. These included the environmental right, integrated water resources management, riverine function versus river health, good governance and enforcement-driven rehabilitation.

In order to achieve the environmental right, minimum standards for ecological function need to be identified, implemented, monitored and adhered to. This will ensure the sustainability of the ecosystem functions to support the environment both for now and the future.

Monitoring and achieving these standards requires a regulatory framework to be in place. This regulatory framework consists of a number of components, i.e. legislative, institutional and management measures, all of which need to exist to

ensure compliance with the minimum standards. Where non-compliance occurs, remedial action such as rehabilitation is needed. Enforcement-driven rehabilitation is as important as proactive management for the achievement of the environmental right, i.e. an environment that is protected so as not to be harmful to our health and wellbeing. Building on the theoretical foundations the following questions were raised:

i. What is the water resources management regulatory framework?
ii. Is it good environmental governance?
iii. Is the environmental right, Section 24 of the Constitution, being achieved?

Chapter 3 laid out the South African regulatory framework for water resources management, in the context of compliance and enforcement. The regulatory framework is comprised of three components, those of:

i. An Enabling Environment – this includes the legislative measures, such as the Constitution, National Environmental Management Act, Act 107 of 1998 (NEMA) and the National Water Act, Act 36 of 1998 (NWA), national principles, policies, regulations and resource management strategies;

ii. Institutional Roles – this includes the various administrative organisations tasked with implementing the legislative measures and developing and implementing the management instruments. Examples of these organisations are: the National, Provincial or Regional Departments of Environment or Water Affairs respectively.

iii. Management measures – these include the "operational instruments of effective regulation" (GWP, 2000:30), such as plans, procedures, methodologies, management objectives, strategies, and tools for their implementation.

In particular the NEMA and NWA are tasked with translating the environmental right enshrined in Section 24 of the Constitution into resource management legislation that then enables the practical implementation of sustainable resource utilisation and protection. The NEMA applies an anthropocentric approach to its framework structure i.e. placing people at the centre of its policy; whereas the NWA applies an eco-centric approach, placing water resources at the centre of its policy. The principles of these statutes clearly identify the role of remedial (rehabilitation) activities as a component of sustainable resource utilisation and

management; however this role is not carried through in the actual sections of the legislation. Similarly, the enforcement mechanisms provided by the legislation are appropriate, but the crucial sections lack guidance in terms of actually identifying the ecological impacts as a result of contraventions and requiring the compulsory rehabilitation of these impacts.

Having set out the regulatory framework in prior chapters, Chapter 4 contains a critical evaluation of this regulatory framework against the foundations of good environmental governance. The regulatory framework in the context of its three components (enabling environment, institutional roles and management measures) was reviewed against indicators of relevance, appropriateness, responsiveness, adequacy, effectiveness, capacity, capability, accountability, reporting and achievement in considering if the framework was contributing to the achievement of Section 24 of the Constitution. The evaluation found that the regulatory framework is well structured despite requiring some amendments; however it is limited by its implementation. There is insufficient focus on the role and contribution of rehabilitation, both proactive and enforcement-driven, to contribute towards the achievement of Section 24 of the Constitution; it is important that this is remedied in the legislation.

Similarly, the role of rehabilitation also needs to be accommodated in the institutional structures. The judiciary holds the enabling environment, institutional roles and management instruments accountable for achieving the environmental right, even within the context of compliance and enforcement. Therefore the role of compliance and enforcement in achieving the environmental right is acknowledged. However the actual implementation of the framework in terms of responsiveness, adequacy, effectiveness, capacity, capability and reporting require some attention. The evaluation concluded that currently the regulatory framework is not contributing to the achievement of Section 24 of the Constitution.

Chapter 5 outlined the operational status quo of compliance and enforcement processes in terms of the NEMA and NWA with regard to water resources; this was also illustrated through the case study of the Bryanston Bicycle Park. The two main challenges identified, were:

i. The enforcement officials and the compliance and enforcement process are mainly focused on correcting the legislative contravention, and less focused on rehabilitating the ecological degradation as a result of the

contravention, thus this degradation is not being addressed or effectively rehabilitated; and

ii. Specialists are brought into the enforcement process too late, usually only after the warning notice has been issued.

Considering these challenges and the outcomes of the critical evaluation of the regulatory framework, Chapter 6 used applied research to develop tools to assist the enforcement officials to improve their effectiveness, especially in terms of enforcement-driven rehabilitation. Three tools were developed:

i. The Legislation Search Tool (LST): provides a searchable database of all the applicable environmental legislation to rivers. The database enables the official to search by specific section of legislation or by search word. The search highlights all the relevant adjacent legislation and institutions responsible for the overlapping or adjacent sections of legislation.

ii. The Site Inspection Checklist (SIC): Development of this tool was two-fold. As river rehabilitation is a common phenomenon around the world, several guidelines have already been developed for conducting river assessments. Firstly, a comparative analysis was conducted of existing assessment methodologies to determine if they could be applied to the South African enforcement screening process, with the aim of being a tool to support enforcement officials identify impacts and rehabilitation objectives. None of the tools assessed were suitably appropriate. Therefore, secondly, a specific tool was developed to provide a uniform record of site inspection and site characterisation that can be understood by “laypersons”, and across institutions and officials. The indicators to be answered on the form guide the officials to specifically observe particular aspects of the site and resultant impacts. The form was developed through applied science and research of existing assessment methodologies applied to the enforcement context. The indicators are answered by selecting the appropriate description from a list of prescribed descriptions.

iii. The Dashboard Tool (DT): using the descriptions selected in the SIC to describe the site, values are assigned to the description measures. These are then computed through matrices of relationships (between indicators and activities and between activities and riverine functions) to produce an output of Dashboard graphs. In particular the key output

graph provides an illustrative indication of the impacts the activities of the site are having on the potential of the site to provide ideal riverine functions. This graph informs the enforcement official what specialist studies should be requested, and what functions and impacts should be addressed in the rehabilitation plan.

The Site Inspection Checklist and Dashboard Tool were tested amongst various enforcement and other officials and updated and adjusted through an iterative process. The key case studies were presented and discussed in Chapter 7.

8.2 Specific findings from the research

Specific findings, observations and issues identified from the research are grouped according to the component of the regulatory framework that they relate to, i.e. the enabling environment, the institutional structures, management instruments, or general.

8.2.1 Enabling environment issues

i. The NEMA and NWA legislation does not specifically provide for the redress of past poor management and environmental degradation. The NEMA section 28(1A) makes provision for issuing a directive in terms of duty of care for impacts as a result of past actions. However where there is no juristic or natural person to issue the directive to, the Department of Environmental Affairs will be responsible for the rehabilitation, in terms of section 24(7). The NEMA should include a particular section or chapter to specifically address rehabilitation of the environment, providing sections on requirements of a rehabilitation plan and monitoring plan. A well-structured rehabilitation plan outlines the target impacts to be rehabilitated, the objectives of the rehabilitation, the method of rehabilitation, an implementation plan of rehabilitation and a monitoring plan against which to monitor progress, implementation and improvement as a result of the rehabilitation, should be a standard request in enforcement based administrative notices. The detail of such plans will be populated by the specialist studies.

ii. The NEMA and NWA legislation lack important definitions, in the context of compliance and enforcement, for example “effect”, in terms of “effect of

the incident" is not defined. This opens a gap for subjective interpretation, for example that "effect" is limited to effects on the site as a result of the incident rather than the cumulative effect on the environment as a result of the incident over time. These definitions should be inserted into the legislation.

iii. Watercourses, in particular, are systems in the environment; therefore impacts may accumulate downstream of contravening activities. The enforcement sections of NEMA (section 31L) and NWA (section 53) do not require an assessment or identification of the impacts or extent (scale, duration, location) of the impacts of contravening activities. Where impacts are identified as a result of contravening activities, these are usually limited to what has been observed by the enforcement official during the site inspection. Similarly, impacts as a result of activities upstream (contravening or otherwise) may also contribute to the cumulative impact of the activities on the particular site. In the example of the Bryanston Bicycle Park, the widening of the stream would have resulted in some erosion and incision of the channel. However, the change in landuse of the upper catchment and resultant increased directed stormwater flow increased the extent of erosion and degradation on the site.

iv. The two key enforcement mechanisms, NEMA section 31L and NWA section 53(1) do not specifically include the requirement for the rehabilitation of resultant environmental degradation from contravening activities. These sections focus on rectifying the contravention or breach in law, but not the effects of the contravention. This is a key gap in the enforcement legislation. Despite the improvements in criminal measures, Craigie (2005:54) points out that one of the noted shortcomings of enforcement tools, that the criminal measures fail to address, relates to the environmental harm caused as a result of the offence.

v. The proactive (licensing and permitting) sections of the legislation are prescriptive in their composition requiring detailed assessments of the impact of potential activities (refer NEMA sections 23(2)(b), 24(4)(a)(iv) and 24G(1)(i)). However, the enforcement sections provide minimal

requirements; only NEMA section 28(4) includes provisions for the identification and assessment of impacts as a result of contravening activities. NEMA section 31L and NWA section 53(1) require no identification or assessment of the extent of the effect/impact of contravening activities. This limits the effectiveness of enforcement-driven rehabilitation to the specific requirements requested by the enforcement official and what they have observed during the site inspection. The NEMA section 31L and NWA section 53(1) should be amended to include specific provisions for the identification and assessment of the extent and significance of impacts/effects of contravening activities, similar to the following NEMA sections:

- NEMA Section 24G(1)(i) assessment of the nature, extent, duration and significance of the consequences of or impacts on the environment of the activity including the cumulative effects;
- NEMA section 23(2)(b) identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities; or
- NEMA Section 24(4)(a)(iv) investigation of the potential consequences of or impacts on the environment of the activity and assessment of the significance of those potential consequences or impacts.

This will enable all affected parties to work from the same information and understand what impacts the rehabilitation plan needs to address. Furthermore, the provision must include the compulsory requirement of rehabilitating the identified effects/impacts. These impacts should not be limited to bio-physical impacts but should also include social, economic, cultural and heritage impacts.

vi. In the case of the Bryanston Bicycle Park, there were several parties and activities that were contributing to the excessive erosion of the stream channel through the wetland. The Bryanston Bicycle Park did widen the channel in some parts, in the belief that this would reduce the flooding on the property. The directed municipal stormwater into the stream and

wetland from the new developments in the catchment resulted in increased flows into the stream and wetland. This, coupled with the widened channel, resulted in the excessive erosion of the stream channel through the wetland. The enforcement process only focused on the Bryanston Bicycle Park's activities, without considering the role or impact of the increased stormwater onto the site. Similarly, without considering the role of the stormwater in the impacts on the site, the enforcement process was placing all the responsibility on the Bicycle Park to rehabilitate the stream. The rehabilitation would need to accommodate the increasing stormwater on the site without apportioning responsibility to Jo'burg Roads Agency (JRA), whose mandate is the management of the stormwater.

vii. The enforcement process, as described in Figure 5.1, does not make provision for integrated enforcement action across several independent transgressors. It requires a unilateral process to be applied against each individual transgressor. The increased directed stormwater is not an illegal activity, however the resultant impact would fall within the ambit of NEMA section 28 Duty of Care and require rehabilitation, where the juristic person would be the Jo'burg Roads Agency.

8.2.2 Institutional roles issues

i. The structures of the institutions involved in water resources management, DEA, DWS and other spheres of government are aligned with the sections of the legislation, and proactive management of the resources. There is no component that focuses on rehabilitation specifically. A dedicated rehabilitation component should be established to identify rehabilitation needs in the area of jurisdiction, to set rehabilitation objectives, design rehabilitation plans, implement rehabilitation projects and qualitatively monitor the outcomes of the rehabilitation, whether initiative-driven or enforcement-driven rehabilitation. Such a unit could address the rehabilitation needs of retrospective environmental degradation, especially cases where the State is now accountable for such rehabilitation. It could also provide assistance and support to initiative-driven and enforcement driven

rehabilitation projects, especially in terms of planning, setting objectives and providing technical guidance.

ii. The involvement of in-house specialists (aquatic ecologists, botanists, etc.) in compliance and enforcement cases can be restricted by the availability of these specialists by their primary Conservation Directorate-based work requirements. From the author's experience working in the sector, the in-house specialists are only consulted to review the submitted rehabilitation plans, but not to guide the development / request for rehabilitation plans. It is suggested that a dedicated ecologist work with the compliance and enforcement units to discuss cases with officials prior to issuing of warning notices, to ensure the instructions contained in the administrative notices include appropriate rehabilitation requirements. This will also provide in-house training and experiential learning to the compliance officials for future cases.

iii. There is insufficient capacity and capability within the institutional bodies in general, and especially in the compliance and enforcement sector. This limits the implementation of the regulatory framework, and thereby limits its effectiveness in contributing towards Section 24 of the Constitution. There is a need for more administrative support to the existing capacity. This is not limited to training, as officials tend to change jobs once they have received training, but should include tools, processes or mechanisms to support decision making and assist the existing contingent of enforcement officials in their day to day functions are needed, in order to ensure improved effectiveness of the compliance and enforcement sector.

iv. There are several overlapping statutes affecting water resources. There are a variety of institutions at the different spheres of government tasked with enforcement of their respective legislation. This leads to fragmentation of enforcement efforts. A suggestion to overcome this fragmentation is to develop a central agency with officials that are mandated in all the environmental legislation. This will reduce overlaps/gaps in mandates, reduce fragmentation of efforts, and enable more effective enforcement and holistic rehabilitation of environmental

degradation. Furthermore, increasing the powers of existing officials to enforce all environmental legislation will increase the capacity (volume) of enforcement officials to carry out compliance and enforcement activities, which was identified as a key challenge to implementation of the regulatory framework. In other words, instead of having 2 officials per 5 statutes, there would effectively be 10 officials over all 5 statutes. This will require a re-design of the compliance and enforcement institutional structure.

v. Through the testing of the proposed Site Inspection Checklist and Dashboard Tools, it was identified that there is a poor understanding among compliance officials with regard to erosion (processes and impacts) as well as the ability to identify alien and invasive vegetation. It is recommended that a basic course in the identification and management of alien and invasive vegetation, as well as a basic course in erosion (processes and impacts) be included into the enforcement training programmes. Both of these topics are not limited to cases including watercourses but can be applied to a wide variety of cases and contexts.

8.2.3 Management instrument issues

i. The NWA applies an eco-centric approach to resource management through the catchment management approach. This enables the management of resources to be flexible and responsive to the needs and characteristics of each individual catchment. This is in keeping with the holistic concept of sustainability. In contrast, the NEMA applies an anthropocentric approach to resource management, where institutional responsibilities and management instruments are limited by political and administrative boundaries, to which the environment does not adhere. The NEMA should review a catchment management approach, for example, aligning geographic listed activities, management plans, etc., to water management areas rather than political boundaries and thereby be more responsive to the specific ecoregions and environmental resources it manages rather than being responsive to the politics of the day.

ii. Without qualitative monitoring and reporting i.e. measuring the actual improved health of the environment as a result of interventions (whether proactive or reactive), it is unclear whether the regulatory framework, its policies, legislation or management instruments are being effective in their objectives, and contributing to the achievement of Section 24 of the Constitution. This is a key gap in the monitoring and review of policy implementation. A detailed policy review is needed of the water resources management sector, compliance and enforcement, and rehabilitation sectors. An appropriate qualitative monitoring programme should be developed to measure the actual environmental health across the country. This will set appropriate management and rehabilitation objectives to improve this state, and against which to monitor progress of outcomes of initiatives and the general objectives of the environmental statutes.

iii. It is recommended that a database, similar to that of the River Habitat Survey, of existing reference sites be compiled. This tool could be useful for comparing degraded sites against reference conditions for specific riverine characteristics, and thus to help set appropriate rehabilitation objectives. This will require a considerable amount of work to identify suitable reference sites for different stream characteristics in the different ecoregions, geology, vegetation types, etc., of the country. The National Freshwater Ecosystem Priority Areas (NFEPA) spatially maps potential sites of priority; but it is not a database of stream characteristics, and many of the mapped sites have not been ground truthed or verified.

8.2.4 General

i. Sections of the administrative notices place a responsibility on the State to carry out rehabilitation or remedial works of environmental degradation where transgressors do not carry it out. Craigie, *et al*., (in Paterson and Kotze, 2005:61) highlight that “compliance potential reduces the financial burden on the state to remediate pollution or degradation.” Therefore it is important that the compliance and enforcement processes and officials appropriately identify the impacts of contravening activities, and the enforcement-driven rehabilitation actually targets the environmental degradation.

ii. As highlighted in the previous chapters, there is a myriad of legislation resulting in overlapping mandates and jurisdictions between institutions and spheres of government. In the case of the Bryanston Bicycle Park, the Department of Water and Sanitation was not involved in the compliance process. Ideally the GDARD enforcement official should have consulted with the DWS regarding the case, as there was a clear overlap in mandate. The DWS could have issued its own administrative notices instructing rehabilitation activities contrary to the GDARD instructions, e.g. to increase the gabions to prevent further channel erosion. The Bicycle Park would then have been caught in the middle, as siding with any particular institution would result in non-compliance of the other.

It is recommended that a formal implementation protocol be developed and implemented in terms of the Intergovernmental Relations Framework Act, Act 13 of 2005, between the enforcement institutions regarding co-operative enforcement, including who to contact, how to contact them, and guidance on which agency should take the lead per case.

iii. In the example of the Bryanston Bicycle Park, the construction of the wooden bridges was to protect the wetlands and watercourse from the cyclists riding through and damaging them. The bridges also limited the cyclists to crossing the wetland and watercourse at specific points. Cycling through a wetland or watercourse is not a listed activity and does not require prior permission. The beneficial impact of the bridges to the environment was not considered in the enforcement process. Despite the further degradation this would incur to the wetland, the bridges had to be removed; similar to the example described by O'Beirne (2011:5) regarding the spraying of water versus the spraying of binder for dust suppression. These examples correspond with Nonet and Selznick (1978) cited in Scholz (1984:386) that enforcement needs to be more than just the "mechanical" administration of the law and the penalising of violators. Contraventions need to be considered holistically i.e. the positive benefits as well as the negative impacts of contraventions, and that enforcement requirements should be responsive to this, for example by off-set mitigation/rehabilitation. A specific policy document and guideline should be developed regarding off-set mitigation or off-site rehabilitation.

8.3 Way forward

The process of rectifying the problems identified will require a two-pronged approach. Firstly, there is a need to conduct a thorough policy review. This research has touched on the enforcement and enforcement-driven rehabilitation components, but a holistic policy review needs to be conducted. It is 21 years since democracy in South Africa and 18 years since the NWA and NEMA were enacted. There needs to be an actual "state of the environment" assessment, measured against baseline data that informs a detailed action plan as to how to go forward and ensure the environment is protected to the minimum standards and does not pose a safety risk to our health and well-being. There needs to be both institutional and legal reform to address the discrepancies and overlaps in the legislative mandates of the institutions and organs of state tasked with the various components of water resources management (in its many resource facets e.g. environment, mining, agriculture, service delivery, etc.). There needs to be an increase both in capacity and capability of enforcement officials in the appropriate fields (not only in riparian management but terrestrial and other ecosystems as well) (refer DEA, 2008:31). However this will still take much time and is linked to the wider context of South African social maturing i.e. environmental sciences is not viewed as a "money making" employment field and therefore there is little interest in these fields of science. However, these challenges can be accommodated by developing management tools that are responsive to the capabilities of officials, and that can guide and support the existing officials in their day to day functions, thereby increasing their capabilities in the process.

Secondly, administrative tools need to be developed to ensure the accountability of enforcement officials in their decision making and to ensure effective rehabilitation of ecological degradation is adequately designed and carried out. The development of these tools should be carried out as an interim measure to support the enforcement regime while it matures and the staff capabilities develop.

The South African environmental enforcement regime is still in a "developmental" stage, and as it matures the necessary capacity, capability and institutional support will evolve. In the interim it is crucial to ensure tools, guides and mechanisms are available to support the regulators and enforcement officials. This will enable lawful, reasonable and procedurally fair decisions resulting in the prevention, and where necessary, appropriate rehabilitation of pollution and ecological degradation.

The literature (FISCRWG, 2001; May *et al.,* 1997; Soman *et al.,* 2007; Karr, 1991) highlight that there are many environmental impacts as a result of anthropogenic activities. Contraventions contribute to these anthropocentrically triggered impacts. There are various components of riverine reaches, and ecological integrity, rehabilitation objectives and activities that need to be taken into account when designing rehabilitation plans for contraventions, as well as considering the scale of severity of the contraventions themselves. Thus, it would be a difficult task to draft a prescriptive section of legislation to guide rehabilitation, as rehabilitation activities cannot or should not be applied uniformly across cases. The merits, impacts and situation of each individual case need to be assessed. Therefore, a decision-support tool would be more practical to help identify priority impacts as a result of contraventions, help to identify rehabilitation objectives (e.g. rehabilitation, restoration or remediation), identify the necessary specialists and studies that are needed to inform the rehabilitation plan, and identify potential rehabilitation activities and monitoring measures.

8.4 Contribution to Knowledge

This research contributes to the body of knowledge through its framework for review of the knowledge. The research outlined the theoretical foundations of the research, in the process highlighting the role of enforcement-driven rehabilitation in both water resources management and in the achievement of Section 24 of the Constitution. In the absence of a formal policy review of the regulatory framework, the research conducted a critical evaluation of the South African water resources management regulatory framework, in order to determine whether it is contributing towards the achievement of Section 24 of the Constitution, the environmental right. In the failure of the regulatory framework to contribute effectively towards the environmental right, the research developed key tools, using applied research, to guide and support enforcement officials. These tools will improve the effectiveness of enforcement-driven rehabilitation and contribute more effectively towards achievement of the environmental right.

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Constitution of the Republic of South Africa, Act 108 of 1996

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Disaster Management Act, Act 57 of 2002

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Mountain Catchment Areas Act, Act 63 of 1970

National Environmental Management Act, Act 107 of 1998

National Environmental Management: Biodiversity Act, Act 10 of 2004

National Environmental Management: Protected Areas Act, Act 57 of 2003

National Environmental Management: Waste Act, Act 59 of 2008

National Forest Act, Act 84 of 1998

National Health Act, Act 61 of 2003

National Heritage Resources Act, Act 25 of 1999

National Water Act, Act 36 of 1998

Public Access to Information Act, Act 2 of 2000

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Water Services Act, Act 108 of 1997

Municipal Structures Act, Act 117 of 1998

Software:

Python version 3.3. Freeware software. https://www.python.org/

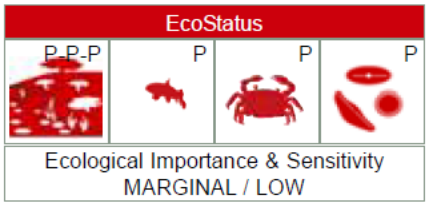
APPENDIX A: Assessments of comparative review of existing riverine assessment tools

Chapter 6, Phase 1, Step 3 of the comparative review of existing riverine assessment tools included testing the selected tools on the case study site of the Bryanston Bicycle Park. This section provides a record of the assessments of each of the seven reviewed tools in Chapter 6 of the thesis.

1. River Health Programme and EcoClassification (South Africa)

An EcoClassification has not been conducted for the specific reach of the river of the case study. However, the case study site falls within a greater catchment that was assessed in 2005. The findings of the River Health Programme EcoClassification assessment (RHP, 2005:28):

"EcoStatus (all indices are red)



The overall EcoStatus for this study unit is **POOR** and comprises the following indices:

The ***Instream Habitat Integrity*** is POOR because of urban development – the majority of the river is canalised, urban runoff is high because of paved areas and sewage spills and industrial discharges are common because infrastructure cannot cope with the high levels of utilisation. It must be mentioned that some of the tributaries feeding the Crocodile River are not as severely impacted.

The ***Riparian Zone Habitat Integrity*** is POOR – natural vegetation has been completely altered because of urbanisation, and encroachment by poplar species is severe.

The ***Fish Assemblage Integrity*** is POOR –increased flow volumes and increased peak flows after heavy rains because impervious surfaces have altered natural flow regimes. There is complete loss of sensitive species even hardy species have lowered frequency of occurrence.

Macro-invertebrate Integrity is POOR – diversity and abundances are severely impacted by urban runoff including sedimentation, sewage flows and industrial discharges.

Water Quality is POOR with high levels of nutrients and an increased frequency of water quality problems. The percentage of species tolerant to organic pollution indicates that the water is free from significant organic pollution. Water quality in the urban areas is severe – mostly because of sewage spillages and industries discharging into the sewer network. The sewerage system is not able to cope with the increase in housing density." (RHP, 2005:28)

The **Management Responses** determined by the River Health Programme's EcoClassification include (RHP, 2005:28):

- "Upgrade sewerage system and improve management.
- Reduce pollution from sewers, illegal discharges and reduction of instream solid waste litter.
- Manage surface stormwater runoff at source.
- Clear alien invasive vegetation from riparian zone.
- Encourage and support Giant Bullfrog Project to ensure the survival of this 'near threatened' species and its habitat.
- Encourage infiltration by reducing impervious surfaces to aid flood attenuation." (RHP, 2005:28)

Note, these management responses are directed at the catchment scale, and while applicable on the site are not case study site specific.

2. River Rehabilitation Assessment (South Africa)

The assessment for the case study site using the River Rehabilitation Assessment is outlined:

Step 1: Identify river section to be assessed

The section of river being assessed is located over 100m reach, from the culvert of the N1 freeway to downstream of the culvert. The section to be assessed includes the culvert and the erosion pool after the culvert.

Step 2: Score river bank indicators

Step 2a: Determine a quality score for the left river bank habitat

i. Landuse adjacent to stream zone: **score 20**

Permanent pasture mixed with woodlots and/or few row crops.

ii. Width of riparian zone from stream zone: **score 1**
6 metres to 15 metres

iii. Connectivity of bank vegetation: **score 30**
No gaps

iv. Riparian vegetation structure: **score 15**
Moderate proportion single stemmed woody plants. Moderate proportion multi-stemmed woody plants. Moderate proportion non-woody vegetation.

v. Riparian vegetation composition: **score 1**
41-60% exotic vegetation

vi. Stream bank structure: **score 1**
Banks unstable, erosion evident, no vegetation

vii. Bank undercutting: **score 5**
Undercutting frequent, undermining bank stability

viii. Level of erosion within the riparian zone: **score15**
Little erosion evident (sheet erosion/small rills)

Total quality class score for left bank habitat: **88 /230**

Step 2b: Determine a quality class rating for the left river bank habitat

Quality class rating for left river bank: **Class IV**. Evaluation is **Fair**. Recommended Action: **Major rehabilitation needed**. Colour: **brown**.

Step 2c: Determine a quality score for the right river bank habitat

i. Landuse adjacent to stream zone: **score 20**
Permanent pasture mixed with woodlots and/or few row crops.

ii. Width of riparian zone from stream zone: **score 1**
6 metres to 15 metres

iii. Connectivity of bank vegetation: **score 30**
No gaps

iv. Riparian vegetation structure: **score 15**
Moderate proportion single stemmed woody plants. Moderate proportion multi-stemmed woody plants. Moderate proportion non-woody vegetation.

v. Riparian vegetation composition: **score 1**
41-60% exotic vegetation

vi. Stream bank structure: **score 1**
Banks unstable, erosion evident, no vegetation
vii. Bank undercutting: **score 5**
Undercutting frequent, undermining bank stability
viii. Level of erosion within the riparian zone: **score15**
Little erosion evident (sheet erosion/small rills)
Total quality class score for right bank habitat: 88 /230

Step 2d: Determine a quality class rating for the right river bank habitat

Quality class rating for right river bank: **Class IV**. Evaluation is **Fair**.
Recommended Action: **Major rehabilitation needed**. Colour: **brown**.

Step 3: Score the instream habitat indicators

Step 3a: Determine a quality score for instream habitat

i. Artificial barriers (weirs, dam walls etc.): **score 10**
Only barriers under extreme low flow.
ii. Channel sediments: **score 5**
Sediment bars of rocks, sand and silt common.
iii. Bed stability: **score** 0
Extensive bed instability, extreme slumping, infilling, deepening.
iv. Embeddedness: **score 30**
Gravel, cobble & boulders 0-25% surrounded by sediment.
v. Canopy cover: **score 5**
Poor.
vi. Aquatic vegetation: **score 10**
Algae dominant in pool, vascular plants along edge.
vii. Woody debris: **score 1**
No visible large pieces.
viii. Pool riffle ratio: **score 10**
Occasional sequence of pool and riffles.

Total quality class score for instream habitat**: 71 /165**

Step 3b: Determine a quality class rating for the instream habitat

Quality class rating for instream habitat: **Class III**. Evaluation is **Good**.
Colour: **yellow**.

Step 4: Determine a quality rating for total habitat

Step 4a: Score the total riparian habitat

Total score= left bank habitat quality score + right bank habitat score+ instream habitat quality score.

Total = 88+88+71

Total = **247 /585**

Step 4b: Determine a quality class rating for the total habitat

Quality class rating for total habitat: **Class IV**. Evaluation is **Fair .**

Colour: **brown**.

Step 5: Create a habitat quality map

Using the colour indication per habitat quality rating, create a map showing the quality rating for the three habitats.

3. Environmental Reconnaissance Checklist (South Africa)

The checklist has been completed for the case study site, and is included. Note, the checklist does not specifically question what activities the development involves; therefore in the context of the case study site the development refers to the construction of the wooden bridges and minor widening of the drainage channel.

SECTION 1 – PROJECT DETAILS				
1.1	Project Reference No	Case Study: comparative assessment of river assessment methodologies.		
1.2	Project Title	EIA Reconnaissance checklist		
1.3	Project Location	Bryanston Bicycle Park, Johannesburg		
1.4	Project Co-ordinates	S 26° 02' 9.12", E 28° 01' 42.45"		
1.5	Property description (Farm portion and ownership)	RE/103/194-IQ (the main section of the Bicycle Park south of the N1 highway) and RE/105/194-IQ (section of the Bicycle Park north of the N1 highway)		
No.	**Review Question**	**Yes**	**No**	**Comments / Notes**
SECTION 2 – SURROUNDING LAND USE				
2.1	Will the development have an impact on the surrounding land use		No	
2.2	Is the proposed development compatible with the Land Use Planning Policies for the area? (such as the			Not applicable. Development is temporary until the road interchange is developed.

	LDOs, Development Frameworks, etc.)			
2.3	What is the relevant town planning scheme?			Bryanston Extension 16
2.4	What is the current zoning of the land and what is the proposed zoning?			Road.
2.5	Will the development compromise the sense of place?		No	No. The development will improve the sense of place.
2.6	Will the development have an impact on conservation and/or open space area?		No	No. The development is aimed at providing more access to the open space. The wooden bridges are designed to prevent damage to the wetland area by cyclists.
No.	**Review Question**	**Yes**	**No**	**Comments / Notes**
SECTION 3 – ECOLOGICAL SENSITIVE AREAS				
3.1	Are there any known sensitive habitats in the vicinity? Will the development have any impact on this habitat (fauna and flora)?	Yes		There is a wetland on the site. The bridges are designed to prevent cyclists riding through the wetland, rather over it, to prevent damage to the wetland. The widening of the channel is to assist flow and prevent flooding. However, this may increase drainage of the wetland.
3.2	Will the development result in loss or disturbance of valuable habitats, ecosystems or habitats for rare and endangered species?		No	The bridges are designed to prevent cyclists riding through the wetland which would result in damaging the sensitive habitats. The widening of the channel is aimed at reducing flooding of the site from poor storm water attenuation upstream. However, widening of the channel may lead to increased drainage of the wetland, resulting in the wetland drying out.
3.3	Is the development located on or near a sensitive coastline which is susceptible to erosion?		No	Site located in Johannesburg.

No.	**Review Question**	**Yes**	**No**	**Comments / Notes**
SECTION 4 – GEOLOGY				
4.1	Is the development in an area liable to subsidence from natural or man-made causes		No	The site has a lot of sediment as a result of upstream erosion. Altered flow regime across the site will result in re-erosion of this sediment. It is not liable to subsidence.
4.2	Is the development located in an area of steep topography which might be susceptible to land slip/slides and/or erosion?	Yes		The site is not on steep topography and is not susceptible to land slip/slides. However, the site comprises sediment from upstream erosion, and this sediment is

				prone to re-erosion on the site.
4.3	Are the soils/geology suited for the development?	Yes		There are no permanent structures in the development.
SECTION 5 – WATER RESOURCES				
5.1	Will the development have an impact on a wetland, watercourse or water body?	Yes		The construction of the bridges involved support pillars being inserted strategically in the wetland. The bridges are aimed to prevent cyclists riding through the wetland but rather over it thereby preventing damage to the wetland. The widening of the channel will affect the watercourse.
5.2	Will the development involve disturbance to natural drainage patterns?	Yes		The aim of the widening of the channel is to prevent the site and wetland from regular flooding due to poor storm water attenuation upstream. However, the stormwater is now further channelled and does not flow into the wetland for attenuation.
5.3	Will the development substantially increase the rate or amount of surface runoff in such a way that it may cause flooding on or off the site or present a problem for the erosion of soils?	Yes		The site is natural vegetation, no additional runoff is anticipated. However, with more of the flood water directed into the channel, and not slowed by flooding through the wetland, there may be increased flow downstream from the site. There has been increased erosion on the site.
5.4	Will the development require channel dredging or the straightening or modification of the channel or the crossing of a river or stream?	Yes		The construction of the wooden bridges includes crossing the stream. However, these are span- bridges and do not impact the flow of the stream underneath. The widening of the channel has resulted in the straightening of the channel.
5.5	Will the development be located in the vicinity of an important groundwater source?		No	No
5.6	Could the development have an impact on the groundwater in the area?		No	There may be a possibility that the deep cut erosion could cut into the water table, thereby drawing more baseflow from groundwater. Would need further detailed studies
5.7	Will the development require large volumes of water, or disposal of large volumes of effluent?		No	No
5.8	Will the development limit use of water for recreation, angling, fisheries, research, conservation or scientific purposes?		No	The aim of the development is to make the site more user friendly for recreational users.
No.	**Review Question**	**Yes**	**No**	**Comments / Notes**

SECTION 6 – SOCIAL ENVIRONMENT				
6.1	Will the development have an impact on the existing quality of life, property value, and Safety and security on the immediate and surrounding communities?	Yes		The process of developing the site removed illegal dumping, fixed sewer overflows, fenced open land and removed squatters and reduced criminal activities in the area. These would contribute to improved security and property value.
6.2	Will the development have an impact on the regional and local economy of the area? (either good or bad)	Yes		Access to the Bicycle Park requires an entry fee to be paid. Subsequently additional recreational activities have been implemented in the adjacent interchange road reserve.
6.3	Will the development result in the creation of jobs?	Yes		The Bicycle Park requires management and maintenance. The park has created several new jobs.
6.4	Will the development result in the relocation of people? If yes, has a new site been identified?	Yes		Squatters were removed from the property by the SAPS.
6.5	Will the development have an impact on the cultural values and practices of the local communities?	Yes		The development provides a safe environment for cycling. The development was driven by the high number of bicycle hi-jackings in other open unsecure areas.
6.6	Will the development have an impact on the social capital of the affected community (its cohesion and networks)?		No	
6.7	Has the distribution of impacts been considered (distribution of impacts on, men, and women, youth and the disabled)?		No	The bicycle park is accessible by all genders, religious and racial groups.
SECTION 7 – CULTURE AND HERITAGE RESOURCES				
7.1	Will the project have an impact on historic, heritage and cultural resources?		No	
7.2	Will the development result in damage or require the relocation of any known human remains?		No	
SECTION 8 – AGRICULTURAL POTENTIAL				
8.1	Will the development result in the loss of agricultural land?		No	The site is not used for agricultural purposes. The development will not cause a permanent change in land use.
8.2	Will the development adversely affect agricultural land in the surrounding areas?		No	There is no agricultural land in the vicinity of the site.
SECTION 9 – AIR QUALITY				
9.1	Will the development have an impact either positive or negative on the air		No	

	quality of the area?			

No.	Review Question	Yes	No	Comments / Notes
SECTION 10 – INFRASTRUCTURE SERVICES				
Will the development have a significant impact on or be constrained by any of the following:				
10.1	Energy		No	
10.2	Access to water	Yes		There is a connection to municipal water on the site. Water will be required for the toilets in the site
10.3	Waste Management (generation and disposal)	Yes		Waste generated from the cycling park will be disposed of by municipal refuse collection. There is a connection to sewer network on the site for the toilets.
10.4	Transportation Networks		No	
10.5	Education		No	
10.6	Housing		No	
SECTION 11 – SUSTAINABLE DEVELOPMENT CRITERIA				
11.1	Has the economic, social and environmental impacts been considered in the overall planning of the development?		No	The impacts have been considered informally. The aim of the development was to provide a safe environment for cyclists to cycle.
11.2	Have all long term and cumulative impacts of the development been taken into account throughout the life-cycle of the project?		No	Yes. The land is leased from the GAUTRANS over a 5 year period. The land is planned to be developed into a road interchange.
SECTION 12 – LEGAL FRAMEWORK				
12.1	Does the development require a new water use licence, or amendment to an existing permit (existing lawful use) in terms of the National Water Act, Act 36 of 1998?	Yes		A water use application for Section 21(i) altering the bed, banks, course or characteristics of a watercourse should be obtained.
12.2	Does the development require a new waste disposal permit, or amendment to an existing waste disposal permit in terms of the National Water Act, Act 36 of 1998 and the Environmental Conservation Act, Act 73 of 1989?		No	The quantity and quality of waste generated on the site complied with domestic waste and does not require a waste disposal permit.
12.3	Does the development require authorisation in terms of the Biodiversity Act, the Mineral and Petroleum Resources Development Act or the Heritage Act?		No	
12.4	Does the development require authorisation in terms of traffic such as new roads, etc.?		No	
12.5	Does the development require a new permit, or amendment to an existing		No	

	permit in terms of the Atmospheric Pollution Prevention Act, Act 45 of 1965?			
12.6	Does the development require authorisation in terms of the Town Planning Scheme?		No	The land does not require to be re-zoned for the development.

OVERALL ASSESSMENT
Comment: No alternative sites were assessed, as the tool was being applied to an enforcement screening of contraventions on the specific site.

4. River Habitat Survey (United Kingdom)

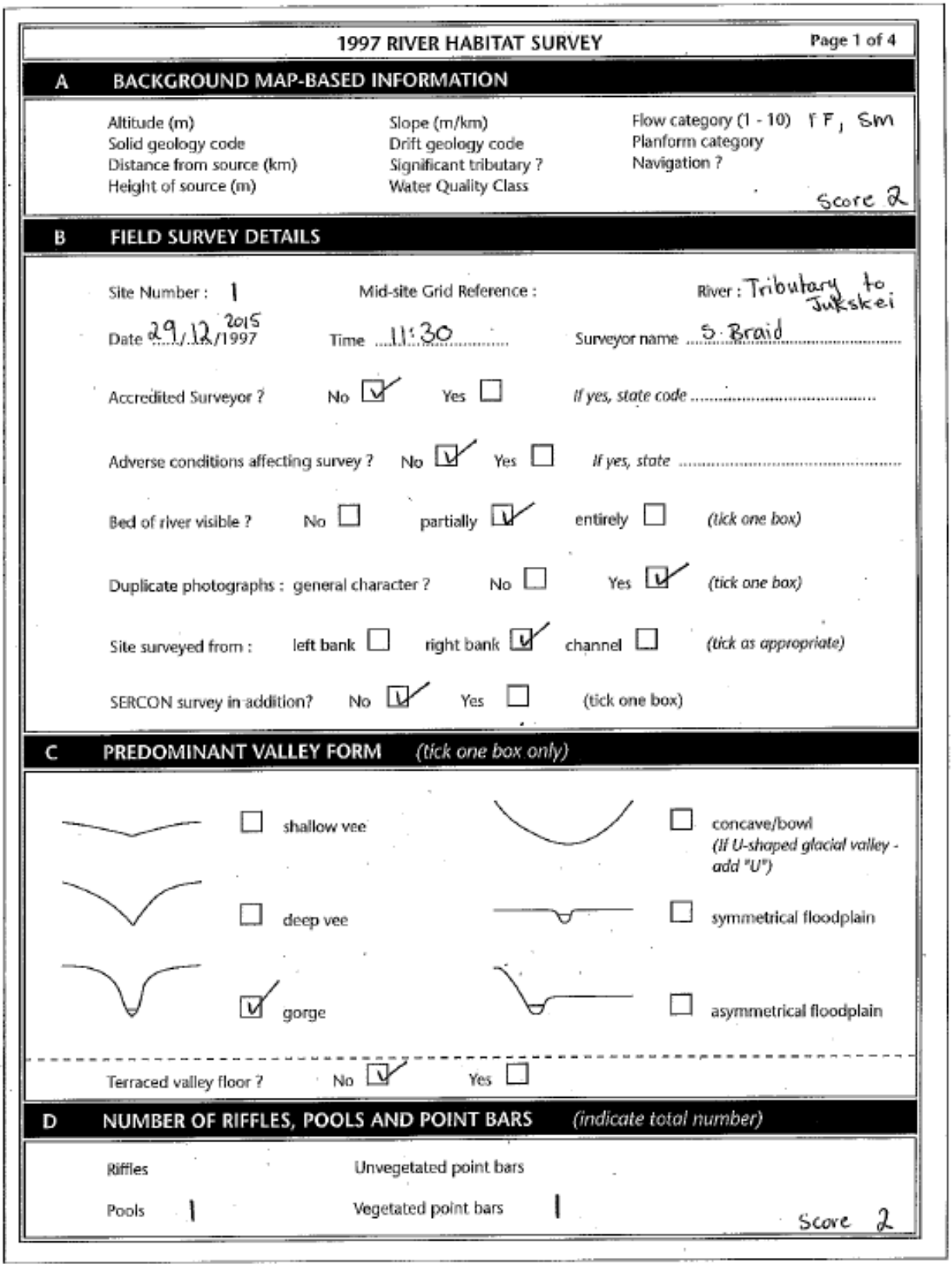
A River Habitat Survey was conducted on the case study site. The results are included. A copy of the completed site forms are included as **Figure A-1**.

On completion of the form, the answers were scored according to the Habitat Quality Assessment (HQA) scoring system: version 1.2. The site **scored 23 points** in the HQA scoring system. No reference site was assessed. Therefore there is no comparison score for a similar river with similar characteristics or in a better condition.

Section A: Background Map-based Information

Altitude (m):	1470m	**Slope (m/km)**	75m/ 1800m	**Flow category (1-10)**	FF (1) SM (1)
Solid geology code:	Granite	**Drift geology code**	Granite derived soils	**Planform category**	
Distance form source (km)	1.8km	**Significant tributary?**	Yes	**Navigation?**	No
Height of source (m)	1545m	**Water quality class**	B-C		

Figure A-1 Completed River Habitat Survey forms over the page.



1997 RIVER HABITAT SURVEY — Page 1 of 4

A BACKGROUND MAP-BASED INFORMATION

Altitude (m) | Slope (m/km) | Flow category (1 - 10) 1 F, Sm
Solid geology code | Drift geology code | Planform category
Distance from source (km) | Significant tributary ? | Navigation ?
Height of source (m) | Water Quality Class

Score 2

B FIELD SURVEY DETAILS

Site Number : 1 Mid-site Grid Reference : River : Tributary to Jukskei

Date 29/12/2015 1997 Time 11:30 Surveyor name S. Braid

Accredited Surveyor ? No ☑ Yes ☐ *If yes, state code* .....

Adverse conditions affecting survey ? No ☑ Yes ☐ *If yes, state* .....

Bed of river visible ? No ☐ partially ☑ entirely ☐ *(tick one box)*

Duplicate photographs : general character ? No ☐ Yes ☑ *(tick one box)*

Site surveyed from : left bank ☐ right bank ☑ channel ☐ *(tick as appropriate)*

SERCON survey in addition? No ☑ Yes ☐ (tick one box)

C PREDOMINANT VALLEY FORM *(tick one box only)*

☐ shallow vee

☐ concave/bowl *(If U-shaped glacial valley - add "U")*

☐ deep vee

☐ symmetrical floodplain

☑ gorge

☐ asymmetrical floodplain

Terraced valley floor ? No ☑ Yes ☐

D NUMBER OF RIFFLES, POOLS AND POINT BARS *(indicate total number)*

Riffles | Unvegetated point bars
Pools 1 | Vegetated point bars 1

Score 2

1997 RIVER HABITAT SURVEY : TEN SPOT-CHECKS

Spot-check 1 is at : upstream end ☑ downstream end ☐ of site *(tick one box)* Score 10

E PHYSICAL ATTRIBUTES *(to be assessed across channel within 1m wide transect)*

[1] = one entry only	1	2	3	4	5	6	7	8	9	10	
LEFT BANK	*Ring EC or SC if composed of sandy substrate*										
Material [1] *NI, BE, BO, CO, GS, EA, PE, CL, CC, SI, WI, GA, BR, BB, BW*	EA										
Bank modification(s) *NK, NO, RS, RI, PC(B), BM, EM*	PC(B)										
Bank feature(s) *NI, NO, EC, SC, PB, WI, SB, VS*	EC									1	
CHANNEL	*GP- ring either G or P if predominant*										
Channel substrate [1] *NI, BE, BO, CO, GR, SA, SI, CL, PE, AR*	SI									1	
Flow type [1] *FT, CH, BW, UW, CE, RP, UP, SM, NP, NO*	FF,SM									2	
Channel modification(s) *NK, NO, CV, RS, RI, DA, FD*	NO										
Channel feature(s) *NI, NO, RO, MB, VB, MI, TR*	RO,VB,TR									2	
RIGHT BANK	*Ring EC or SC if composed of sandy substrate*										
Material [1] *NI, BE, BO, CO, GS, EA, PE, CL, CC, SP, WI, GA, BR, BB, BW*	EA										
Bank modification(s) *NK, NO, RS, RI, PC(B), BM, EM*	PC(B)										
Bank feature(s) *NI, NO, EC, SC, PB, VI, SB, VS*	EC									1	

↑ Enter channel substrates not occurring in spot-checks but present in >1% whole site.

F BANKTOP LAND USE AND VEGETATION STRUCTURE *(to be assessed over a 10m wide transect)*

Land use : choose one from BL, CP, OR, MH, SC, TH, RP, IG, TL, WL, OW, SU, RS

LAND USE WITHIN 5m OF LEFT BANKTOP	TH/SU										
LEFT BANKTOP *(structure within 1m)* B/EI/S/C	C									1	
LEFT BANK FACE *(structure)* B/EI/S/C	B										
RIGHT BANK FACE *(structure)* B/EI/S/C	B										
RIGHT BANKTOP *(structure within 1m)* B/EI/S/C	C									1	
LAND USE WITHIN 5m OF RIGHT BANKTOP	TH/SU										

G CHANNEL VEGETATION TYPES *(to be assessed over a 10m wide transect : use E (≥ 33% area) or ✓(present)*

NONE											
Liverworts/mosses/lichens											
Emergent broad-leaved herbs											
Emergent reeds/sedges/rushes											
Floating-leaved (rooted)	✓									1	
Free-floating											
Amphibious											
Submerged broad-leaved											
Submerged linear-leaved											
Submerged fine-leaved											
Filamentous algae	✓										

Use end "catch-all" column for types not occurring in spot checks as well as overall assessment over 500m (use E or ✓) ↑

SITE NO.	1997 RIVER HABITAT SURVEY : 500m SWEEP-UP	Page 3 of 4

H LAND USE WITHIN 50m OF BANKTOP *Use E (≥ 33% banklength) or ✓(present)*

	L	R		L	R
Broadleaf/mixed woodland *(BL)*			Rough pasture *(RP)*		
Coniferous plantation *(CP)*			Improved/semi-improved grass *(IG)*		
Orchard *(OR)*			Tilled land *(TL)*	✓	✓
Moorland/heath *(MH)*			Wetland (eg bog, marsh, fen) (WL)		
Scrub *(SC)*			Open water *(OW)*		
Tall herbs /rank vegetation *(TH)*	✓	✓	Suburban/urban development *(SU)*	✓	✓
Score 0			Rock and scree *(RS)*		

I BANK PROFILES *Use E (≥ 33% banklength) or ✓(present)*

Natural/unmodified	L	R	Artificial/modified	L	R
Vertical/undercut			Resectioned		
Vertical + toe			Reinforced - whole bank		
Steep (>45°)			Reinforced - top only		
Gentle			Reinforced - toe only		
Composite			Artificial two-stage		
			Poached	✓	✓ (E)
			Embanked		
Score 2			Set-back embankments		

J EXTENT OF TREES AND ASSOCIATED FEATURES

TREES *(tick one box per bank)*

	Left	Right	
None	☐	☐	
Isolated/scattered	☑	☑	(1)
Regularly spaced, single	☐	☐	
Occasional clumps	☐	☐	
Semi-continuous	☐	☐	
Continuous	☐	☐	

ASSOCIATED FEATURES *(tick one box per feature)*

	None	Present	E (>33%)	
Shading of channel	☐	☐	☐	
Overhanging boughs	☐	☐	☐	
Exposed bankside roots	☐	☑	☐	(1)
Underwater tree roots	☐	☐	☐	
Fallen trees	☐	☐	☐	
Coarse woody debris	☐	☐	☐	

Score 2

K EXTENT OF CHANNEL FEATURES *(tick one box per feature)*

	None	Present	E(>33%)			None	Present	E (>33%)	
Waterfall(s)	☐	☑	☐	(1)	Marginal deadwater	☐	☐	☐	
Cascade(s)	☐	☐	☐		Exposed bedrock	☐	☑	☐	(1)
Rapid(s)	☐	☐	☐		Exposed boulders	☐	☐	☐	
Riffle(s)	☐	☐	☐		Unvegetated mid-channel bar(s)	☐	☐	☐	
Run(s)	☐	☐	☐		Vegetated mid-channel bar(s)	☐	☐	☐	
Boil(s)	☐	☐	☐		Mature island(s)	☐	☐	☐	
Glide(s)	☐	☐	☐		Unvegetated side bar(s)	☐	☐	☐	
Pool(s)	☐	☑	☐	(1)	Vegetated side bar(s)	☐	☑	☐	(1)
Ponded Reach(es)	☐	☐	☐		Discrete silt deposit(s)	☐	☐	☐	
					Discrete sand deposit(s)	☐	☑	☐	(1)

Score 5

1997 RIVER HABITAT SURVEY: DIMENSIONS AND INFLUENCES Page 4 of 4

L CHANNEL DIMENSIONS *(to be measured at one site on a straight uniform section, preferably across a riffle)*

LEFT BANK		CHANNEL		RIGHT BANK	
Banktop height (m)	3m	Bankfull width (m)		Banktop height (m)	3m
Is banktop height also bankfull height? (Y or N)	Y	Water width (m)	1m	Is banktop height also bankfull height? (Y or N)	Y
Embanked height (m)	0,5m	Water depth (m)	10cm	*Embanked height (m)*	0,5m

If trashline is lower than banktop break in slope, indicate: height above water (m) =

Bed material at site is: consolidated (compact) ☐ unconsolidated (loose) ☐ unknown ☐

Location of measurement is: riffle ☐ run or glide ☐ other ☐

M ARTIFICIAL FEATURES *(indicate total number or tick appropriate box)*

None		Major	Intermediate	Minor		Major	Intermediate	Minor
☐	Weirs				Revetments			
	Sluices				Outfalls			
	Culverts	1			Fords			
	Bridges				Deflectors			
					Other (state)			

Is water impounded by weir/dam? No ☐ Yes, <33% of site ☐ >33% of site ☐

N EVIDENCE OF RECENT MANAGEMENT *(tick appropriate box(es))*

None ☑ Dredging ☐ Mowing ☐ Weed-cutting ☐

Enhancement ☐ Other (state).....

O FEATURES OF SPECIAL INTEREST *(use √ or E (> 33% length)*

None	☑						
Waterfalls > 5m high	☐	Artificial open water	☐	Bog	☐	Fringing reed-bank	☐
Braided/side channels	☐	Natural open water	☐	Carr	☐	Floating mat	☐
Debris dams	☐	Water meadow	☐	Marsh	☐	Other (state).....	
Leafy debris	☐	Fen	☐	Flush	☐		

Score 0

P CHOKED CHANNEL *(tick one box)*

Is 33% or more of the channel choked with vegetation? No ☑ Yes ☐

Q NOTABLE NUISANCE PLANT SPECIES *(Use √ or E (> 33% length)*

None ☑ Giant Hogweed ☐ Himalayan Balsam ☐ Japanese Knotweed ☐ Other (state).....

R OVERALL CHARACTERISTICS *(Circle appropriate words, add others as necessary)*

Major impacts: landfill - tipping - (litter) - (sewage) - pollution - drought - abstraction - mill - dam - road - rail - industry - housing - mining - quarrying - (overdeepening) - afforestation - fisheries management - silting

Land Management: set-aside - (buffer strip) - headland - abandoned land - parkland - MoD

Animals: otter - mink - water vole - kingfisher - dipper - grey wagtail - sand martin - heron - (dragonflies/damselflies)

Other significant observations:

S ALDERS *(tick appropriate box(es))*

Alders? None ☑ Present ☐ Extensive ☐ Diseased Alders? None ☐ Present ☐ Extensive ☐

5. Stream Planning Procedure (Australia)

The process is time consuming, costly and requires extensive specialist input.

Due to the nature of the process being initiative-driven, the process was not completed on the case study site.

6. Stream Visual Assessment (United States)

A stream visual assessment was conducted on the case study site, the results are included:

Stream Visual Assessment Protocol

Owners name	Bryanston Bicycle Park	**Evaluator's name**	S. Braid	**Date**	29/12/2014
Stream name	Tributary to the Jukskei River, Johannesburg		**Waterbody ID number**	Case study 1B	
Reach location	Site assessment located on downstream site of culvert under N1 high.				
Ecoregion	Highveld Grassland	**Drainage area**	3.6km^2	**Gradient**	75/1800m
Applicable reference site	Comparative assessment of Stream Visual Assessment Protocol on the Bryanston Bicycle Park.				

Landuse within drainage (%):	**Row crop**		**hayland**		**Grazing/ pasture**		**forest**		**residential**	√
confined animal feeding operations			**Canopy cover**		**Industrial**		**Other**			
Weather conditions today	Sunny and clear skies, warm			**Past 2-5 days**	Rain and cloudy					
Active channel width	1m	**Dominant substrate:**	boulder	gravel	**Sand X**	silt	mud			

Assessment Scores	Score		Score
Channel condition	1	Pools	3
Hydrologic alteration	1	Invertebrate habitat	3
Riparian zone	8	Score only if applicable	
Bank stability	1	Canopy cover	1
Water appearance	3	Manure presence	1
Nutrient enrichment	3	Salinity	n/a
Barriers to fish movement	1	Riffle embeddedness	8
Instream fish cover	1	Macro-invertebrates observed (optional)	-3

Overall score (Total divided by number of indicators scored)	= 32 ÷ 14 = **2.29**	<6.0	**Poor**
		6.1 – 7.4	**Fair**
		7.5 – 8.9	**Good**
		> 9.0	**Excellent**

Suspected causes of observed problems: High volume and directed stormwater flows into the channel have increased the velocity of the water through the channel, resulting in excessive erosion and channel deepening. The channel has incised deeply, leading to drying out of adjacent wetland area.

Recommendations: Install check dams into the erosion gullies to re-collect sediment and raise the river bed. Attenuate stormwater in the park upstream of the wetland. Design spill way to promote laminar flow into the wetland, rather than directed flow into the channel.

The overall score for the site assessment was **2.28**. This is ranked as **poor**. The outcome does not provide guidance as to was causing the low score (environmental degradation) and what the rehabilitation should focus on.

7. Problem and Opportunity Identification (United States)

A Problems and Opportunity Identification assessment was not conducted on the case study site because it is too detailed and specialised for the enforcement screening.