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For Water Supply and Water Resource Infrastructure

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DEFINITIONS

Aerobic:	Having molecular oxygen (O_2) present.
Anaerobic:	Not having molecular oxygen (O_2) present.
Auditing:	A systematic and objective assessment of an organisation's activities and services conducted and documented on a periodic basis.
Biodiversity:	The variety of life in an area, including the number of different species, the genetic wealth within each species, and the natural areas where they are found.
Blacklist:	Record of previous failures to perform or deliver.
Capillary fringe:	The zone just above the water table that remains almost saturated. This varies from approximately 10 cm in sandy soils to about 30 cm in some clay soils.
Catchment:	All the land area from mountaintop to seashore which is drained by a single river and its tributaries.
Coastal wetlands:	Wetlands influenced by tides and contain waters that show appreciable salinity.
Debushing:	Clearing of the site of bush and undergrowth vegetation, but not including the removal of tree stumps.
Designed landscape:	An evocative, meaningful, and sustainable totality that evolves over time in response to a wide range of diverse influences.
Destumping:	The removal of tree stumps.
Environment:	A place where living, non-living and man-made features interact, and where life and diversity is sustained over time.
Evaporation:	The change by which any substance (such as water) is converted from a liquid state into and carried off in vapour.
Floodplain:	A flat expanse of land bordering a river channel, formed through sediment deposition and other alluvial processes, and often characterized by frequent flooding as a result of bank overspill from the river channel.
Groundwater:	Subsurface water in the zone in which permeable rocks, and often the overlying soil, are saturated under pressure equal to or greater than atmospheric.
Inland wetlands:	Fresh water (non-tidal) wetlands that can often be likened to a basin filled with soil which has an impervious layer that retains water.
Landscape:	Land modified for human use and occupation, embracing both the natural (wilderness) environment and the urban.
Landscape architecture:	The science, art and technique of planning and design of integrated man-made and natural elements and spaces to improve the quality of life.
Marsh:	A wetland dominated by emergent herbaceous vegetation and which may be seasonally wet but which is usually permanently or semi-permanently flooded or saturated to the soil surface.
Monitoring:	A systematic and objective observation of an organisation's activities and services conducted and reported on regularly.
Natural vegetation:	All existing vegetation species, indigenous or otherwise, of trees, shrubs, groundcover, grasses and all other plants found growing on the site.
Open water:	Permanently or seasonally flooded areas characterized by the absence (or low abundance) of emergent plants.

Overburden:	The soil overlying desirable material extracted during borrowing or quarrying.
Pan:	An inward draining flat bottomed depression lacking an outlet usually intermittently to seasonally flooded.
Peat:	Organic soil material with a particularly high organic matter content which, depending on the definition, usually has at least 20% organic carbon by weight.
Pollution:	The result of the release into air, water or soil from any process or of any substance, which is capable of causing harm to man or other living organisms supported by the environment.
Protected Plants:	Plant species officially listed on the Protected Plants List (each province has one), and which may not be removed or transported without a permit to do so from the relevant provincial authority.
Red Data Species:	Plant and animal species officially listed in the Red Data Lists as being rare, endangered or threatened.
Rehabilitation:	Making the land useful again after a disturbance. It involves the recovery of ecosystem functions and processes in a degraded habitat. Rehabilitation does not necessarily reestablish the pre-disturbance condition, but does involve establishing geological and hydrologically stable landscapes that support the natural ecosystem mosaic.
Riparian vegetation:	Vegetation occurring on the banks of a river or a stream (i.e. vegetation fringing a water body).
Runoff:	The total water yield from a catchment including surface and subsurface flow.
Soil saturation:	The soil is considered saturated if the water table or capillary fringe reaches the soil surface.
Subsoil:	The soil horizons between the topsoil horizon and the underlying parent rock.
Swamp:	A wetland dominated by trees or shrubs. In Europe, permanently flooded reed-dominated wetlands may also be referred to as swamps.
Topsoil:	The upper soil profile irrespective of the fertility appearance, structure, agriculture potential, fertility and composition of the soil, usually containing organic material and which is colour specific.
Transplanting	The removal of plant material and replanting the same plants in another designated position.
Veld:	Unimproved areas of natural vegetation.
Watercourse:	A geomorphological feature characterized by the presence of a streamflow channel, a floodplain and a transitional upland fringe seasonally or permanently conveying surface water.
Watershed:	An area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel.
Waterlogged:	Soil or land saturated with water long enough for anaerobic conditions to develop.
Wetland:	A seasonally, temporarily or permanently wet area, often exhibiting a specific vegetation community.

ACRONYMS

DEAT:	Department of Environmental Affairs and Tourism
DE:	Design Engineer
DWAF:	Department of Water Affairs and Forestry
ECO:	Environmental Control Officer
EIA:	Environmental Impact Assessment
EM:	Environmental Manager
EMP:	Environmental Management Plan
EMS:	Environmental Management System
EO:	Environmental Officer
EP:	Environmental Planner
I&AP:	Interested and Affected Party
IEM:	Integrated Environmental Management
IEMF:	Integrated Environmental Management Framework
PM:	Project Manager
PSP:	Professional Service Provider
RoD:	Record of Decision
SABS:	South African Bureau of Standards
SE:	Site Engineer
SUP:	Sustainable Utilisation Plan

APPLICABLE LEGISLATION

- Animals Protection Act (Act 71 of 1962)
- Atmospheric Pollution Prevention Act (Act 45 Of 1965)
- Conservation of Agricultural Resources Act (Act 43 of 1983)
- Constitution of the Republic of South Africa (Act 108 of 1996)
- Defence Act (Act 44 of 1957)
- Environment Conservation Act (Act No. 73 Of 1989)
- Environmental Planning Act (Act No. 88 of 1967)
- Explosives Act (Act 15 of 2003)
- Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947)
- Forest Act (Act 122 of 1984)
- Forest and Veld Conservation Act (Act No. 13 of 1941)
- Hazardous Substances Act (Act No. 15 of 1973)
- Human Tissues Act (Act No. 65 of 1983)
- Lake Areas Development Act (Act No. 139 of 1975)
- Land Survey Act (Act No. 9 of 1921)
- Minerals And Petroleum Resources And Development Act (Act No. 28 Of 2002)
- Mountain Catchment Areas Act (Act 63 of 1970)
- National Environmental Management Act (Act No. 107 Of 1998)
- National Heritage Resources Act (Act No. 25 Of 1999)
- National Monuments Act (Act 28 of 1969)
- National Parks Act (Act 57 of 1976)
- National Resources Development Act (Act No. 51 of 1947)
- National Water Act (Act No. 36 Of 1998).
- Occupational Health And Safety Act (Act 85 Of 1993)
- Provincial and Local Government Ordinances and Bylaws
- Removal of Graves and Dead Bodies Ordinance (Ordinance No. 7 of 1925)
- Sea Birds and Seals Protection Act (Act 46 of 1973)
- Sea Fishery Act (Act 12 of 1988)
- Sea-Shore Act (Act 21 of 1935)
- Soil Conservation Act (Act No. 76 of 1969)
- Water Services Act (Act 108 of 1997)

- Ramsar Convention
- Bonn Convention

EXECUTIVE SUMMARY

This document constitutes a generic, user friendly environmental best practice manual for planners of a wide range of projects.

The manual will primarily be for use during the planning and design phases ahead of construction, upgrading and maintenance of Water Supply and Water Resource Infrastructure. Reclamation and clearing projects may also benefit from reference to these guidelines.

The purpose of this manual is to ensure that all projects are planned within the ambit of sound environmental standards and norms and to ensure that these standards are properly defined and given due consideration during the necessary stages of project planning.

The principles of environmental planning first come into play at pre-feasibility level, where due cognisance of environmental aspects may have an impact on the budget and / or site selection of a project. What is required by decision makers at this level is therefore a broad brush understanding of the sensitivities of a generic environment, not specific to any particular project or project component, addressed in terms of the following environmental aspects:

- Biophysical Environment
    - Climate
    - Geology
    - Topography
    - Surface hydrology
    - Ground water
    - Soil
    - Flora
    - Fauna
- Aesthetic environment
- Socio-economic environment
    - Archaeological resources
    - Historical resources
    - Cultural resources
    - Air quality
    - Noise
    - Social issues
    - Land use and services
    - Tourism

Although the broad-brush approach is useful in orientating decision makers, it does not necessarily equip planners to take responsible and sustainable decisions regarding environments that are by their very nature sensitive: for these Special Environments, the generic principles of environmental planning are often lacking. What is required therefore is not only a more detailed guide to the accurate identification and delineation of Special Environments, but also a description of their inherent sensitivities, the problems to be anticipated when developing projects within these areas, and suggested solutions to these potential problems. Special Environments that will be addressed include:

- Water courses
- Wetlands
- Dunes and drift sands

- Estuaries
- Ridges

These principles of environmental planning, both in terms of Generic and Special Environments again become relevant during the undertaking of more detailed site assessments (such as EIA's) and the development of Management Plans.

Over and above the environmental planning principles addressed above, there are often specific considerations relevant to the various components of any Water Supply and Water Resource Infrastructure project. In this respect, principles of environmental planning again come into play during the detail design and planning stage. These guidelines are described in terms of the planning requirements of various components of Water Supply and Water Resource Infrastructure and include the following:

- Pipelines
- Tunnels
- Canals
- Gauging weirs
- Dams and impoundments
- River diversions
- Fishways
- Roads
- Bridges
- Water supply boreholes
- Erosion control
- Reservoirs
- Water treatment plants
- Sewage treatment systems
- Borrow areas
- Buildings and structures

The compilation of an overall Master Plan for a development is standard planning practice for projects of all scales and types, and ultimately contributes to a more environmentally friendly, cost effective and aesthetically pleasing product for users, operators and the public at large. Such a Master Plan must be drawn up taking into consideration not only the environmental planning principles addressed thus far, but also spatial design criteria, including the following:

- Responsiveness
    - To natural environment
    - To human needs
    - To the micro-climate
- Functionality
    - Circulation
    - Space
- Aesthetic function
    - Of line
    - Of form
    - Of texture
    - Of colour
    - Of rhythm
    - Of variety
    - Of harmony
    - Of composition
- Spatial elements

    - Street furniture
    - Signage
    - Pathways
    - Roads
- Sustainability
    - Robustness and resilience
    - Maintenance

Lastly, it is acknowledged that a fair amount of on-site reconnaissance, survey and investigation work is often involved during the pre-feasibility and planning phases of a project. As such, in an effort to avoid unnecessary environmental damage which may be sustained during such on-site work, a generic Environmental Code of Conduct has been developed, which should be adhered to by any person or organisation accessing the site for a reason related to the planning of the project at hand. Aspects covered in this respect would include:

- Health and safety
- Safeguarding sensitive environments
- Safeguarding flora
- Safeguarding fauna
- Managing waste and pollution
- Managing roads and access
- Managing prospecting boreholes, excavations and test pits
- Rehabilitation
- Interaction with landowners and stakeholders

Refer also to the following documents, which together with this manual comprise a complete set of environmental guidelines and performance specifications, relevant for all phases of the project lifecycle:

- *Department of Water Affairs and Forestry, February 2005.* ***Environmental Best Practice Specifications: Construction****. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. Pretoria.*
- *Department of Water Affairs and Forestry, February 2005.* ***Environmental Best Practice Specifications: Operation****. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. Pretoria.*
- *Department of Water Affairs and Forestry, February 2005.* ***Environmental Best Practice Guidelines: Decommissioning Planning****. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. Pretoria.*

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The following figures are included in support of the best practice manual:

1. INTRODUCTION

1.1 DWAF Vision

'-*We have a vision of a democratic, people-centred nation working towards human rights, social justice, equity and prosperity for all.*
-We have a vision of a society in which all our people enjoy the benefits of clean water and hygienic sanitation services.
-We have a vision of water used carefully and productively for economic activities, which promote the growth, development and prosperity of the nation.
-We have a vision of a land in which our natural forests and plantations are managed in the best interests of all.
-We have a vision of a people who understand and protect our natural resources so as to make them ecologically stable and safeguard them for current and future generations.
-We have a vision of a Department that serves the public loyally, meets its responsibilities with energy and compassion and acts as a link in the chain of integrated and environmentally sustainable development.
-We have a vision of development and co-operation throughout our region of playing our part in the African Renaissance.''[1]

1.2 DWAF Mission

'The mission of the Department of Water Affairs and Forestry is to serve the people of South Africa by:
-Conserving, managing and developing our water resources and forests in a scientific and environmentally sustainable manner in order to meet the social and economic needs of South Africa, both now and in the future.
-Ensuring that water services are provided to all South Africans in an efficient cost-effective and sustainable way.
-Managing and sustaining our forests, using the best scientific practice in a participatory and sustainable manner.
-Educating the people of South Africa on ways to manage, conserve and sustain our water and forest resources.
-Co-operating with all spheres of Government in order to achieve the best and most integrated development in our country and region.
-Creating the best possible opportunities for employment, the eradication of poverty and the promotion of equity, social development and democratic governance.''[2]

1.3 DWAF Values

'-The Department of Water Affairs and Forestry is a loyal servant of the government and the people of South Africa.
-As public servants, our skills will, at all times, be used for the benefit of the people and for the reconstruction and development of our country in the spirit of Batho Pele (People First).

[1] National Water Act (Act 36 of 1998)
[2] National Water Act (Act 36 of 1998)

-As management, our responsibility is to provide high quality transformation leadership and a disciplined work ethic and to promote a working culture for motivated, accountable and committed teamwork.
-As citizens of the African continent, we are dedicated to long-term integrated regional security and co-operation, and to the spirit of the African Renaissance.
-Our working environment is governed by the principles of representivity, equality, mutual respect and human development.'[3]

1.4 Aims of the Environmental Best Practice Guidelines and Specifications

'-To give effect to the DWAF Vision and Mission.
-To create a DWAF standard for Best Practice in Environmental Planning and Management.
-To guide all role players in Water Resource and Water Services Development Projects in terms a Best Practice standard in Environmental Planning and Management.
-To comply with the requirements of the National Water Act (Act No. 36 Of 1998), the Water Services Act (Act 108 of 1997) and the National Environmental Management Act (Act No. 107 Of 1998) as overarching legislation.' [4]

1.5 Context of this document

The function of this document is as an Environmental Planning and Design Tool to be used during the planning phases of not only new developments, but also upgrade, maintenance and rehabilitation projects.

The manual will be primarily for use during the planning and design phases ahead of construction, upgrading and maintenance of Water Supply and Water Resource Infrastructure, but reclamation and clearing projects may also benefit from reference to these guidelines.

In addition to its function as an environmental planning and design guideline, this manual also contains an Environmental Code of Conduct, which is relevant for every person in any capacity gaining access to the site for a reason related to the planning of the project at hand.

1.6 Scope of this document

Responsible and sustainable environmental planning may have an impact on the type, extent, location and budget of a project. What is required by decision makers at an early stage is therefore a broad brush understanding of the sensitivities of a generic environment, not specific to any particular project or project component, addressed in terms of salient environmental aspects.

Although this broad-brush approach is useful in orientating decision makers, it does not necessarily equip them to take responsible and sustainable decisions regarding environments that are by their very nature sensitive. For these Special Environments,

[3] National Water Act (Act 36 of 1998)
[4] National Water Act (Act 36 of 1998)

the generic principles of sound environmental planning are often lacking. As such, a detailed guide is provided in aid of the accurate identification and delineation of Special Environments, a description of their inherent sensitivities, the problems to be anticipated when developing projects within these areas, and suggested solutions to these potential problems.

Over and above environmental planning principles addressed above, there are often specific environmental planning considerations relevant to the various components of a Water Supply and Water Resource Infrastructure project. In this respect, planners will have access to environmental planning guidelines covering specific planning requirements for various components of Water Supply and Water Resource Infrastructure.

The compilation of an overall Master Plan for the development, depicting all physical aspects of a project, is standard planning practice for projects of all scales and types. More importantly, a Master Plan is a critical link in the planning process in that it allows for objective evaluation in terms of the functionality, practicality and cost-effectiveness of a proposed development. This will ultimately yield a better product for users, operators and the public at large.

A Master Plan also aids in providing clarity to the Implementing Agent, Stakeholders, Interested and Affected Parties and the Contractor in terms of the holistic planning goals.

Lastly, it is acknowledged that a fair amount of on-site reconnaissance, survey and investigation work is often involved during the planning phases of a project. As such, in an effort to avoid unnecessary environmental damage which may be sustained during such on-site work, a generic Environmental Code of Conduct has been developed, which should be adhered to by any person or organisation gaining access the site.

1.7 Application of this document

At pre-feasibility and project planning level, decision makers should make use of the best practise manual to gain a broad brush understanding of generic environmental sensitivities, and so be empowered to take environmentally responsible strategic decisions. In this respect, a guideline in terms of certain identified Special Environments is also included.

These principles of environmental planning, both in terms of Generic and Special Environments again become relevant during the undertaking of more detailed site planning, assessments (such as EIA’s) and the development of Management Plans.

In an effort to streamline the planning process, decision makers will also have access to more detailed environmental planning guidelines for the various components of Water Supply and Water Resource Infrastructure projects.

The development of a Master Plan requires that a comprehensive and detailed planning exercise be undertaken, considering not only salient environmental principles, but also the basic principles of spatial design. In this way, a Master Plan facilitates communication and decision making on all levels and allows for efficient programming and budgetary control, as well as the timeous identification and rectification of fatal flaws.

Ideally, a Master Plan is developed early enough in the project planning phase to be available for prospective tenderers during the tender phase, and for inclusion in the project specific Environmental Management Plan (EMP).

The Environmental Code of Conduct is relevant throughout the project life cycle and should be issued to every person in any capacity gaining access to the site at any time during the planning phase of the project lifecycle (i.e. during pre-feasibility, project planning, detail design etc.).

Once the planning phase of a project is complete, then the project enters into a Construction Phase, and all the requirements of the IEMF (Integrated Environmental Management Framework) in this respect are to be adhered to.

2. ENVIRONMENTAL PLANNING GUIDELINES (GENERIC ENVIRONMENTS)

At pre-feasibility and project planning level, decision makers should make use of the following environmental planning guidelines to gain a broad brush understanding of generic environmental sensitivities, and so be empowered to take environmentally responsible strategic decisions.

These principles of environmental planning are specifically relevant during the undertaking of Strategic Environmental Assessments, Sustainable Utilisation Plans, Environmental Impact Assessments and Environmental Management Plans and should be specified in the terms of reference for such.

This section draws extensively from the document entitled *Environmental Checklist for Structure Plans*[5].

2.1 Biophysical environment

- Take note of sensitive or vulnerable terrestrial, aquatic or marine ecosystems. Ensure that a holistic view is taken of the biophysical environment and its processes, so that the impacts of future developments may be evaluated in proper perspective.
- Determine to what extent the impact on terrestrial, aquatic or marine ecosystems may undermine their respective ability to sustain life and productivity at an acceptable level of environmental quality, and devise an overall strategy to counter such threats.
- Compile a 'Harvesting of Natural Resources' policy for projects that entail large scale environmental change (e.g. for the development of a dam), where Special Environments are involved (see Chapter 3), or where stakeholders will be affected by the project. Such a policy will address the proper preparation, harvesting, use and utilisation of:
  - Animal species (in terms of relocation);
  - Flora (in terms of firewood, medicinal plants and endangered species);
  - Useable / saleable rock, stone, sand and gravel;
  - Topsoil.

2.1.1 Climate

- Be aware of prevailing wind directions, annual rainfall (and the rainy season) and minimum and maximum temperatures.
- Orientate developments and structures to alleviate the influence of strong winds, or to maximise breezes in the case of hot climates.
- Avoid siting land uses associated with noxious gas emissions or bad odours close to or upwind of residential or recreation areas.

[5] DEPARTMENT OF ENVIRONMENT AFFAIRS AND TOURISM. JULY 1991

- Avoid residential developments and sports complexes in low lying areas subjected to air pollution problems or temperature inversions.
- Allow for proper ventilation of structures within areas prone to heat waves and high humidity.
- Position and orientate developments and structures to maximise northern exposure and minimise frost-belt situation in areas prone to extremely low temperatures and frequent frost.
- Consider the occurrence and frequency of extreme weather conditions (e.g. droughts, flash floods, snow or cyclones) when siting and designing developments and structures.
- Consider microclimatic conditions (e.g. local catabatic air flows or urban heat islands) in the siting and orientation of land uses.

2.1.2 Geology

- Avoid development in areas with problematic geological conditions (especially areas with hazards such as sink holes).
- Avoid development on significant fault lines and ensure that safe building standards are applied.
- Retain resource areas (i.e. areas with significant deposits of minerals, gems or construction materials) for future resource exploitation and use, or make provision for their exploitation before further development.
- Where possible, conserve aesthetically outstanding rock formations, features and landmarks.

2.1.3 Topography

- Plan land uses and traffic networks in sympathy with the topography (i.e. specifically prominent land forms such as mountains, ridges and steep hills), thereby retaining significant and formative land forms in a natural state.
- Take slope orientation into account to locate land uses where they can benefit most from climatic conditions (e.g. maximising sunlight, protection from wind etc.).
- Retain significant and formative land forms in a natural state (i.e. specifically prominent land forms such as koppies, mountains, ridges and steep hills).
- Where possible, avoid development on gradients steeper than 1:4.
- Where possible, avoid development on flat or depressed terrain with potential drainage problems (i.e. gradients flatter than 1:20).
- Ensure the protection of sensitive coastal areas against development encroachment, high recreational pressure etc.
- Avoid development in areas with potential landslide hazards.
- Avoid development over and within outcrops of unique and high aesthetic value.

2.1.4 Surface hydrology

- Ensure that surface water features of conservation value (e.g. drainage lines, wetlands, lakes and estuaries) are adequately protected. This includes within structural developments, open space systems, reserves or recreation areas.
- Respect all drainage lines, whether perennial or non-perennial as natural watercourses.

- Ensure that surface water features of recreational value (e.g. dams) are adequately protected within open space systems, reserves or recreation areas.
- Avoid development in flood-prone areas (1:50 year floodlines) and design developments to accommodate natural drainage of the landscape.
- Promote the productive use of water features and sources (e.g. for fish production, irrigation, recreation etc.) where feasible and appropriate.

2.1.5 Ground water

- Promote the sustainable use and protection of ground water sources, as well as the restriction or avoidance of polluting land uses or development in such areas.
- Avoid development in areas with high water tables or poor drainage, especially land uses such as waste disposal sites that can pollute ground water.

2.1.6 Soil

- Avoid development in areas with problematic soil conditions (e.g. silts, sand or clays of poor stability or low compressibility), or propose alleviating conditions.
- Promote good farming practices and avoid development that will greatly increase the erosion of susceptible soils (e.g. dispersive soils).
- Retain fertile soils with a high agricultural potential for agricultural use.
- Retain areas with resources such as kaolin or other clay deposits of commercial value for future resource exploitation and use, or make provision for their exploitation before further development.

2.1.7 Flora

- Ensure that endangered plant species are protected within natural open space, reserves or other suitable land uses, or relocated if feasible.
- Provide for the protection of vegetation communities of particular conservation value (e.g. those exhibiting species variety, soil binding functions, aesthetic attraction etc.) and utilise protected areas for environmental education.
- Promote the systematic eradication of invasive plant species infestations, especially in protected areas and close to streams.
- Formulate guidelines or propose measures for minimising threats to vegetation communities or plant species (e.g. firewood collection, overgrazing, vandalism, off-road driving etc.), such as veld and fire management.
- Promote the sustainable use and protection of indigenous vegetation for food, medicine or other uses.

2.1.8 Fauna

- Ensure that endangered animal species (i.e. birds, fish, wild animals and insects) and their habitat are protected within open space, reserves or other suitable land uses, or relocated if possible.
- Provide for the protection of animal communities of particular conservational value (i.e. those exhibiting species diversity, predators important for pest control etc), and utilise protected areas for environmental education.

- Provide for permanent game movement corridors up and downstream of in-traversable structures such as dams and weirs.
- Provide for temporary game movement corridors where construction camps and sites are expected to pose a problem.
- Provide for the protection of animal communities of recreational value (i.e. potential for angling, hunting, bird watching etc), and utilise protected areas for environmental education.
- Promote the eradication or containment of exotic animal species that threaten local ecosystems.
- Formulate guidelines or propose measures for minimising threats to animal species or communities (e.g. through habitat loss, veld fires or human intervention), such as the provision of migration corridors.
- Promote the sustainable use and protection of wildlife or marine sources for food and other purposes.

2.2 Aesthetic environment

- Protect significant landscape or townscape elements, as well as scenic attributes, against injudicious development or designs that can detract from their value.
- New developments must integrate and blend with the surrounding landscape and land use.

2.3 Socio-economic environment

- Establish a Project Steering Committee (PSC), where Interested and Affected Parties (I&AP's) can present their inputs and where informed decision making may take place.
- Make use of existing social communication structures as basis for all community interaction initiatives.
- Ensure that all project related social issues are addressed. This may include the establishment of a Community Action Committee (CAC), a Labour Desk, a Graves Policy, Compensation Policies, Relocation Action Plans, a Royalties' policy, and an Equity Policy. Such issues must be planned well in advance.
- Compile a 'Housing and Recreation' policy together with Stakeholders where the project will entail significant development of employee housing for extended periods of time.
- Allow for remuneration, transport and catering at meetings involving Stakeholders and Interested and Affected Parties.
- Allow for information sessions and educational tours as required.
- Make Strategic Development Plans (see Figure 1) available to stakeholders and I&AP's. Such plans aid in explaining and describing the extent of the project and all its components.

2.3.1 Archaeological resources

- Take note of any known sites of archaeological value in the area.
- Undertake a Phase One Archaeological Investigation of the development site to locate additional sites that may occur.

- Ensure the adequate protection of identified sites of archaeological value under threat by new development.
- Obtain a permit / authorisation from SAHRA regional office before removing or damaging any archaeological find or site

2.3.2 Historical resources

- Take note of any known sites of historical value in the area.
- Ensure the adequate protection of identified sites of historical value under threat by new development.
- Obtain a permit / authorisation from SAHRA regional office before removing or damaging any historical site. Such historical structures must be extensively documented (building material and historic context) surveyed (profile sketches and layout plans) and photographed as stipulated by the National Heritage Resources Act (Act no. 25 of 1999) before they may be damaged or destroyed.

2.3.3 Cultural resources

- Take note of any graves, cemeteries or burial sites within the area.
- Take note of any events, actions, or traditions that are current in the area.
- Ensure the adequate protection of graves, cemeteries, burial sites, places of worship, initiation schools and other sites of cultural value under threat by new development.
- Obtain approval from the relevant Provincial Department of Health before planning to relocate any grave. This includes interaction with relatives of the deceased. Authorisation for exhumation and re-interment must also be obtained from the relevant local or regional council. In addition, the institution conducting the relocation needs authorisation under Section 24 of the Human Tissues Act (Act No. 65 of 1983). Graves older than 60 years, but younger than 100 years are also protected in terms of the National Heritage Resources Act (Act No. 65 of 1983). Graves older than 100 years are considered as being archaeological.

2.3.4 Air quality

- Take note of existing air pollution levels and the degree to which this represents a health hazard.
- Take note of the proximity of communities dependent on wood or coal as an energy source.
- Take note of the proximity of polluting industries or very high concentrations of traffic.
- Promote and sustain measures for the limitation of air pollution to acceptable levels, such as electrification or the use of pollution free energy sources such as solar power.
- Minimise air pollution impacts through appropriate siting of polluting activities and traffic routes.

2.3.5 Noise

- Take note of high levels of noise pollution in the area, including routes or areas with heavy traffic, loud music, light industry etc.
- Minimise noise pollution impacts through the appropriate siting of traffic routes or other noise generating activities and facilities.
- Plan for sound attenuation structures, such as earth berms, walls etc. where the development is anticipated to be a nuisance.

2.3.6 Social issues

- Propose measures to revitalise depressed areas, or for their adaptation to new circumstances.
- Relate the population growth and rate of urbanisation to the future needs for resources (such as land and water) and services.
- Take into account the seasonal influx of holiday makers or migrant workers on the capacity of services, infrastructure, environment and residential communities.
- Take note of the income of the community with respect to the affordability of services and the utilisation of appropriate technology.
- Take note of issues such as incidence of misbehaviour, crime, drug abuse or violence in the area and consider safety issues, such as visibility and the creation of 'defensible space'.

2.3.7 Land use and services

- Take note of any existing regional plans, including Development Frameworks, Development Plans and Town Planning Schemes that may be of relevance to the area under investigation.
- Attempt to integrate new and existing land uses.
- Keep natural open space and conserved areas intact to maintain the efficient functioning of natural corridor systems.
- Provide for access through or over in-traversable structures such as dams and weirs, especially where routes have been inundated.
- Be aware and respect the existence of access routes. If necessary, protect those of cultural, historical and social significance.
- Protect high potential farmland (i.e. crops, orchards and vegetable gardens) against land uses, misuse or development that can damage or reduce their productivity.
- Formulate guidelines to reduce the impact of farming activities in unsuitable areas, such as phasing out of activities, installing erosion protection etc.
- Take note of existing situations of surface or ground water pollution (e.g. illegal dumping, noxious effluent discharge, intensive use of agricultural fertilisers and pesticides) which pose a threat to human health or ecosystems.
- Take note of the proximity of communities who are without adequate sewage disposal facilities or waste removal services.
- Take note of any dumping or production of hazardous waste (e.g. toxic or radioactive substances).
- Formulate guidelines or propose measures for limiting water pollution, such as upgrading sewage services and introducing more efficient effluent control.

- Avoid the location of polluting land uses such as sewage works, waste disposal sites and cemeteries in areas of high water tables.

2.3.8 Tourism

- Take note of vistas, views, scenic routes and landmarks of high aesthetic or tourist value in the area.
- Take note of any destinations of high tourist value in the area.
- Protect and / or enhance features that may contribute to the tourist attraction of a place or area (such as providing a lookout).

3. ENVIRONMENTAL PLANNING GUIDELINES (SPECIAL ENVIRONMENTS)

Although a broad-brush understanding of environmental sensitivities (addressed in Chapter 2) enables decision makers to take environmentally responsible strategic decisions at pre-feasibility and project planning level, it does not necessarily equip them to take sustainable decisions regarding environments that are by their very nature sensitive.

For such Special Environments, the generic principles of sound environmental planning are often lacking, and a more detailed understanding of the sensitivities of such environments is required if potential negative impacts (both on the proposed development and on the receiving environment) are to be avoided.

These principles are again relevant during the undertaking of Strategic Environmental Assessments, Sustainable Utilisation Plans, Environmental Impact Assessments and Environmental Management Plans and should be specified in the terms of reference for such.

- Determine whether or not a Sensitive Environment is present. Various levels of assessment may be required, depending on local site characteristics.
- If yes, then determine what kind of Special Environment is present and the extent. Special Environments include not only those detailed in this document, but also the various Geographical Areas listed in Schedule 1 of the Regulations under Section 24(5) of the National Environmental Management Act (Act No. 107 Of 1998). Environmental Authorisation is required before specified activities may be undertaken in these areas:
    - An area protected by any legislation or identified by any policy or plan for the conservation of biological diversity, water resources, landscape or geological features or archaeological, palaeontological, architectural or cultural sites.
    - The core areas of biosphere reserves.
    - Any area designated by the Republic of South Africa in terms of any international agreement, treaty or convention to which it is a party (such as Ramsar Sites).
- Determine the project objectives (i.e. pollution control, erosion control, water provision etc.).
- Document site characteristics that may be of relevance (either to the Special Environment or the problem at hand).
- Design and plan the most appropriate action, bearing in mind the unique characteristics and sensitivities of the environment in question. Bear in mind socio-economic conditions of the surrounding area (theft, vandalism etc).
- Ensure that the budget allows for maintenance, post construction.
- Ensure that the relevant legislation is adhered to during planning and construction.
- Programme the works to fall within the most appropriate season.
- Based on the type of environment in question, programme the type and timing of maintenance and monitoring and auditing work.

It should be noted that the absence of one or more of the listed sensitive environments does not imply that the environment does not contain sensitive aspects such as those discussed in section 2 of this document.

3.1 Water courses

This section draws extensively from document entitled *Stream Corridor Restoration: Principles, Processes and Practises*[6].

3.1.1 Importance of water courses

a) Habitat function

- Habitats provide organisms or communities of organisms with the necessary elements of life, such as space, food, water, and shelter.
- Under suitable conditions often provided by stream corridors, many species can use the corridor to live, find food and water, reproduce, and establish viable populations. Some measures of a stable biological community are population size, number of species, and genetic variation, which fluctuate within expected limits over time.
- To varying degrees, stream corridors constructively influence these measures. The corridor's value as habitat is increased by the fact that corridors often connect many small habitat patches and thereby create larger, more complex habitats with larger wildlife populations and higher biodiversity.

b) Conduit function

- The conduit function is the ability to serve as a flow pathway for energy, materials, and organisms. A stream corridor is above all a conduit that was formed by and for collecting and transporting water and sediment. In addition, many other types of materials and biota move throughout the system. The stream corridor can function as a conduit laterally, as well as longitudinally, with movement by organisms and materials in any number of directions:
    - Materials or animals may further move across the stream corridor, from one side to another.
    - Organic debris and nutrients may fall from higher to lower floodplains and into the stream within corridors, affecting the food supply for stream invertebrates and fishes. Moving material is important because it impacts the hydrology, habitat, and structure of the stream as well as the terrestrial habitat and connections in the floodplain and uplands.
    - Stream corridors are conduits for the movement of energy, which occurs in many forms. The gravity-driven energy of stream flow continually sculpts and modifies the landscape. The corridor modifies heat and energy from sunlight as it remains cooler in spring and summer and warmer in the fall. Stream valleys are effective airsheds, moving cool air from higher to lower elevations in the evening.
    - The highly productive plant communities of a corridor accumulate energy as living plant material, and export large amounts in the form of leaf fall or

[6] FEDERAL INTERAGENCY STREAM RESTORATION WORKING GROUP. AUGUST 2000.

detritus. The high levels of primary productivity, nutrient flow, and leaf litter fall also fuel increased decomposition in the corridor, allowing new transformations of energy and materials.
  - At its outlet, a stream's outputs to the next larger water body (e.g. increased water volume, higher temperature, sediments, nutrients, and organisms) are in part the excesses of energy from its own system.
  - Streams are conduits for distribution of plants and their establishment in new areas. Flowing water may transport and deposit seeds over considerable distances. In flood stage, mature plants may be uprooted, relocated, and re-deposited alive in new locations. Wildlife also aid in the redistribution of plants by ingesting and transporting seeds throughout different parts of the corridor.
  - Sediment (bed load or suspended load) is transported through the stream. Alluvial streams are dependent on the continual supply and transport of sediment, but many of their fish and invertebrates can also be harmed by too much fine sediment. When conditions are altered, a stream may become either starved of sediment or choked with sediment down-gradient.

c) Filter and barrier functions

- Stream corridors may serve as barriers that prevent movement or filters that allow selective penetration of energy, materials and organisms. In many ways, the entire stream corridor serves beneficially as a filter or barrier that reduces water pollution, minimizes sediment transport, and often provides a natural boundary to land uses, plant communities, and some less mobile wildlife species.
- Materials, energy, and organisms which moved into and through the stream corridor may be filtered by structural attributes of the corridor. Attributes affecting barrier and filter functions include connectivity (gap frequency) and corridor width:
  - Attributes such as the structure of native plant communities can physically affect the amount of runoff entering a stream system through uptake, absorption, and interruption.
  - Vegetation in the corridor can filter out much of the overland flow of nutrients, sediment, and water.
  - Siltation in larger streams can be reduced through a network of stream corridors functioning to filter excessive sediment.
  - Ground water and surface water flows are filtered by plant parts below and above ground.
  - Chemical elements are intercepted by flora and fauna within stream corridors. A wider corridor provides more effective filtering, and a contiguous corridor functions as a filter along its entire length.
- Elements moving along a stream corridor edge may be selectively filtered as they enter the stream corridor. In these circumstances it is the shape of the edge, whether it is straight or convoluted, which has the greatest effect on filtering functions. Still, it is most often movement perpendicular to the stream corridor which is most effectively filtered or halted.
- Abrupt edges concentrate initial filtering functions into a narrow area. A gradual edge increases filtering and spreads it across a wider ecological gradient.

d) Source and sink functions

- Sources provide organisms, energy or materials to the surrounding landscape. Areas that function as sinks absorb organisms, energy, or materials from the surrounding landscape.
- The influent or 'losing' reach is a source of water to the aquifer, and the effluent or "gaining" reach is a sink for ground water. Stream corridors or features within them can act as a source or a sink of environmental materials. Some stream corridors act as both, depending on the time of year or location in the corridor.
- Stream banks most often act as a source, for example, of sediment to the stream. At times, however, they can function as sinks while flooding deposits new sediments there.
- At the landscape scale, corridors are connectors to various other patches of habitats in the landscape and as such they are sources and conduits of genetic material throughout the landscape.
- Stream corridors can act as a sink for storage of surface water, ground water, nutrients, energy, and sediment allowing for materials to be temporarily fixed in the corridor.
- Dissolved substances, such as nitrogen, phosphorus, and other nutrients, entering a vegetated stream corridor are restricted from entering the channel by friction, root absorption, clay, and soil organic matter.

3.1.2 Identification and delineation of water courses

a) Cross section criteria:

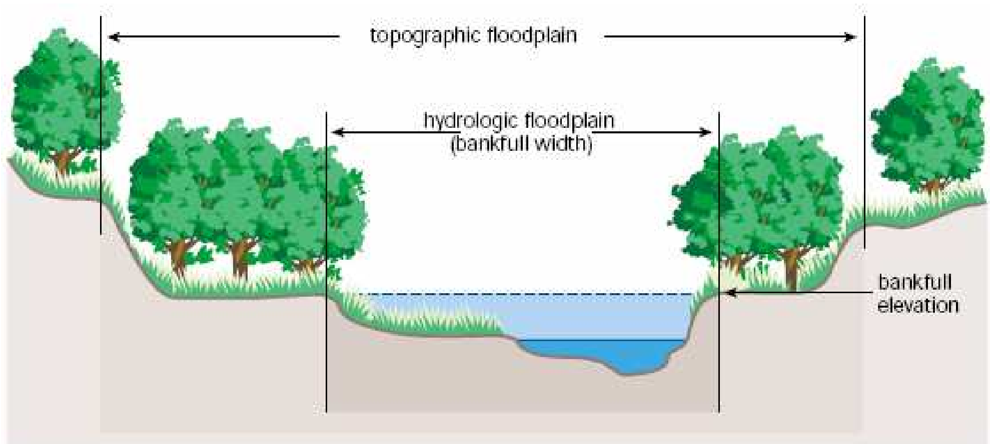
Water and other materials, energy, and organisms meet and interact within the stream corridor over space and time. This movement provides critical functions essential for maintaining life such as cycling nutrients, filtering contaminants from runoff, absorbing and gradually releasing floodwaters, maintaining fish and wildlife habitats, recharging ground water, and maintaining stream flows. A stream corridor is an ecosystem that usually consists of three major elements:

Stream flow channel:

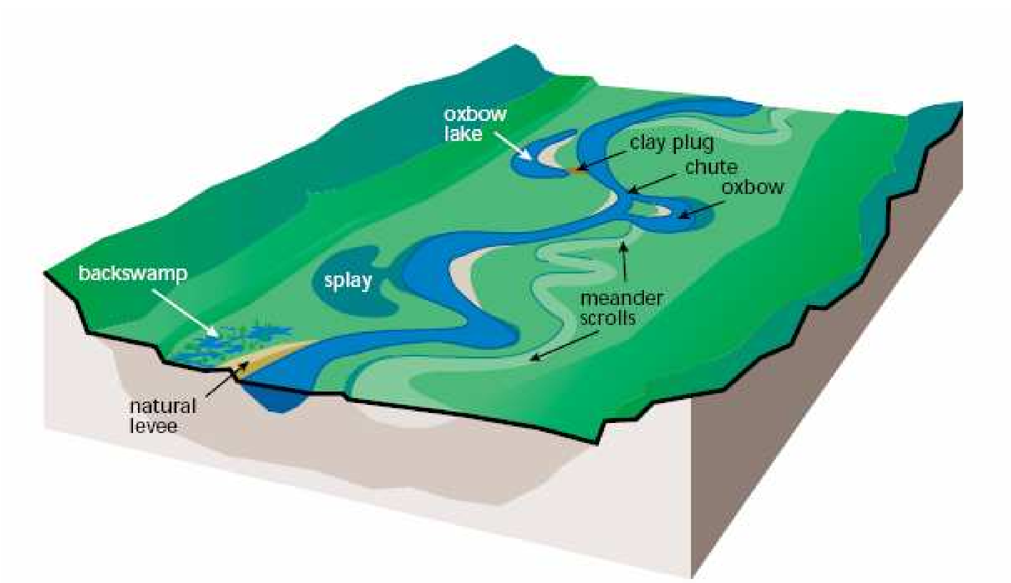
- A stream-flow channel is essentially the pathways precipitation takes after it falls to earth. Aspects of stream-flow include its quantity, quality, and timing, and consists of two basic components:
  - Stormflow, which is precipitation that reaches the channel over a short time frame through overland or underground routes.
  - Baseflow, which is precipitation that percolates into the ground and moves slowly through substrate as ground water before reaching the channel. It sustains stream flow during periods of little or no precipitation.
- Practitioners categorize streams based on the balance and timing of the stormflow and baseflow components. There are three main categories:
  - Ephemeral streams flow only during or immediately after periods of precipitation (generally less than 30 days per year).
  - Intermittent or seasonal streams flow only during certain times of the year (usually longer than 30 days per year).
  - Perennial streams flow continuously during both wet and dry times. Baseflow is dependably generated from the movement of ground water into the channel.

Floodplain:

- A floodplain is a highly variable area on one or both sides of the stream channel that is inundated by floodwaters at some interval. Two types of floodplains are defined:
    - Hydrologic floodplain, which is the land adjacent to the baseflow channel and is inundated about two years out of three. Not every stream corridor has a hydrologic floodplain.
    - Topographic floodplain, which is the land adjacent to the channel including the hydrologic floodplain and other lands up to an elevation based on the elevation reached by a flood peak of a given frequency (for example, the 100-year floodplain).
- Topographic features are formed on the floodplain by the lateral migration of the channel. These features result in varying soil and moisture conditions and provide a variety of habitat niches that support plant and animal diversity. Floodplain landforms and deposits include:
    - Meander scroll, a sediment formation marking former channel locations.
    - Chute, a new channel formed across the base of a meander. As it grows in size, it carries more of the flow.
    - Oxbow, a term used to describe the severed meander after a chute is formed.
    - Clay plug, a soil deposit developed at the intersection of the oxbow and the new main channel.
    - Oxbow lake, a body of water created after clay plugs the oxbow from the main channel.
    - Natural levees, formations built up along the bank of some streams that flood. As sediment-laden water spills over the bank, the sudden loss of depth and velocity causes coarser sized sediment to drop out of suspension and collect along the edge of the stream.
    - Splays, delta-shaped deposits of coarser sediments that occur when a natural levee is breached. Natural levees and splays can prevent floodwaters from returning to the channel when floodwaters recede.
    - Backswamps, a term used to describe floodplain wetlands formed by natural levees.



Section through the floodplain of a water course. Source: FEDERAL INTERAGENCY STREAM RESTORATION WORKING GROUP. Stream Corridor Restoration: Principles, Processes and Practises. August 2000.



Typical components of a water course. Source: FEDERAL INTERAGENCY STREAM RESTORATION WORKING GROUP. Stream Corridor Restoration: Principles, Processes and Practises. August 2000.

Transitional upland fringe:

- The transitional upland fringe serves as a transitional zone between the floodplain and surrounding landscape. Thus, its outside boundary is also the outside boundary of the stream corridor itself. While stream-related hydrologic and geomorphic processes might have formed a portion of the transitional upland fringe in geologic times, they are not responsible for maintaining or altering its present form.
- The transitional upland fringes can be flat, sloping, or in some cases, nearly vertical.

Vegetation is an important and highly variable element in the stream corridor (also known as riparian vegetation):

- The distribution riparian vegetation communities would be based on different hydrologic and soil conditions. In smaller streams the riparian vegetation might even form a canopy and enclose the channel. In some minimally disturbed stream corridors, a series of plant communities might extend uninterrupted across the entire corridor.

b) Long section criteria

- The overall longitudinal profile of most streams can be roughly divided into three zones (erosion, transfer, and deposition occur in all zones, but the zone concept focuses on the most dominant process):
    - Zone 1, or headwaters, often has the steepest gradient. Sediment erodes from slopes of the watershed and moves downstream.
    - Zone 2, the transfer zone, receives some of the eroded material. It is usually characterized by wide floodplains and meandering channel patterns.
    - The gradient flattens in Zone 3, the primary depositional zone.
- The form of the channel can change as it moves through the three longitudinal zones. Natural channels are rarely straight. Sinuosity is a term indicating the amount of curvature in the channel. Low to moderate levels of sinuosity are typically found in Zones 1 and 2 of the longitudinal profile. Extremely sinuous streams often occur in the broad, flat valleys of Zone 3.
- No matter the channel form, most streams share a similar attribute of alternating, regularly spaced, deep and shallow areas called pools and riffles:
    - Pools typically form near the outside bank of bends.
    - Riffle areas usually form between two bends.

3.1.3 Inherent sensitivities of water courses

a) Hydrologic and hydraulic processes

- Flows range from no flow to flood flows in a variety of time scales. The variability of stream-flow is a primary influence on the biotic and abiotic processes that determine the structure and dynamics of stream ecosystems. High flows are important not only in terms of sediment transport, but also in terms of reconnecting floodplain wetlands to the channel.
- In general, completion of the life cycle of many riverine species requires an array of different habitat types whose temporal availability is determined by the flow regime. Adaptation to this environmental dynamism allows riverine species to persist during periods of droughts and floods that destroy and recreate habitat elements.

b) Geomorphic processes

- Three primary geomorphic processes are involved with flowing water:
    - Erosion, the detachment of soil particles.
    - Sediment transport, the movement of eroded soil particles in flowing water.
    - Sediment deposition, settling of eroded soil particles to the bottom of a water body or left behind as water leaves. Sediment deposition can be transitory, as

in a stream channel from one storm to another, or more or less permanent, as in a larger reservoir.

- Stream channels and their floodplains are constantly adjusting to the water and sediment supplied by the watershed:
  - o Daily changes in stream flow and sediment load result in frequent adjustment of bedforms and roughness in many streams with movable beds.
  - o Floods not only remove vegetation but create and increase vegetative potential along the stream corridor. Low flow periods allow vegetation incursion into the channel. Similar levels of adjustment also may be brought about by changes in land use in the stream corridor and the upland watershed.
- Long-term changes in runoff or sediment yield from natural causes, such as climate change, wildfire, etc., or human causes, such as cultivation, overgrazing, or rural-to-urban conversions, may lead to long-term adjustments in channel cross section and plan that are frequently described as channel evolution.

c) Physical and chemical characteristics

- Appropriate flow regime and geomorphology in a stream corridor may do little to ensure a healthy ecosystem if the physical and chemical characteristics of the water are inappropriate.
- Suspended sediment plays an important role in water quality.
- Water temperature is a crucial factor in terms of the stream's ecological health:
  - o Dissolved oxygen solubility decreases with increasing water temperature, so the stress imposed by oxygen-demanding waste increases with higher temperatures.
  - o Temperature governs many biochemical and physiological processes in cold-blooded aquatic organisms, and increased temperatures can increase metabolic and reproductive rates throughout the food chain.
  - o Many aquatic species can tolerate only a limited range of temperatures, and shifting the maximum and minimum temperatures within a stream can have profound effects on species composition.
  - o Temperature affects many abiotic chemical processes and temperature increases can lead to increased stress from toxic compounds, for which the dissolved fraction is usually the most bioactive fraction.
- Alkalinity, acidity, and buffering capacity are important characteristics of water that affect its suitability for biota and influence chemical reactions:
  - o Many biological processes, such as reproduction, cannot function in acidic or alkaline waters.
  - o Rapid fluctuations in pH also can stress aquatic organisms.
  - o Acidic conditions also can aggravate toxic contamination problems through increased solubility, leading to the release of toxic chemicals stored in stream sediments.
- Dissolved oxygen (DO) is a basic requirement for a healthy aquatic ecosystem. Most fish and aquatic insects "breathe" oxygen dissolved in the water column:
  - o Some fish and aquatic organisms are adapted to low oxygen conditions, but certain fish species suffer if DO concentrations fall below a concentration of 3 to 4 mg/L.

- o Many fish and other aquatic organisms can recover from short periods of low DO in the water. However, prolonged episodes of depressed dissolved oxygen concentrations of 2 mg/L or less can result in “dead” water bodies.
- o Prolonged exposure to low DO conditions can suffocate adult fish or reduce their reproductive survival by suffocating sensitive eggs and larvae, or can starve fish by killing aquatic insect larvae and other prey.
- o Low DO concentrations also favour anaerobic bacteria that produce the noxious gases or foul doors often associated with polluted water bodies.
- o Undisturbed streams generally contain an abundant DO supply. However, external loads of oxygen-demanding wastes or excessive plant growth induced by nutrient loading followed by death and decomposition of vegetative material can deplete oxygen.

- In addition to carbon dioxide and water, aquatic plants (both algae and higher plants) require a variety of other elements to support their bodily structures and metabolism. Just as with terrestrial plants, the most important of these elements are nitrogen and phosphorus. Additional nutrients, such as potassium, iron, selenium, and silica, are needed in smaller amounts and generally are not limiting factors to plant growth. When these chemicals are limited, plant growth may be limited.
- Toxic organic chemicals are synthetic compounds that contain carbon, such as polychlorinated biphenyls (PCBs) and most pesticides and herbicides. Many of these synthesized compounds tend to persist and accumulate in the environment because they do not readily break down in natural ecosystems.
- A variety of naturally occurring metals, ranging from arsenic to zinc, have been established to be toxic to various forms of aquatic life when present in sufficient concentrations.

d) Terrestrial ecosystems

- Terrestrial ecosystems are fundamentally tied to processes within the soil. The ability of a soil to store and cycle nutrients and other elements depends on the properties and microclimate (i.e., moisture and temperature) of the soil, and the soil’s community of organisms. These factors also determine its effectiveness at filtering, buffering, degrading, immobilizing, and detoxifying other organic and inorganic materials.
- The ecological integrity of stream corridor ecosystems is directly related to the integrity and ecological characteristics of the plant communities that make up and surround the corridor. These plant communities are a valuable source of energy for the biological communities, provide physical habitat, and moderate solar energy fluxes to and from the surrounding aquatic and terrestrial ecosystems.
- The characteristics of the plant communities directly influence the diversity and integrity of the faunal communities. Plant communities that cover a large area and that are diverse in their vertical and horizontal structural characteristics can support far more diverse faunal communities than relatively homogenous plant communities, such as meadows.
- The quantity of terrestrial vegetation, as well as its species composition, can directly affect stream channel characteristics. Root systems in the stream bank can bind bank sediments and moderate erosion processes. Trees and smaller woody debris that fall into the stream can deflect flows and induce erosion at some points and deposition at others. Thus woody debris accumulation can influence pool

distribution, organic matter and nutrient retention, and the formation of microhabitats that are important fish and invertebrate aquatic communities. Stream flow also can be affected by the abundance and distribution of terrestrial vegetation.

- The short-term effects of removing vegetation can result in an immediate short-term rise in the local water table due to decreased evapo-transpiration and additional water entering the stream. Over the longer term, however, after removal of vegetation, the baseflow of streams can decrease and water temperatures can rise, particularly in low-order streams.
- The removal of vegetation can cause changes in soil temperature and structure, resulting in decreased movement of water into and through the soil profile. The loss of surface litter and the gradual loss of organic matter in the soil also contribute to increased surface runoff and decreased infiltration.
- In most instances, the functions of vegetation that are most apparent are those that influence fish and wildlife. At the landscape level, the fragmentation of native cover types has been shown to significantly influence wildlife, often favouring opportunistic species over those requiring large blocks of continuous habitat.
- In some systems, relatively small breaks in corridor continuity can have significant impacts on animal movement or on the suitability of stream conditions to support certain aquatic species. In others, establishing corridors that are structurally different from native systems or that are inappropriately configured can be equally disruptive. Narrow corridors that are essentially edge habitat may encourage generalist species, nest parasites, and predators, and, where corridors have been established across historic barriers to animal movement, they can disrupt the integrity of regional animal assemblages.
- Stream corridors are used by wildlife and are a major source of water to wildlife populations, especially large mammals. The faunal composition of a stream corridor is a function of the interaction of food, water, cover, and spatial arrangement. These habitat components interact in multiple ways to provide eight habitat features of stream corridors:
    - Presence of permanent sources of water. Stream corridors offer the optimal habitat for many forms of wildlife because of the proximity to a water source and an ecological community.
    - High primary productivity and biomass. Water is especially critical to fauna in where stream corridors are the only naturally occurring permanent sources of water on the landscape. These relatively moist environments contribute to the high primary productivity and biomass of the riparian area, which contrasts dramatically with surrounding cover types and food sources.
    - Dramatic spatial and temporal contrasts in cover types and food availability.
    - Critical microclimates. Stream corridors provide critical microclimates that ameliorate the temperature and moisture extremes of uplands by providing water, shade, evapo-transpiration, and cover.
    - Horizontal and vertical habitat diversity.
    - Maximized edge effect. The spatial distribution of vegetation is a critical factor for wildlife. The linear arrangement of streams results in a maximized edge effect that increases species richness because a species can simultaneously access more than one cover (or habitat) type. Edges occur along multiple habitat types including the aquatic, riparian, and upland habitats.
    - Effective seasonal migration routes.

- o High connectivity between vegetated patches. Forested connectors between habitats establish continuity between forested uplands that may be surrounded by un-forested areas. These act as feeder lines for dispersal and facilitate repopulation by plants and animals. Thus, connectivity is very important for retaining biodiversity and genetic integrity on a landscape basis

e) Aquatic ecosystems

- The biological diversity and species abundance in streams depend on the diversity of available habitats. Naturally functioning, stable stream systems promote the diversity and availability of habitats.
- A stream's cross-sectional shape and dimensions, its slope and confinement, the grain-size distribution of bed sediments, and even its plan affect aquatic habitat. Under less disturbed situations, a narrow, steep-walled cross section provides less physical area for habitat than a wider cross section with less steep sides, but may provide more biologically rich habitat in deep pools compared to a wider, shallower stream corridor. A steep, confined stream is a high-energy environment that may limit habitat occurrence, diversity, and stability.
- Unconfined systems flood frequently, which can promote riparian habitat development. Habitat increases with stream sinuosity. Uniform sediment size in a streambed provides less potential habitat diversity than a bed with many grain sizes represented.

f) Dynamic equilibrium

- In constantly changing ecosystems like stream corridors, stability is the ability of a system to persist within a range of conditions. The maintenance of this dynamic equilibrium requires that a series of self-correcting mechanisms be active in the stream corridor ecosystem. These mechanisms allow the ecosystem to control external stresses or disturbances within a certain range of responses thereby maintaining a self-sustaining condition.
- Many stream systems can accommodate fairly significant disturbances and still return to functional condition in a reasonable time frame, once the source of the disturbance is controlled or removed. Often the removal of stress and the time to recover naturally are an economical and effective restoration strategy.
- When significant disturbance and alteration has occurred, however, a stream corridor may require several decades to restore itself. Even then, the recovered system may be a very different type of stream that, although at equilibrium again, is of severely diminished ecological value in comparison with its previous potential.
- Disturbances can often stress the system beyond its natural ability to recover. In these instances restoration is needed to remove the cause of the disturbance or stress (passive) or to repair damages to the structure and functions of the stream corridor ecosystem (active).

3.1.4 Suggested mitigation and management of water courses

a) Corridor connectivity

- Thresholds at which a stream corridor achieves ideal habitat, conduit, filter, and other functions are likely found at different corridor widths, which vary according to soil type and gradient. A conservative indicator of effective corridor width is the minimum required for the stream corridor to significantly prevent chemical contaminants contained in runoff from reaching the stream.

- A corridor which extends across the stream, its banks, the floodplain, and the valley slopes should be maintained or restored wherever possible. Ideally, the corridor should also include an upland portion for the entire stream length to maintain functional integrity.
- A stream corridor must provide its minimal functions adequately, and its connectivity requirement and width attributes must be determined accordingly:
  - If, for example, a particular species requires that the corridor offer interior habitat, the corridor width must allow for the necessary habitat.
  - The requirements of the most sensitive species typically are used for optimum corridor dimensions. When these dimensions extend beyond the land base available for restoration, management of adjacent land uses becomes a tool for making the corridor effectively wider than the project parameters.
  - Optimum corridor dimensions can be achieved through collaboration with individuals and organizations that have management authority over adjacent lands.
- Practical considerations may restrict conservation or restoration of a stream corridor to a zone of predefined width adjacent to the stream. Restricting restoration to a narrow part of the stream corridor usually does not restore the full horizontal diversity of broad floodplains, nor does it fully accommodate functions that occur during flood events, such as use of the floodplain by aquatic species. In floodplains where extensive subsurface hydrologic connections exist, limiting restoration to streamside buffer zones is not recommended since significant amounts of energy, nutrient transformation, and invertebrate activities can occur at great distances from the stream channel outside the buffer areas.
- Where a contiguous, wide stream corridor is not achievable, a ladder pattern of natural habitat, crossing the floodplain and connecting the upland segments, might facilitate sediment trapping during floods and provide hydraulic storage and organic matter for the stream system.
- Where competing land uses prevail, innovative management practices that serve the functions of the corridor beyond land ownership boundaries can often be prescribed where land owners are supportive. Altering land cover, reducing chemical inputs, carefully timed mowing, and other management practices can reduce disturbance in the corridor.
- When restoring stream corridors, examination of landscape patterns is beneficial in identifying a reference stream corridor upon which to base restoration criteria. The reference should provide information about gap width, landform, species requirements, vegetative structure, and boundary characteristics of the stream corridor:
  - The stream corridor is dependent on interactions with the stream to sustain its character and functions. Therefore, to the extent feasible, restoration processes should include blockage of artificial drainage systems, removal or setback of artificial levees, and restoration of natural patterns of floodplain topography, unless these actions conflict with other social or environmental objectives (e.g., flooding or habitat).
  - Restoration of micro-relief is particularly important where natural flooding has been reduced or curtailed because a topographically complex floodplain

supports a mosaic of plant communities and ecosystem functions as a result of differential ponding of rainfall and interception of ground water.
    - Micro-relief restoration can be accomplished by selective excavation of historic features within the floodplain such as natural wetlands, levees, oxbows, and abandoned channels. Aerial photography and remotely sensed data, as well as observations in reference corridors, provide an indication of the distribution and dimensions of typical floodplain micro-relief features.

b) Soil properties

- Stream corridor functions depend not only on the connectivity and dimensions of the stream corridor, but also on its soils and associated vegetation. The variable nature of soils across and along stream corridors results in diverse plant communities. It is important to understand the soils and their related potentials and limitations to support diverse native plant and animal communities, especially during stream restoration and channel reconstruction.
- The functions of soil and the connection between soil quality, runoff, and water quality need to be identified and considered. For all land uses, emphasis needs to be placed on implementing conservation land treatment that promotes soil quality and the ability of the soils to carry out four major functions:
    - Regulating and partitioning the flow of water (a conduit and filter function).
    - Storing and cycling nutrients and other chemicals (a sink and filter function).
    - Filtering, buffering, degrading, immobilizing, and detoxifying organic and inorganic materials (a filter, sink, and barrier function).
    - Supporting biological activity in the landscape (a source and habitat function).

c) Habitat sustainability

- Vegetation is a fundamental controlling factor in stream corridor function. Habitat, conduit, filter/barrier, source, and sink functions are all critically tied to the vegetative biomass amount, quality, and condition.
- The maintenance of adequate and appropriate buffer strips within riparian systems is important for the maintenance of stream ecology. These buffer strips:
    - Provide shade that reduces water temperature.
    - Cause deposition of (i.e., filter) sediments and other contaminants.
    - Reduce nutrient loads of streams.
    - Stabilize stream banks with vegetation.
    - Reduce erosion caused by uncontrolled runoff.
    - Provide riparian wildlife habitat.
    - Protect fish habitat.
    - Maintain aquatic food webs.
    - Provide a visually appealing greenbelt.
    - Provide recreational opportunities.
- Although the value of buffer strips is well recognized, criteria for their sizing are variable. In urban stream corridors a wide buffer is an essential component of any protection strategy. Its primary value is to provide physical protection for the stream channel from future disturbance or encroachment.
- A network of buffers acts as the right of way for a stream and functions as an integral part of the stream ecosystem.

- Buffer configuration and composition influence wildlife habitat quality, including suitability as migration corridors for various species and suitability for nesting habitat. Re-establishment of linkages among elements of the landscape can be critically important for many species.
- Establishment of inappropriate and narrow corridors can have a net detrimental influence at local and regional scales. Local wildlife management priorities should be evaluated in developing buffer width criteria that address these issues.

- Because small and/or isolated patches of habitat can be so important to migrants, riparian restoration efforts should not overlook the important opportunities they afford.
- Connectivity is an important evaluation parameter of stream corridor functions, facilitating the processes of habitat, conduit, and filter/barrier. Stream corridor preservation and restoration should maximize connections between ecosystem functions.
- Habitat and conduit functions can be enhanced by linking critical ecosystems to stream corridors through design that emphasizes orientation and proximity.
- Designers should consider functional connections to existing or potential features such as vacant or abandoned land, rare habitat, wetlands, diverse or unique vegetative communities, springs, movement corridors or associated stream systems. This allows for movement of materials and energy, thus increasing conduit functions and effectively increasing habitat through geographic proximity.

- Generally, a long, wide stream corridor with contiguous vegetative cover is favoured, though gaps are commonplace. The most fragile ecological functions determine the acceptable number and size of gaps. Wide gaps can be barriers to migration of smaller terrestrial fauna and indigenous plant species.
- Aquatic fauna may also be limited by the frequency or dimension of gaps. The width and frequency of gaps should therefore be planned in response to stream corridor functions.
- Bridges must be designed to allow migration of animals, along with physical and chemical connections of river and wetland flow (e.g. underpasses constructed beneath roadways to serve as conduits for species movement).

d) Edge treatment

- The structure of the edge vegetation between a stream corridor and the adjacent landscape affects the habitat, conduit, and filter functions. Boundaries between stream corridors and adjacent landscapes may be straight or curvilinear:
  - A straight boundary allows relatively unimpeded movement along the edge, thereby decreasing species interaction between the two ecosystems.
  - Conversely, a curvilinear boundary with lobes of the corridor and adjoining areas reaching into one another encourages movement across boundaries, resulting in increased interaction.
  - The shape of the boundary can be designed to integrate or discourage these interactions, thus affecting the habitat, conduit, and filter functions.
- Heterogeneity within the stream corridor is an important consideration. Typically, vegetation at the edge of the stream corridor is very different from the vegetation that occurs within the interior of the corridor. The topography, aspect, soil, and

hydrology of the corridor provide several naturally diverse layers and types of vegetation.

- An edge that gradually changes from the stream corridor into the adjacent ecosystems must be maintained, to soften environmental gradients and minimize any associated disturbances. These transitional zones encourage species diversity and buffer variable nutrient and energy flows.
- Although human intervention has made edges more abrupt, the conditions of naturally occurring edge vegetation can be restored through design.
- To maintain a connected and contiguous vegetative cover at the edge of small gaps, taller vegetation should be designed to continue through the gap. If the gap is wider than can be breached by the tallest or widest vegetation, a more gradual edge may be appropriate.

3.2 Wetlands

This section draws extensively from the following documents:

- *Practical Wetland Management*[7]*.*
- *Wetland-Assess: A Rapid Assessment Procedure for Describing Wetland Benefits (First Draft for Comment)*[8]*.*
- *Wetlands and People: What Values do Wetlands Have for us and how are these Values affected by our Land Use Activities*[9].

3.2.1 Importance of wetlands

- Flood attenuation capability, based on the following:
  - The size of the wetland relative to the catchment.
  - Slope.
  - Surface roughness.
  - Presence of valley bottom depressions.
  - Flow patterns of storm flows (presence of channels).
  - Inherent run-off potential of the soil.
  - Land use and conservation practices.
- Stream-flow augmentation, based on the following:
  - If a wetland is isolated from the stream system, as is the case for many pans and some seepage slopes, then the wetland would not contribute any water to the stream system.
  - A wetland area which remains permanently saturated would generally have greater potential to release water to the stream system than an area which is seasonally saturated.
  - Peat increases the water storage capacity of the soil in a wetland but has a very low hydraulic conductivity, as is the case for dense clay soils, thereby limiting the release of water.
  - Following winter die back, the amount of live transpiring plant material is very limited and the standing dead material greatly reduces evaporation from the wetland.
- Sediment trapping, based on the following:

[7] BRAACK, AM, WALTERS D, KOTZE DC.. 2000. RENNIES WETLAND PROJECT
[8] KOTZE D C, MARNEWECK G C, BATCHELOR A L, LINDLEY D S, COLLINS N B. APRIL 2004.
[9] RENNIES WETLAND PROJECT. 1997

- Effectiveness in attenuating floods.
  - Extent of vegetation cover.
  - Extent of sediment sources delivering sediment to the wetland.
- Phosphate removal, which contributes to water quality.
- Nitrate removal, which contributes to water quality.
- Toxicant removal which contributes to water quality.
- Reduction in erosion control, based on the following:
  - Vegetation cover.
  - Surface roughness.
  - Level of physical disturbance of the soil in the wetland.
  - Runoff intensity from the catchment.
- Biodiversity. Ecological integrity of the system is based on the following:
  - Extent of buffer zone around wetland.
  - Connectivity of wetland to other natural areas in the landscape.
  - Alteration of natural hydrological regime.
  - Alteration of natural sediment regime.
  - Alteration of nutrient / toxicant regime.
  - Change in structure of the natural vegetation.
  - Invasive & pioneer species encroachment.
  - Over-utilization of biota.
  - Presence of obstructive / hazardous barriers.
  - Wetland of a threatened or rare type: Certain wetland types have been much more severely affected than others and certain vegetation types have been far more transformed than others, and remaining natural areas of these veld types may be very important.
  - Level of cumulative loss of wetlands in the catchment.
  - Presence of Red data species or suitable habitat for Red Data species.
- Carbon storage (trapping).
- Water supply, based on the following:
  - Representation of different hydrological zones (i.e. the more prolonged the wetness of an area, the more reliable it will be as a source of water for human use).
  - Current water use for domestic / agricultural purposes.
  - Number of households who depend on the resource.
  - Irreplaceability of the wetland water source for its users.
- Source of extractable / harvestable resources, based on the following:
  - Total number of different resources used in the wetland.
  - Number of households whose livelihoods depend on the wetland.
  - Total income generated.
  - Irreplaceability of the wetland resource.
- Socio-cultural significance, based on the following:
  - Scenic beauty of the wetland.
  - Presence of any charismatic species such as cranes, and hippopotami.
  - The presence of palaeontological (i.e. fossil) sites, archaeological sites, battle fields, meteorite sites, graves or burial grounds.
  - Location in a rural communal area: In many rural communal areas wetlands still have cultural significance.
  - Known local cultural practices in the wetland (including traditional cleansing ceremonies, baptisms, traditional fishing practices, harvesting of plants for

traditional crafts, and harvesting of plants for traditional medicines. Even song writing may be considered here).
    - Known local taboos and beliefs relating to the wetland.
- Tourism and recreation potential, based on the following:
    - Current use.
    - Appropriate tourist locations nearby.
    - Cultural heritage and the aesthetics.
    - Presence of waterfowl, antelope and fish that can be sustainable harvested through hunting/fishing.
    - Absence of dangerous animals such as crocodiles.
- Education and research potential, based on the following:
    - Current use.
    - Reference site suitability.
    - Long term data collected.
    - Accessibility.

3.2.2 Identification and delineation of wetlands

a) Identification criteria:

- In order to establish whether or not a known wetland is present, obtain wetland data from the National Wetland Inventory, undertaken as part of the National Land Cover (NLC) 2000 initiative to provide a broad overview of the wetlands in the catchment. Contact the Department of Environmental Affairs and Tourism in Pretoria.
- To establish whether the wetland is known to be performing an important biodiversity function, contact the Provincial Nature Conservation body to see if there are any records of the wetland supporting a threatened species or being of a rare or threatened wetland type or possessing other notable natural features. Also check whether it falls within a vegetation type that has been subject to a high cumulative loss/transformation. *It must be emphasized that failure of a wetland to qualify based on these criteria, by no means indicates that it does not have a biodiversity value*.
- There are six types of wetland distinguishable according to their function:
    - Floodplains.
    - Channelled valley bottom wetlands.
    - Non-channelled valley bottom wetlands.
    - Hill slope seepage wetlands feeding a stream.
    - Hill slope seepage wetlands not feeding a stream.
    - Pans and other depressions.
- Some parts of the wetland are saturated to different degrees than others:
    - The permanently saturated zone is waterlogged for 12 months of the year.
    - The seasonally saturated zone is waterlogged for 5 - 11 months of the year.
    - The temporarily saturated zone is saturated for 1 - 4 months.

The presence of a wetland may be established using the following identification criteria:

High water table*:*

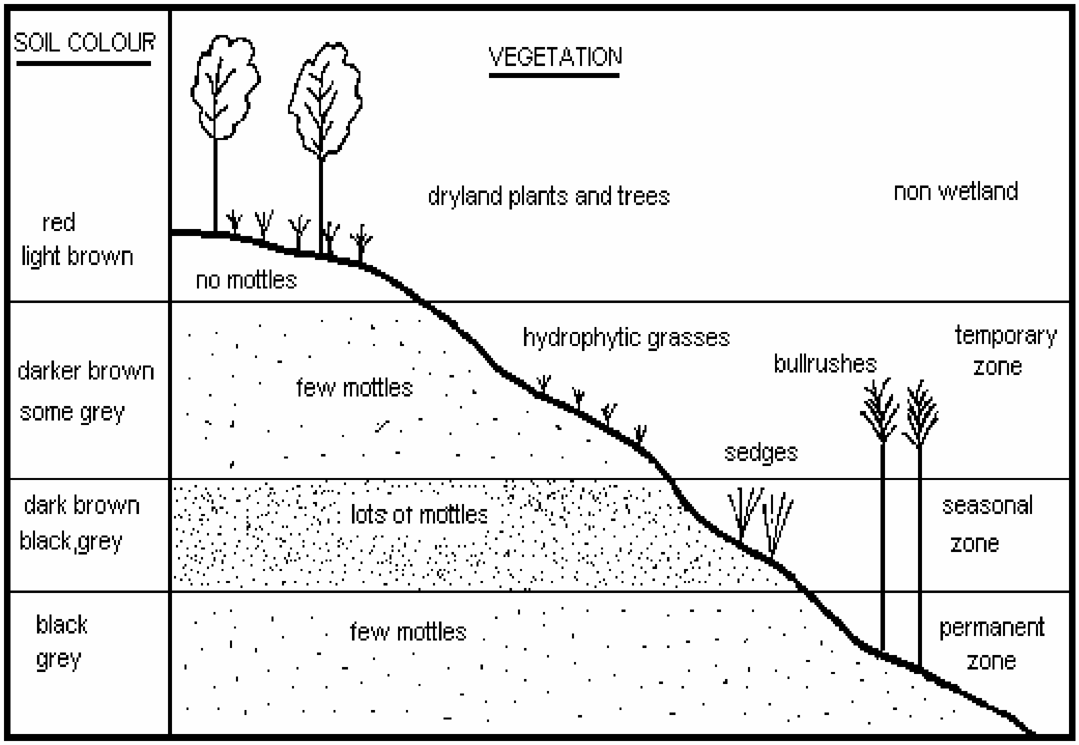
- Water is crucial for wetlands to survive. However, as the water table depth changes in response to climate change (from year to year, season to season, and within a season) the presence of water within the soil profile, cannot always be used as a reliable field indicator. However, the soil morphology also indicates the water regime very clearly. It is for this reason that we concentrate on looking at hydromorphic soils, and hydrophytic plants for the delineation. *As the water table is often difficult to identify, especially for temporary and seasonal wetlands, it is not essential for this characteristic to be visibly confirmed in order to delineate a wetland.*

***Hydromorphic soils**:*

- The water regime has a strong effect on the colour patterns of the soil. The colour patterns develop slowly and reflect 'average' conditions over a long time. These colour patterns are read by looking at the soil colour, and the presence of mottles in the top 50 cm of the soil profile. *Hydromorphic soils must always be present in order to delineate a wetland*.
  - Well drained soils are mostly found to be uniformly red/brown/yellow in colour while wetland soils are generally grey in colour (due to iron oxide leaching).
  - The wettest parts of the wetland, which are most anaerobic, tend to have the highest organic matter contents and are thus darker in colour than dryland soils (these get progressively darker or blacker as you move into the wetter sections of the wetland).
  - Soil which is grey but has many mottles may be interpreted as indicating a zone with a fluctuating (rising and falling) water table.
- An important point to remember is that in some wetlands, especially those where the iron content of the soil is low, mottles may be scarce throughout the 3 wetness zones.
- In wetlands which are covered in very sandy soil or course sediment, the organic material and iron oxides are often leached out. This gives the soils a white bleached look. In this case you will not be able to use colour or the presence of mottles to delineate the wetland. Instead use other indicators such as the presence of hydophytic plants or hydrology.

***Hydrophytic plants**:*

- Hydrophytic plants have adapted to surviving in waterlogged soils: they generally have a rooting depth of 50 cm, and therefore need to be in contact with the water table at this depth, or less. It is for this reason that you only sample the soil for signs of hydromorphy up to this depth. Should a wetland dry out, the hydrophytic plants will be replaced by dryland plants. This often happens in wetlands that have been severely impacted upon by donga erosion or drains. Hydrophytic plants should preferably be present in order to delineate a wetland.



Section through a wetland showing typical zones. Source: BRAACK AM, WALTERS D, KOTZE DC. Practical Wetland Management. 2000. Rennies Wetland Project.

b) Delineation of wetlands

- Wetlands are characteristically- found in bottomland positions, which have gentle slopes giving rise to poorly drained conditions where water is retained in the soil. However, wetlands are also found in other positions, including:
    - Footslopes, which have gentle slopes.
    - Mid-slopes, in small areas where groundwater discharges.
    - Valley-heads, where groundwater may also be discharging.
- A wetland boundary is identified by finding the point of transition between the dryland soils and the wetland (hydromorphic) soils. This is done by sampling the soil along a transect using a soil auger.
- The transition zone where hydromorphic soils begin to appear within the top 500mm of the soil profile is regarded as the wetland boundary.
- This can be confirmed by the change in plant communities from mesophytes (plants adapted to living in well drained soils) to hydrophytes (plants adapted to living in waterlogged soils), as the degree of water logging in the soil increases.

3.2.3 Inherent sensitivities of wetlands

- Land uses on-site can affect the functioning of wetlands. Such potentially detrimental land uses include the following:

- o Changes to the flow pattern within the wetland through drainage channels which cause flow to become more channelled and less diffuse, thereby reducing the wetness of the area.
- o Disturbances of the soil, making it more susceptible to erosion.
- o Changes in the surface roughness and vegetation cover (when these are reduced the ability of the wetland to slow down water flow, reduce erosion and purify water is reduced).
- o Replacement of the natural vegetation by introduced plants, which generally reduces the value of the wetland for wetland dependent species.
- o The production of crops and planted pastures.
- o Timber production.
- o Grazing by domestic stock (poorly managed).
- o Mowing and harvesting of plants.
- o Burning (poorly managed).
- o Damming (irresponsible).
- o Wastewater purification.
- o Roads.
- o Alien plants.
- o Non-sustainable fishing and hunting.

- Land uses off-site can affect the functioning of wetlands. Such potentially detrimental land uses include the following:
  - o Damming.
  - o Pumping.
  - o Mining.
  - o Intensive animal production.
  - o Sewage works.
  - o Industries.
  - o Crop production.
  - o Poorly managed grazing lands.
  - o Human settlements with inadequate sanitation.

As a general rule, the more you alter the hydrology of a wetland the greater will be the effect on its functioning. Uses which do not alter the hydrology and which do not affect the functioning of the wetland negatively need to be promoted.

3.2.4 Suggested mitigation and management of wetlands

a) Burning

- Stream source wetlands (seeps and springs) with herbaceous cover are often subjected to local veld or firebreak burning because of their position on the slopes. They are prone to subsurface fires as their small size, steep gradients and shallow soils allow them to drain and dry out frequently. Extreme care needs to be taken in selecting correct burning conditions as the recovery of the post burning vegetation at these sites appears to be very slow.
- Plains wetlands (flood plains and marshes) have gentle gradients and tend to be relatively large in size with corresponding higher potential for hydrological functions. Burning methods on plains wetlands with herbaceous cover should allow for rapid plant re-growth.

- Burning the herbaceous layer of stream banks can assist in maintaining plant vigour thus enhancing their ability of combating scour and improving bank stability.
- Burn the wetland every second year if the rainfall is more than 800 mm per year.
- Burn every third or fourth year if the rainfall is less than 800 mm per year.
- In Cape Fynbos regions burn at up to 30 year intervals.
- Where practical divide the burning into burning blocks and burn each half alternately leaving the other half un-burnt to provide wildlife refuge. Where this is not practical, attempt to rotate burning with other wetlands in close proximity. Apply cool “patch” burns by burning when the fuel is moist after rain, or in the evenings or early mornings after dew when there is a high relative humidity and low air temperature. Burn at the onset of the growing season so as to ensure rapid plant re-growth. This is vital.
- Burning a wetland when it is dry, can result in underground fires if the wetland soils have a high organic content.
- Delay burning to another day or even year if in dry years there is a danger of soil ignition, when weather conditions are consistently unsuitable or if winter breeding animals (e.g. wattled cranes) have not completed breeding.
- Little can be done to minimise the hydrological impact of early winter burning, other than to protect permanently and seasonally wet areas where possible. Early winter burning may detract from the grazing resource if large numbers of herbivores are attracted to the early winter flush and grazing of these areas should preferably commence only after the end of winter.

b) Grazing

- On average the grazing capacity in a wetland is one and a half times higher than in a non wetland area, but this is dependent on many factors such as species composition and the water regime of the wetland. Ensure that the determined grazing capacity is not exceeded.
- Where regular monitoring of grazing is possible apply a flexible rotational system where the grass sword is allowed to be grazed down to a threshold level of 80mm and / or when the most favourable plants have been grazed down to 40mm high.
- Where regular monitoring is not possible apply a fixed rotational grazing system of 14 days in and 24 days out of the wetland.
- Either graze the entire wetland and allow a full growing season rest period every 4 years, or graze three quarters of the wetland excluding one quarter from stock on an annual rotational basis.
- All grazing must be discontinued when the soils are waterlogged (as this is when erosion can set in) until conditions have improved. Once the wetlands dry out, it is safe to use the wetlands for grazing once more.

c) Cultivation

- Wetlands should not be cultivated. In South Africa wetlands are protected by the Conservation of Agricultural Resources Act 43 of 1983 (administered by the Directorate: Resource Conservation) that prevents land users from cultivating or draining wetlands. The recommendations below refer to lowering of impacts on wetlands which are already cultivated:
  - No more than 30% of the temporary zone of a wetland should ever be cultivated.

  - No parts of the seasonal or permanent zone should be cultivated under any circumstances.
  - No drainage of the area to be cultivated should be undertaken (i.e. plant tolerant crops and avoid the wetter areas).
  - Minimum tillage techniques should be used to reduce the amount of soil disturbance.
  - Make use of ley cropping – this refers to the practice of planting a plant cover to protect the soil from compaction caused by rain drops, moisture loss through evaporation and water erosion.
  - Leave strips of wetland vegetation between cultivated areas.
  - Adding organic matter on to the soil in the form of mulch.
  - Do not cultivate the same area every season. Leave cultivated areas fallow but vegetated periodically.
  - Plant perennial pastures where possible.
- Traditional cultivation practices, which are more sensitive to the functioning of the wetland, include:
  - Planting crops which are tolerant of water logging, minimizing the need to drain.
  - Tillage and harvesting by hand, resulting in less soil compaction and potential disturbance than with mechanical tillage and harvesting.
  - Not using pesticides and artificial fertilizers, which reduces the impact on water quality.

d) Rehabilitation of wetlands

- Remove the cause of the damage, not the symptoms and manage the resource correctly.
- Re-establish the natural water flow patterns within the wetland.
- Do not concentrate water. Always try and spread it out, this should reduce the possibility of erosion occurring.
- Do not underestimate the force of the water during high flow periods.
- Many wetland soils are highly erodible, be aware of this when designing structures.
- There are two rehabilitation options:
  - Stabilising the problem area and maintaining the present condition of the wetland.
  - Reclaiming the wetland area that has been lost.
- A large variety of herbaceous plants with their rapidly spreading capabilities and dense near surface root mat, and surface cover, are extremely effective firstly against scouring of riverbeds and wetlands, and secondly for enhancing the stability of gentle or shallow banks.
- The plant stems induce sediment deposition tending to raise the floor of eroded channels, even widening the channel profile. Herbaceous plants absorb the energy of fast flowing water rather than reflecting it.
- The combination of these factors, plus the ability of many herbaceous plants to thrive in direct sunlight, of being fire tolerant and having strong regenerative powers, makes them ideal for rehabilitating stream banks and wetland erosion.
- Trees contribute cohesion and stability to steep banks - providing the roots reach down to full bank height, and the toe hold and bank face are protected from undercutting by tree roots and an established cover.

3.3 Dunes and drift sands

This section draws extensively from the document entitled *Coastal Dunes of South Africa: South African National Scientific Programmes Report No 109*[10].

3.3.1 Importance of dunes and drift sands

<u>a) Coast buffer zone</u>

- Frontal dunes are a major component of the littoral active zone. With beaches they form the most important sea and wind energy dissipating front to the land. They store and yield sand, damping coast recession by maintaining the sand supply to shores and beaches. This protective buffer shields all landward resources and developments from the direct impact of the elements.
- Dunes contain a diverse and specialised flora adapted not only to each geographic area, but also to each facet of the dunes and backshore zones, and to the environmental features peculiar to the littoral zone (e.g. the high salt spray and very porous sands). This vegetation play the following primary roles:
    - Consisting of living organisms, it responds reciprocally to changes in form of the sediments.
    - It stabilises shifting sand and other unconsolidated sediments.
    - It enhances sediment accretion by reducing the surface velocity of wind or water.
- Due to their varied topography, dunefields exhibit important microclimatic differences to the prevailing local weather conditions, particularly of exposure, temperature and rainfall.
    - In dunefields, the alternating relief of ridges with hollows and slacks provide high microclimatic diversity. Aspect sequences of hot and cool, exposed windward and protected leeward sites, open sunny or shaded cover. The high year-round humidity of the immediate coast, the ocean damped temperature extremes and protection given by dunes provides a benign habitat for living.
    - High dune cordons induce a higher rainfall belt along the immediate coast where longshore rains are a feature of all seasons. This phenomenon is most striking where high dune cordons are backed by plains or valleys.
    - Advective sea fog and surf zone mist is banked up against the seaward slopes of higher dunes (over 50m) by onshore winds.

<u>b) Economic uses</u>

- There is a perennial availability of shellfish as a food base, readily at hand and easily obtainable.
- Freshwater is available at the surface in slacks or by digging shallowly at the fore-dune back-dune junction.
- There is an availability of brushwood for building material and firewood.
- A benign climate exists as temperature extremes are damped by proximity to the sea.
- Dunes represent a source of sand and other minerals.
- Dunes offer strategic uses, such as lighthouse, beacon and fire lookout tower sites.

[10] TINLEY, K. L. 1985. REPUBLIC OF SOUTH AFRICA.

- Older dune sands landward of the active dune zone may be used for crops, housing or other purposes. Calcareous sweetveld pasture for herbivores including game and stock may be found here. This is particularly valuable where they abut sourveld.
- Coastal dunes represent an important subsistence resource for rural people, including the provision of fresh water (from the dune aquifer), food (both from the sea and from the land) and construction and craft materials.

c) Recreation

- Dunes form an intrinsic part of the coast environment, which is the greatest free recreational amenity in the country. Frontal dunes and beaches have the highest recreational value.
- Dunes are a unique landform offering high scenic value, especially on coastal plains where other eminences are absent.
- Bare dunefields offer an extraordinary wilderness experience for the active or passive eco-tourist.

d) Culture, education and research

- Dunes represent important prehistory (archaeological) sites and palaeo-environmental markers recording changes in climate and sea levels. They are also laboratories for geomorphic and ecological processes that occur over a relatively short time and portray both past and present dynamics and succession. The practical value of this research lies in their application for protecting coastal resources - in guiding developments and activities and in the maintenance, redirection and enhancement of natural processes.
- Though discontinuous, the linear distribution of dunes along the coast provides a vital link and pathway for the migration of plants and animals between similar or related habitats around the intervals formed by contrasting arid or extreme moist geographic regions.
- Where dunes have contrasting relief they exhibit a high local microclimatic, edaphic, biotic and bio-geographical diversity related to the variety of distinct slope aspects, crest slack catena sequences, to the age of dunes and their proximity to the sea. This is overlain by the larger regional geographic gradients of which rainfall and the content of the immediately abutting ecosystems are major determinants of the biotic mix and relationships of communities on coastal dunes.
- Unique ecosystem types are represented in coastal dunes containing rare and endemic plants, animals and biotic communities (e.g. the coastal Fynbos of the south Western Cape). Coast dunes also contain many biotic elements at their geographic limits of distribution (relic or initial outlying areas).
- Dunes are unique mobile geological landforms, which are regulated by the interaction of wind transported sand with obstacles, the amount of sand, the density of plant growth and wind speed regimes.

3.3.2 Identification and delineation of dunes and drift sands

a) Types of dunes

- All dunes are wind formed, as a result of Aeolian material heaped into accumulations. Generally, the windward slope against which the sand is blown is gentle in contrast with the steep leeward side formed by falling and sliding sand (also referred to as the slipface). The transfer of sand from the compacted windward side to the leeward avalanching slopes results in the dune moving or migrating in a downwind direction.
- Windward faces are more stable due to denser packing of particles by the wind. Sunward slopes, and especially the crests are the driest and hence the most mobile facets.
- The shade slopes are cooler and moister and hence relatively more stable.
- Coastal dunes form where sand is deposited onshore by the sea and at river mouths, or where the sea level drops, and the sand is blown landward by the wind. Coastal dunes are characterised by the following:
  - They are typically alkaline due to their generally high calcareous content from finely weathered shell fragments.
  - The finer sands and shell detritus compose the dune backbones as they are carried inland. Coarser sands occur in the foredunes.
  - Coastline soils have a high salt load content as a result of salt and spray aerosols carried by onshore winds.
  - The weathering potential is high all year round by moist and warm conditions.
  - Unlike desert dunes, coastal dunes receiving more than 50mm mean annual rainfall become stabilised by plant growth.
- Although there are relatively few simple or basic dune forms, many combinations of dune types exist:
  - Compound dunes composed of two or more dunes of the same type, coalescing, overlapping or superimposed.
  - Complex dunes combining two or more different types occurring together or superimposed.
  - Combinations of compound and complex dunes.

b) Classification of dunes

- Bare or free dunes.
  - *Mobile sand sheets and mounds*. On the coast these bodies display a rippled surface which feed climbing dunes, windward dunes, parabolic dunes and precipitation ridges.
  - *Crescentic or transverse dunes.* The crests and slipfaces of all these types are orientated transversely to the wind direction, the concave curve of the leeward slipfaces facing downwind.
    - ❖ *Barchan dunes*. Isolated, crescent shaped dunes, advancing downwind.
    - ❖ *Barchanoid dunes*. Parallel rows of linked or coalesced barchans with a single slipface on each arc. Where the ridges are straighter, they are referred to as transverse dunes.
    - ❖ *Transverse dunes*. Parallel straight to slightly curved dune ridges with their axes orientated at right angles to the wind direction. Simple forms with an unidirectional wind have a single slipface.

        - *Reversing dunes*. A transverse of barchanoid type which periodically and seasonally develops a second slipface nearly opposite to that of the first. These are formed typically where winds alternate seasonally and periodically from opposing directions. Although the crestline and slipfaces vary with opposing winds, the main dune body retains its curved form which is related to the persistently stringer of the opposing winds.
        - *Buttress barchanoid dunes*. Rows of reversing barchanoid or transverse dunes inclined upwards at right angles from the beach onto the bared seaward slopes of otherwise forested high parabolic dunes.
    - *Linear or longitudinal dunes*. Dune ridges elongated in lines parallel to the formative winds, separated by sandy, gravely or rocky interdune corridors.
    - *Star dunes*. Peaked dunes having three or ore whorled radiating sinuous arms with multiple slipfaces formed by effective winds of moderate strength blowing from several directions.

- Vegetated dunes.
    - *Strand plant foredune hummocks*. Hummock dune topography is formed by sand accumulating amongst and around the aerial parts of isolated plants
        - *Driftline embryo dunes*. The earliest stage of dune formation is the formation of small mounds of sand built up around isolated pioneers of bare sand. These may either be eroded, or continue to enlarge and coalesce laterally.
        - *Hummock or hillock dunes*. Rounded or oval plant formed dunes, isolated, clumped or in lines. Moist subsoil is a determinant for the maintenance of hummock dunes.
        - *Parallel beach ridge hummock dunes*. Hummock dunes formed along parallel swash bars or beach berms, each ridge separated from the other by a slack or trough.
    - *Retention ridge or precipitation dunes*. Dunes produced where sand carrying winds meet a vegetated front, lose velocity and drop their sand load along the junction. Its profile and advance is similar to a transverse dune, except the growth of vegetation through the slipface results in the upward growth of the dune ridge.
    - *Parabolic dunes*. U- or V- shaped blowouts or tongues of advancing sand with its sides and leading leeward slipfaces partially stabilised by vegetation. Its leading edge is a concave mound of sand forming a steep rounded nose that migrates downwind.
        - *Blowouts*. Crater-like deflation and wind scour hollows initiated by openings or weak spots of dunes partially stabilised by vegetation, moisture or both. Blowouts are commonly oval in shape.
        - *Accretion ascending parabolic dunes*. A bare, trough shaped mobile dune breached into and overriding vegetated dunes which surround it on three sides. This parabolic type grows both upwards and forwards burying everything in its path. It is open at its sand-source end. The leading edge is formed by a rounded nose of sand with a leeward slipface below the ridge curve and its sides. These slipfaces may be partially or temporarily stabilised by through growth of buried vegetation.
        - *Deflation hairpin parabolic dunes*. A deflation migratory dune type with a convex nose of sand advancing downwind leaving paired parallel ridges behind it. The resultant dune ridge lines are in the form of a long,

narrow hairpin. The open end and upwind tips of the paired dune ridges face their source area.

- ❖ *Parallel wind-rift ridges*. Unidirectional parabolic dunes with breached noses. The lateral slipface rims, left behind by the nose migrating downwind, remain as parallel dune ridges.

- Dunes related to topographic barriers.
  - o *Climbing-falling dunes*. Where strong sand-laden winds meet opposing hillslopes, a climbing dune is banked up against the windward slope, and the finer sand blows over the hill dropping in the lee down the slope to form the falling dune counterpart.
  - o *Headland bypass dunes*. Originating in the same way as climbing dunes, this type develops strips of migrating dunes which cross the plateau or headland to feed the shoreline of the embayment opposite.
  - o *Windward diverging dunes*. Migrating dunes that diverge around an obstacle.

3.3.3 Inherent sensitivities of dunes and drift sands

The three major properties that all soft coasts share are:

- Their malleability.
- Their temporary stabilisation and protection by plant growth.
- Their hypersensitivity or vulnerability to disturbance.

Sandy coasts are composed of four features closely related by the interchange of sand supply between each. These include:

- Beaches.
- Frontal Dunes.
- Inshore or surf zone sand bars and banks.
- River mouths and estuaries.

Together these form a single geomorphic system referred to as the littoral active zone. The sand is shifted between these four, and any change in one of them entrains changes in the others.

All soft coasts are composed of unconsolidated shifting sediments which are unstable and in a constant state of flux. A false impression of stability is imparted to frontal dunes where they are covered by bush. This cover merely attests to an extended temporary balance in dune dynamics. Of all soft coast forms, the embryo dune line of the backbeach being built up by creeping plants is the most transient and requires special protection against damage from trampling.

3.3.4 Suggested mitigation and management of dunes and drift sands

<u>a) Development restrictions</u>

- The golden rule for development on soft coasts is to avoid the littoral active zone, especially the frontal dunes and backbeach, which essentially represents the country's coastal buffer. During planning, a comparative analysis should be made between the oldest and the most recent aerial photographs to determine the littoral active zone, and hence the setback line for development.

- Roads. Railways, bridges, powerlines, parking lots, houses and any other movable structures must not be placed within reach of the littoral active zone, and especially not within the coastal buffer zone and in estuaries. It is recommended that major roads, railways and powerlines are located four to five kilometres landward of the coastline. Bridges and traffic ways that have to cross through these areas should be built on piers as opposed to filled in causeways.
- Where bush covered coast dunes form a distinct series of ridges and troughs parallel to the beach, permit only camping and caravanning activities in the trough behind the first definite dune ridge. Confine permanent structures of any nature to landward-most third or fourth dune trough and ridge zone.
- Where multiple small dune barrier ridges occur on shorelines which are growing seawards, restrict the location of any permanent structure of any kind to beyond the oldest landward vegetated ridge. The younger ridges are colonised by dune pioneer plants and are still in an extremely unstable state.
- Where relatively small vegetated dunes occur as a single or double ridge only, all development should be confined to the landward base of the dunes. Dunes stabilised by indigenous forest or bush should not be removed to obtain a view. Dunes covered by Rooikrans may be cleared, and even reformed, provided stabilisation is carried out. What may be expected to occur as a result of shaping is the recurring accumulation of sand, which will have to be removed on a regular basis and the dune re-stabilised.
- In high, steep, and broad vegetated dune cordons, all permanent development should be confined to the landward base of the dunes. On-site placement of structures should take advantage of natural gaps in the tree canopy. Footpaths must not result in donga erosion, or mass slumping may occur after downpours.
- Where dunes are poorly developed, or where only a gradual rise occurs landward from the backbeach zone, the closest any permanent development should be permitted is between 40 and 50m back from the seaward edge of the completely vegetated sands.
- All vehicle and footpath access onto beaches must be orientated away from the predominant and gale force wind directions. Where wind originates from two opposing quarters, then access should be at right angles to the two major opposing winds.
- Avoid the use of French drains or pit latrines in living areas serviced by fresh water from the dune aquifer. Avoid the disposal of waste in these areas as well.
- Prevent overgrazing or thinning out of dune vegetation by stock or game as this induces the formation of blow outs and donga slumping.
- Structures within dune areas must be protected against fire, and fire frequency within these areas must be controlled. In the south Western Cape, large areas of dunes are vegetated by highly flammable Fynbos. There are two main peaks of fire occurrence in these areas: in the summer dry season, and in winter during Berg Wind conditions. On the eastern seaboard where savannah abuts bush covered dunes, a similar fire risk exists during dry spells.
- In most cases, industry and municipal sized towns cannot be supported by local water supply from dune aquifers.

b) Reclamation

- Reclamation of dunes can only be justified where drift sands endanger resources or structures. Essentially, the dune feature represents the most effective method for controlling a drift sand problem.
- Bare dunes should not be stabilised simply because they are bare. Left alone, bare dunes (especially of the transverse type) may remain essentially the same for many decades.
- Where mobile dunes pose little or no threat either to natural resources, development, structures or infrastructure, then the best option is to leave them alone.
- Once it has been determined that reclamation is in fact required, determine the following features before initiating any programme:
  - Identify the landscape and shoreline position of the mobile sand.
  - Identify the reach of the active littoral zone.
  - Identify the type of dune.
  - Identify which processes are active.
  - Identify the trend and direction of change.
  - Determine an action priority of highest to lowest (i.e. complete or partial stabilisation, maintenance, or enhancement of existing conditions) based on a land use analysis of the area.
- Reclamation o dunes must be directed to two key sites, namely the sand source and along the landward encroaching front. Reclamation must be done so that the natural processes are harnessed into doing most of the dune building and stabilisation work.
- Dune stabilising methods must make use of flexible materials with open sieve-like characteristics, such as brush wood or cut reed mats, under or inter-planted with pioneer dune plants indigenous to the area.
- If stabilising materials are in short supply, then old fish nets may be used along the leading edge of the migrating dune, while planting up the backbeach with strand plants.
- Invasive or other problem plants such as Port Jackson and Rooikrans should be used for brushwood. Green or rip pods must be removed prior to placing.
- Ideally only locally indigenous strand plants should be used in dune reclamation. These should be planted in mixed clumps and not as single species communities.
- A migrating parabolic dune may be contained by:
  - Covering both the advancing crest zone and the sand source area near the beach with a one metre deep cover of densely packed brushwood, or a single layer of closely packed reed stems.
  - Local dune pioneer plants should be planted during the rains, immediately ahead of the brushwood laying. Otherwise inter-planting with dune plants may be done after the rains.
  - Wherever possible, use only problem plants as brushwood.
  - Where a littoral dune is absent, an artificial one may be initiated along the driftline, either by planting dune pioneer plants, or by erecting a brushwood or reed slat fence.
  - If a high water table is present, then the surface of sand at the seaward base of the parabolic dune may be skimmed off to expose the moist sand. This alone will stabilise the source area.
- Bare transverse dunes are, by virtue of their hyper-mobility, the most difficult type to reclaim:

- o As all the dunes are reversing, it is possible to establish indigenous dune colonising pioneers in the slacks between dunes and in dune hollows against the compact semi-stable dune base.
- o Attention must first be given to the landward encroaching margin and to the sand source area.

3.4 Estuaries

This section draws extensively from the following documentation:

- *Water SA Volume 27: Some Factors Governing the Water Quality of Microtidal Estuaries in South Africa*[11].
- *Managing Estuaries in South Africa: An Introduction*[12].
- *Conceptual Models of Australia's Estuaries and Coastal Waterways: Applications for Coastal Resource Management*[13].
- *Water SA Vol 28 No 2: Assessment of the Conservation Priority Status of South African Estuaries for use in Management and Water Allocation*[14].

3.4.1 Importance of estuaries

a) Habitat function

- Habitat for salt tolerant faunal and floral species.
- Habitat for a diversity of species: estuarine, terrestrial. and marine species.
- Sediment trapping.
- Storing and cycling of nutrients.
- Absorbing, storing and detoxifying of nutrients.
- Migratory corridor.
- Soil Formation.
- Erosion prevention.
- Support endemic species.

b) Source of extractable / harvestable resources

- Source of food such as fish.
- Source of raw materials such as plant fibres.
- Source of bait.
- Genetic resources.
- Higher rate revenue from property owners at pristine / scenic areas.

c) Socio-cultural significance

- People live close to estuaries to enjoy the attractive setting.

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[11] ALLENSON, B.R. 3 JULY 2001
[12] BREEN, C. M. AND MACKENZIE, M. 2001. INSTITUTE OF NATURAL RESOURCES, PIETERMARITZBURG
[13] RYAN DA, HEAP AD, RADKE L, HEGGIE DT. 2003. GEOSCIENCE AUSTRALIA.
[14] TURPIE JK, ADAMS JB, JOUBERT A, HARRISON TD, COLLOTY BM, MAREE RC, WHITFIELD AK, WOOLDRIDGE TH, LAMBART SJ, TALJAART J, VAN NIEKERK L. APRIL 2002.

- Recreational activities such as fishing, water sports and cultural outings (tourism and recreation).
- Opportunities for jobs and income generation.
- Nursery for marine fish and crustaceans (fisheries and aquaculture).
- Provide transport: Sheltered deep water access for harbours and ports.
- Shorelines for industrial and urban development.
- Improve water quality.
- Reduce flooding.
- Erosion control.
- Drought recovery.
- Storage capacity (E.g. contains oil spills).
- Sediment supply and regulation.
- Stormwater control.

3.4.2 Identification and delineation of estuaries

There are approximately 260 functioning estuaries in South Africa, together making up approximately 70000ha of the country's most productive habitats. Estuaries form where the river meets and potentially has interaction with the sea. The following types of estuaries are to be found:

- **Permanently open estuaries**: These are usually quite large systems with a perennial river and / or strong tidal exchange with the sea. Under low river flow conditions tidal exchange is sufficient to keep the mouth open. And under high river flow conditions the influence of the river is evident right until the river mouth. (e.g. Breede, Swartkops).
- **Temporarily closed / open estuaries**: Approximately 180 of South African estuaries fall into this category. The estuaries are often closed for many months, or sometimes even longer than a year. Usually river flow and tidal exchange are not sufficient to keep the river mouth permanently open. Mouth opening events usually occur after floods. (e.g. Groen, Mlalazi).
- **River mouths**: These estuaries are usually permanently open to the sea and their main characteristic is that the river dominates the physical process. Penetration of sea water into the estuary is limited and in time of high water flows the mixing zone of freshwater and seawater is pushed into the sea. (e.g. Orange, Thukela)
- **Estuarine lakes**: These occur where a coastal lake is connected to the sea by a channel. These lakes are usually large and shallow. The temperature and salinity levels of these lakes are influenced by the river and the sea, but also by solar influences. (e. g. Kosi, St Lucia).
- **Estuarine bays**: These estuaries have wide mouths with strong tidal exchange resulting in a continuously open mouth, and the regular replacement of marine water in the lower and middle reaches. These marine dominated systems are often utilised as harbours. (e.g. Durban Bay, Richards Bay)

3.4.3 Inherent sensitivities of estuaries

a) Consequences of activities in the catchment

- Supply of freshwater decreases due to upstream storage and abstraction.
- Sediment load changes due to changed flow regimes.

- Water quality deteriorates due to increased concentrations of suspended and dissolved substances in river water.

b) Consequences of activities on and around the estuary.

- Encroaching Structures such as weirs, bridges etc:
    - Restriction of biological exchange with the sea and reduction in estuary size due to weirs and causeways.
    - Altered hydraulic conditions due to bridges and embankments.
    - Changes in sediment dynamics (channel meandering, sand banks etc) due to erosion control structures such as bulkheads and canalisation.
    - Obstruction of boats, disruption of the natural shoreline character and 'privatisation' of public property due to jetties.
    - Major transformation of the estuary ecology due to activities associated with harbours and marinas.
- Sudden changes to sediment levels and composition due to the disruptive process of dredging.
- Reduction in faunal and floral species due to over harvesting of living resources.
- Scouring of estuaries due to mouth breaching (artificial opening of estuary mouths).
- Gradual erosion of the natural character due to creeping development and excessive recreational use.

3.4.4 Suggested mitigation and management of estuaries

- All development in estuary areas is listed in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Specialist studies are imperative for such highly sensitive environments.
- Development within a defined wetland or riparian zone may need to apply under Section 21 of the Environmental Conservation Act (Act No. 73 of 1989) for reclamation of land below the high water mark.
- Development and construction activities must be confined to demarcated areas.
- Causeways should be constructed as far from the mouth as possible.
- Reduce embankments to a minimum.
- Elevate bridges and minimise the amount of pillars in the estuary.
- Bulkhead and canalisation material should be as flexible as possible.
- Jetties should only be constructed in permissible zones and should be of a temporary nature and blend in with the natural environment (natural materials etc).
- Regulate harbour and marina activities that are potential sources of pollution.

- Monitor input of water flow, sediment and suspended and dissolved substances.
- Regulate the storage and abstraction of water.
- Water release from dams should simulate that of natural conditions in intensity and frequency.
- Remove excess sediment through dredging, breaching and utilising the ebb tide to scour out deposited material:
    - Accumulated sediment may only be removed with appropriate authorisation.
    - Dredging must simulate natural process of sediment disposal into the ocean.

    - Disposal of dredged material is only permitted at appropriate and authorised sites.
- Mouth breaching (i.e. at river mouths) may only be undertaken with appropriate authorisation:
    - Breaching should simulate natural process of sediment disposal into the ocean.
    - Breaching should occur in late winter/early spring to simulate natural cycles.

- Regulate carrying capacity of recreational use, such as boating etc.
- Establish compatibility of various development and recreation types.
- Develop SUP's in accordance with DWAF's Recreational Water Use Policies and Guidelines. SUP's are to guide land use and at and around estuaries and regulate development.
- Develop awareness campaigns (demarcation, signage, print media etc) to inform visitors on appropriate recreational behaviour.

3.5 Ridges

This section draws extensively from the final draft document entitled *Development Guidelines for Ridges*[15].

3.5.1 Importance of ridges

- Ridges are characterized by high spatial heterogeneity due to the range of differing aspects (north, south, east, west and variations thereof), slopes and altitudes all resulting in differing soil (e.g. depth, moisture, temperature, drainage, nutrient content), light and hydrological conditions.
- The temperature and humidity regimes vary on both a seasonal and daily basis. Moist cool aspects are more conducive to leaching of nutrients than warmer drier slopes.
- Variation in aspect, soil drainage and altitude are generally predictors of biodiversity. This implies that ridges will be characterized by a particularly high biodiversity. The diversity of plant communities on ridges can often be observed, with different communities associated with different slopes and aspects.
- Associated faunal communities are similarly diverse. For example, a wide variety of bird groups utilize ridges, koppies and hills for feeding, roosting and breeding.
- Ridges and kloofs form caves, an important habitat for highly specialized animals, e.g. bats.
- Variable microclimate conditions often result in a vast array of invertebrate communities associated with the high plant diversity characterizing ridges. Hills and koppies generally have more insects (both in terms of individuals and species) than the immediate surroundings.
- Some taxonomic groups, e.g. the poorly known and under collected bryophytes, are found predominantly on ridges, hills, koppies and in kloofs.

[15] PFAB, M. Department Of Agriculture Conservation Environment and Land Affairs: Directorate of Nature Conservation. April 2001

- Ridges are particularly suitable for providing a refuge for biodiversity in an urbanized landscape as they function as islands in context of relative environmental isolation.
- Ridge systems represent natural corridors as they function both as wildlife habitat, providing resources needed for survival, reproduction and movement, and as biological corridors, providing for movement between habitat patches. Both functions are potentially critical to conservation of biological diversity, especially within the urban landscape.
- Ridges provide aesthetically pleasing environments for the surrounding inhabitants and attract tourists and recreational users to the area.
- In general, natural areas in the urban environment provide environments for recreation, relaxation and education. Many surveys of urban areas have indicated that urban residents attach high value to nature and wildlife around the home.

3.5.2 Identification and delineation of ridges

- Due to similar biodiversity, ecological and aesthetic values, ridges refer to hills, koppies, mountains, kloofs and gorges defined essentially by the slope of the site, whereby any topographic feature in the landscape is characterized by slopes of 5° or more (i.e. > 8.8%, > 1 in 11 gradient).

3.5.3 Inherent sensitivities of ridges

- As a consequence of the influence of topography on rainfall, many streams originate in ridges and contribute water inputs into wetlands. Development on or disturbance to ridges could increase water runoff into streams and wetlands.
- Disturbance to and exposure of the soil to wind and water could, under the influence of gravity, result in loss of soil material, erosion of slopes and colluvial 'creep' down the slope. These forces affect the equilibrium of the ecosystem, and could result in the loss or migration of species, habitat alteration and even habitat destruction.
- Many Red Data / threatened species of plants and animals inhabit ridges. Development of these ridges would imply a threat to their habitat and perpetuate further threat to their survival.
- Animals, birds and invertebrates are reliant on hilltops as refuge from creeping development. Loss of these refuges could result in the invasion of urban areas by vermin, pests and other problem species, or the complete loss of these species to the area.
- Ridges are generally highly visible features within the surrounding area by virtue of their elevated topography. It follows that any disturbance to or development on ridges would in turn be highly visible. Unscrupulous destruction of a ridge environment would therefore have an impact on the aesthetic quality of the entire area.

3.5.4 Suggested mitigation and management of ridges

- Avoid routing roads and pipelines directly over ridges where possible. Make use of lower lying areas or valley sides for a lower impact.

- Where ridges must be traversed, avoid routing roads and pipelines perpendicularly up steep slopes. Opt for a more gradual alignment which zig-zags up the slope. This will help to avoid erosion and unnecessary visual impact.
- For ridges that are minimally transformed or impacted upon (i.e. less than 5% transformed), no further development should be allowed.
- For ridges that are moderately transformed or impacted upon (i.e. 5%-35% transformed), the viability of further development should be carefully considered favouring low impact activities such as tourism if any.
- For ridges that are significantly transformed or impacted upon (i.e. 35%-65% transformed), further development should be contained within areas that are already transformed.
    - Further subdivisions of ridges should be discouraged, and the consolidation of subdivisions should be encouraged. Where possible, the ecological footprint of the developments should be limited to no more than 5% of the property.
- It is not recommended to proceed with any development within ridges without an Environmental Impact Study, including both functional (ecological) processes and compositional (biodiversity) aspects. In this respect, investigation into the following aspects is recommended as a minimum requirement:
    - A Red Data study for both fauna and flora;
    - An invertebrate study;
    - A hydrological / geohydrological study;
    - A geotechnical study;
    - A pollution study, including both air and water pollution;
    - A social study, including cultural, historical and open space value aspects;
    - A visual study;
    - A study of service provision and access.
- Specialist studies should be undertaken where investigations reveal issues of concern. All specialist studies are to examine cumulative impacts.

4. ENVIRONMENTAL PLANNING GUIDELINES (PROJECT COMPONENTS)

In an effort to streamline the planning process for Water Supply and Water Resource Infrastructure, environmental planners and decision makers should make use of the following environmental planning guidelines relevant for specific components of Water Supply and Water Resource Infrastructure projects.

4.1 Pipelines

- The installation of pipelines for the bulk transportation of sewage and water is listed in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Where soil conditions are highly saline such as in coastal areas, make use of plastic pipes (or an alternative material) which will not corrode.
- Where possible, avoid aligning pipelines over mountains and ‘koppies’: opt to skirt around these.
- Where pipelines cross drainage lines or rivers, ensure that the pipeline is laid at a sufficient depth, and that provisions are made to properly secure the pipeline (so that it is not exposed or washed away during flood periods). This may include encapsulating the pipeline.
- Do not align pipelines under powerlines.
- Avoid large and prominent trees: it may only be possible to identify these on site, at which time deviations to the planned alignment should be planned to avoid the driplines of large and prominent trees.
- Avoid cultivated lands, orchards, graves and other sensitive features that would lead to costly compensation.
- Plan to zig-zag the alignment up mountains to avoid unsightly scars.
- Ensure that air and scour valves must not be higher than 250mm from the ground level.
- Pipelines that cross water courses must be incorporated into a bridge or culvert design where possible. Alternatively, the disturbed point of crossing must be reinstated as close as possible to the original contours. Make allowance for erosion control structures to protect the backfilled trench.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.
- Allow for ground truthing and final planning on site. The Environmental Planner, Design Engineer, Social Officer, Surveyor and, where relevant, the contractor, should be involved in this final planning.

4.2 Tunnels

- The construction of a tunnel is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Plan tunnels and the treatment thereof to have the least possible environmental impact.

- Avoid aligning tunnels through areas of high groundwater levels, such as aquifers.
- Pre-empt the effects of the interception of groundwater by the tunnel on the regional groundwater regime by undertaking a survey of static levels in the region.
- Where tunnels are not for the conveyance of water, they must be kept ventilated and dewatered.
- Where necessary, make provision for escape routes for people and animals in the form of slopes grids at tunnel entrances.
- Where tunnels are water bearing, pay particular attention to the energy dissipating facilities provided at the emergence portals and where these outfall into a natural system (refer to section 4.11).
- Pay attention to the effect of the quantity of discharged water on nearby infrastructure (such as roads, bridges and fences).
- Portals must be designed to be aesthetically unobtrusive and to blend with the environment.
- Surge tanks in water-carrying tunnels must be planned with due cognisance of the aesthetic impact of these structures.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.

4.3 Canals

- The construction of a canal is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Avoid aligning canals through areas of high groundwater levels. Avoid intersecting the water table.
- Pre-empt the effects of the interception of groundwater by the canal on the regional groundwater regime by undertaking a survey of static levels in the region.
- Avoid large and prominent trees: it may only be possible to identify these on site, at which time deviations to the planned alignment should be planned to avoid the driplines of large and prominent trees.
- Avoid cultivated lands, orchards, graves and other sensitive features that would lead to costly compensation.
- Ensure that the canal is made safe for people and animals. Make provision for escape routes.
- Erect security fencing along the servitude lines of the canal to protect Government property and for the safety of communities.
- Plan so that access for people, animals and vehicles is not compromised wherever possible. Where this is unavoidable, ensure that alternative access is provided.
- Inform local communities of the restrictions, permissible use and dangers associated with the canal.
- All under drainage and stormwater flood berms must be designed to obtain 1:3 (V:H) side slopes.

4.4 Gauging weirs

- The construction of a gauging weir is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.

- Impounding surface water along a watercourse requires permission from the relevant provincial DWAF. A licence in terms of Section 21 of the National Water Act, 1998 (Act No. 36 Of 1998) is required in this regard, for which there are specific process requirements. This is not, however applicable to Government Waterworks.
- Select a site that will not be highly visible or obtrusive once construction is complete.
- Take cognisance of sport and recreational requirements (i.e. such as canoeing) and ensure that the design allows for the continued safe use of the river for such activity.
- Avoid large and prominent trees: it may only be possible to identify these on site, at which time deviations to the planned structure should be instituted.
- Design the gauging structure to have a negligible effect on water levels and not to breach the level of the natural river banks.
- Allow for animal movement and safe crossing through positioning, layout and design of the structure.
- Do not locate the recorder hut in the middle of rivers.
- Plan the recorder hut to have the least disturbance to, and be least visible within the riparian vegetation zone.
- Plan for future sediment stockpile areas, for use during maintenance operations.

- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.
- Allow for up and down stream protection of weir flanks using a proper drainage and anchor system. One or more of the following methods are approved as industry norms in various situations:
    - Place anchor poles or boulders for erosion control.
    - Place storm water berms and drains at correct intervals and positions.
    - Install channel lining plus a proper drainage and anchor system, topsoil and a grass seed mixture.
    - Install modular retaining systems.
    - Install slope stabiliser systems (such as gabions or ‘Armourflex’).
    - Build concrete retention walls and stabilise slopes with boulders, topsoil and a grass seed mixture.

4.5 Dams and impoundments

- The construction of a dam is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Impounding surface water along a watercourse requires permission from the relevant provincial DWAF. A licence in terms of Section 21 of the National Water Act, 1998 (Act No. 36 Of 1998) is required in this regard, for which there are specific process requirements. This is not, however applicable to Government Waterworks.
- Where water is stored in a watercourse, measures must be taken to ensure that the upstream and downstream movement of aquatic species is not prevented, including those species which normally migrate through the watercourse (refer to section 4.7).
- Dam walls and spillways should be built to withstand 1:50 year flooding.

- Ensure that no existing man-made objects and structures within the dam basin are left to become a danger to people and animals.
- Any objects and structures in dam basins which are perceived to be of danger, for example newly formed islands, temporary concrete pump structures, temporary water abstraction weirs, etc. must be rehabilitated / mitigated to be safe for people and animals and to be ecologically friendly and aesthetically pleasing.
- When positioning a dam along a watercourse, avoid wetlands wherever possible. If this is unavoidable, locate the dam at the lowest part of the wetland (without flooding the wetland). This allows the wetlands to carry on performing its functions.
- The first wet season flow from a dam's catchment is often retained in the dam because levels are depleted at the end of the dry season. This may impact both on the river biota and the downstream users. Measures must be taken to ensure water release through the outflow control so that at least 50% of the early season flow entering the dam is released.
- Do not plan to begin impoundment before natural resources have been harvested according to the 'Harvesting of Natural Resources' policy (Chapter 2.1.7).
- Where possible, programme impoundment to begin after the necessary rehabilitation work in the basin has been completed.
- Ensure that the Reserve Release Requirements are determined (i.e. for sustained downstream ecological requirements and basic human needs) during early planning and that the necessary releases are planned for throughout construction and operation.
- In managing the outflow control it is essential that the needs of the downstream water users and the natural environment are accounted for.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.
- Allow for safe adequate, easily accessible public ablutions at the dam wall.
- Ensure that all recreational planning and development is undertaken according to the approved SUP for the dam in question.
- Ensure that slipways are rough-finished to enable ease of use in the long term.
- Protect down stream flanks of dams with a proper drainage and anchor system. One or more of the following methods are approved as industry norms in various situations:
    - Place anchor poles for erosion control.
    - Place storm water berms and drains at correct intervals and positions.
    - Install channel lining plus a proper drainage and anchor system, topsoil and a grass seed mixture.
    - Install modular retaining systems.
- Consider the appearance of the structure. Where necessary, adapt the design to be more aesthetically pleasing.

4.6 River diversions

- The diversion of a river is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Diverting a water course requires permission from the relevant provincial DWAF. A licence in terms of Section 21 of the National Water Act, 1998 (Act No. 36 Of 1998) is required in this regard, for which there are specific process requirements. This is not, however applicable to Government Waterworks.

- Ensure that river diversions are big enough to allow the Mean Annual Runoff to pass without damming the water up in the future dam basin and without inundating riparian vegetation.
- Avoid large and prominent trees, communities and natural features: it may only be possible to identify these on site, at which time deviations to the planned alignment should be planned to avoid the driplines of large and prominent trees.
- Ensure rivers are diverted only where required and as authorised. No ad-hoc diversions are permitted.
- Make all river diversions safe for people and animals.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.
- Protect the slopes of all river diversions. One or more of the following methods are approved as industry norms in various situations:
    - Sandbags.
    - Reno mattresses.
    - Plastic liners and / or coarse rock (undersize rip-rap).

4.7 Fishways

- Environmental screening for fishways is to be conducted for all DWAF projects involving the construction of a barrier[16]. Such barriers include, but are not necessarily limited to dams, impoundments and gauging weirs.
- The feasibility of installing a fishway must also be considered in terms of the following:
    - Anticipated effectiveness versus cost (i.e. often barriers in excess of 5m in height will not be traversable by the species in question).
    - Management (i.e. often, installing a fishway in a remote area defeats the purpose, as the locals use it as a fishing ground).
- Input from a fish biologist or other suitably qualified professional is required to determine the necessity for a fishway on the barrier in question.
- Document site characteristic that may be of relevance when determining whether or not a fishway is necessary:
    - Characteristics of the river.
    - The presence of migratory biota.
    - Characteristics of the barrier.
- If it is determined that a fishway is necessary, then a fishway specialist may then provide advice on the most suitable design for the particular circumstances. Types of fishways include:
    - Pool and weir / pool and orifice / ladder type fishways.
    - Vertical slot / bucket and slot / slotted fishways.
    - Denil / chute type fishways.
- Where the construction of a fishway is not feasible in terms of financial costs and limited benefits obtained, then other means of mitigating the impact of the barrier on migratory biota in the river may be investigated:
    - Fish lifts.
    - Fish locks.
    - Fish passages through the outlet works.
    - Translocation of fish around barriers.

[16] As concluded from the March 1990 workshop entitled 'Fishways in South Africa' held in Pretoria under the auspices of DWAF

  - Establishment of artificial propagation facilities close to the dam and / or the construction of spawning beds in the river below the barrier.
- Design and plan the most appropriate action, bearing in mind the characteristics of the biota, as well as of the river in question. The following considerations must be taken into account:
  - Size of the largest fish.
  - Swimming capabilities of the weakest fish.
  - The number of fish likely to use fishway at any time.
  - The maximum distance which a fish can leap and the distance required for acceleration (as a rule, plunge pools are to be at least 2m deep).
  - Presence of climbing and / or crawling species.
  - The number of fish migrating at any given time.
  - The period and river flows during which the biota in the river normally undertake their migrations.
- Fishway requirements:
  - The choice of barrier design and the location of the barrier should consider the optimum functioning of the fishway as well as that of the river.
  - The functioning of the barrier and the fishway should be integrated as far as possible so that any natural overflow or release of water from the barrier takes place down the fishway or is used as an attraction and / or auxiliary water for the fishway.
  - Water spilling over a dam or weir must fall into a plunge pool and not directly onto a concrete or rock. A non-vertical downstream face is preferable.
  - Access location to be at most upstream point to which the fish can swim before encountering the barrier.
  - The access point should be located near to the channels habitually used by fish. Water spilling over the barrier should flow into these natural river channels to facilitate fish movement to the fishway entrance.
  - Shore-located entrances are preferable, as the shoreline provides a lead for the fish and is easily accessible for monitoring purposes.
  - The velocity of the water exiting the downstream end of the fishway must be more attractive (i.e. higher) that the general flow leaving the rest of the barrier. Too high a tailwater can reduce this velocity, while too low a tailwater may not provide sufficient swimming depth.
  - Where appropriate, structures such as scour valves may be utilised in the creation of cues.
  - A balance must be found between resting areas sized so that the velocity stimulus to proceed to the next step in the ladder is easily found.
  - Avoid creating standing waves in the corners of resting pools which could stimulate fish to leap out of the fishway and to avoid excessive turbulence.
  - Locate exits away from drawdown areas and areas of high flow velocities.
  - Design the fishway to be lower than the lowest point of the barrier, ensuring the functioning thereof during dry periods.
- Once a fishway design has been proposed, then a suitable expert (such as an ichthyologist) should be asked to check the feasibility of the final proposal and monitor the workings thereof.
  - The fish must be able to swim through the fishway without undue effort, risk of injury or unnatural exposure to predators.
  - Suitable hydraulic conditions exist for the fish for which the fishway is constructed.

- The fishway must operate effectively at the hydraulic regime of the river during migration time.
- The design must be guided by fish stimuli rather than by fish response.
- Optimise speed and success of fish passage to minimize delay, stress damage and fallback of fish.
- If flood peaks are delayed by the barrier, the design should enable the flow down the fishway to be manipulated in order to ensure synchronization with a flood or high flow event in the river above the barrier.

- Minimise construction, operation and maintenance costs by using construction methods and materials appropriate to the remoteness and geometric, hydraulic and geological characteristics of the site.
- Based on the type of fishway, the river and the behaviour of the biota, programme the works to fall within the most appropriate season.
- Ensure that the budget allows for maintenance, post construction.
- Monitoring requirements, such as access to the fishway under high flow conditions, facilities to install fish traps etc. should be taken into account at the design stage. These may include:
    - Walkway grids and handrails
    - Stop locks
    - Grab holders
    - Hooks for fishway buckets
    - Fishway bucket nets
- Consult with fish biologists in respect of the design for monitoring facilities and equipment.
- If debris flows are expected, trash racks or screens should be provided at the water entrance (i.e. fishway exit) which will not impede the progress of fish exiting the fishway. These must be placed at a suitable angle.
- Fishways should ideally be designed to be maintenance free, but provision for access to remove sediment and debris will be required in almost every situation.
- Based on the type of fishway installed, programme the type and timing of maintenance and monitoring work.

4.8 Roads

- The construction of a national, provincial or municipal road, or one passing through an environmentally sensitive area is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Design and locate access to provincial roads in accordance with the requirements of, and to the standards laid down by the Provincial or controlling authority.

- Plan access roads to complement the future use of the area (e.g. for a dam, facilitate access to the future shore line, or near the High Flood Level of the dam, in accordance with the SUP).
- Plan for safe pedestrian and cycling access and crossing where necessary.
- Surfacing of access roads must respond to the anticipated use intensity of the development. Tarred surfaces should be considered for high traffic routes.

- Make use of existing roads and tracks where feasible, rather than creating new roads.
- Limit the number of roads required, and ensure that these are direct, linking all the necessary components.
- Plan roads to avoid duplex soils, sodic patches, Red Data Plants, large trees, bird nesting areas, animal dens and rock outcrops, graves and structures.
- Plan roads to avoid large and prominent trees, communities and natural features: it may only be possible to identify these on site, at which time deviations to the planned alignment should be planned to avoid the driplines of large and prominent trees.
- No access roads may be designed to put heritage sites, protected or valued features at risk or in danger (refer to section 2.3).
- Plan access roads so that excessive bush clearing is avoided, especially in sensitive areas (refer to section 2.1).
- Wherever possible, but particularly in urban areas and neighbourhoods, retain trees as close as possible to the verge of the road (i.e. up to 3m if possible).
- Roads should not traverse slopes with gradients in excess of 8%. Where this is unavoidable, stabilise the road surface.
- Avoid planning roads through wetlands: seek an alternative route.
- Avoid roads through drainage lines and riparian zones wherever possible. Where access through a drainage line is unavoidable, then the road must be planned to disturb the least riparian vegetation.
- Ensure that causeways have minimal disruption to flow patterns, both upstream and downstream of the crossing, and do not cause damming of the water at the crossing.
- Where drifts are planned through rivers, ensure that Reserve releases (i.e. for sustained downstream ecological requirements and basic human needs) are catered for and that no damming-up is experienced.
- Adequate culverts are required as to have a minimal impact on water flow patterns through the drainage line.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.

4.9 Bridges

- The construction of a bridge is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Any drift or culvert installation that will in any way cause an obstruction in a drainage line requires permission from the relevant provincial DWAF. A licence in terms of in terms of Section 21(c) and (i) of the National Water Act (Act 36 of 1998) is required in this regard, for which there are specific process requirements.
- Avoid large and prominent trees, communities and natural features.
- Ensure that causeways and bridges do not cause damming.
- Ensure that culverts / pipes with energy dissipation / dispersion mechanisms are integral into the design of the crossing.
- Allow for approaches not exceeding a gradient of 1:3 (V:H) and allow for proper drainage, grading of cut and fill slopes, erosion protection and slope stabilisation as required (refer to section 4.11).

4.10 Water supply boreholes

- The abstraction of sub-surface water at volumes in excess of 10 cubic metres per day is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Avoid large and prominent trees, communities and natural features: it may only be possible to identify these on site, at which time the location of the hole may be altered to avoid the driplines of large and prominent trees.
- Do not plan to utilise existing water supply boreholes yielding water of substandard quality: undertake testing of the water supply borehole to ascertain quality if necessary.
- Plan water supply boreholes to lie within socially secure areas.

4.11 Erosion control

- Design slopes aimed at the prevention of soil erosion, of efficient storm water control, of the eventual reestablishment of vegetation and of ultimately achieving aesthetically acceptable landscapes:
- Plan for cut and fill slopes not exceeding a gradient of 1(V):3(H) wherever possible.
- In general, slopes steeper than 1(V):3(H) or slopes where the soils are by nature dispersive or sandy, must be stabilised. One or more of the following methods are approved as industry norms in various situations:
    - Topsoil covered with a geotextile[17], plus a specified grass seed mixture[18].
    - A 50:50 by volume rock:topsoil mix 200mm thick, plus specified grass seed mixture[19].
    - Logging or stepping (logs placed in continuous lines following the contours).
    - Earth or rock-pack cut-off berms[20].
    - Benches (sand bags).
    - Packed branches.
    - Ripping and / or scarifying along the contours.
    - Stormwater berms.
- Near vertical slopes of 1(V):1(H) or 1(V):2(H) must be stabilised using hard structures, preferably with a natural look, and with facilities allowing for plant growth. One or more of the following methods are approved as industry norms in various situations:
    - Retaining walls (loffel or otherwise).
    - Stone pitching.
    - Gabions.
    - Shotcrete.
    - Sandbags.
    - Reno mattresses.
    - Plastic liners and / or coarse rock (undersize rip-rap).
- Stone pitch the outfalls of all grassed waterways and subsurface drains.
- Landscape features are often effective mechanisms for water management, retention and dissipation. Investigate the softer option before opting for a civil solution.

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[17] Preferably made of sisal, with openings of at least be 225mm^2 and guaranteed to last at least 24 months
[18] The subsoil must be broken up / roughened to properly bind with the topsoil
[19] The subsoil must be broken up / roughened to properly bind with the topsoil
[20] Angled across the contour at approximately 30 degrees form the bisector of the contour

4.12 Reservoirs

- The construction of off-stream storage dams and reservoirs, with a capacity of 80 000 cubic metres or more is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- Avoid large and prominent trees, communities and natural features: it may only be possible to identify these on site, at which time the location of the reservoir may be altered to avoid the driplines of large and prominent trees.
- Locate reservoirs so as to cause minimal visual impact (i.e. take cognisance of relative location of populated areas and the visibility from these areas and the relative location of other similar structures). This is particularly relevant when reservoirs are located on mountains.
- Where feasible, opt to partially or totally bury the structure to reduce visual impact.
- Treat reservoirs so that they blend in visually with the surrounding landscape (i.e. provide domed roofs that blend with the topography and use earthy, non-reflective textures and finishes).
- Screen reservoirs with plants and rocks, imitating the surrounding environment. Alternatively paint reservoirs to blend in with the surrounding landscapes.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.

4.13 Water treatment plants:

- The construction of a water treatment plant is a listed activity in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.
- According to the General Authorisations in terms of Section 39 of the National Water Act, 1998 (Act No. 36 Of 1998), wastewater storage dams and wastewater disposal sites may only be located:
    - Outside of a watercourse.
    - Above the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a water supply borehole which is utilised for drinking water or stock watering.
    - On land that is not, or does not overlie, a Major Aquifer (identification of a Major Aquifer will be provided by the Department upon written request).
- Ensure that waste water structures are able to handle more than the design capacity.
- Avoid large and prominent trees, communities and features: it may only be possible to identify these on site, at which time deviations to the planned alignment should be planned to avoid the driplines of large and prominent trees.
- Ensure that no stormwater is allowed to enter any waste water disposal installation. Pay special attention in the Water Management Plan to the control of runoff under normal and storm conditions (i.e. through shaping, trenches and berms).

4.14 Sewage treatment systems

- The treatment of effluent, wastewater and sewage with an installed capacity of more than 15000 cubic metres is a listed activity in terms of the Environmental

Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT.

- Do not plan to locate any effluent, wastewater or sewage treatment facility, site toilet, sanitary convenience, septic tank or French drain as follows:
    - within the 1:100 year floodline, or alternatively within a horizontal distance of 100m of a water resource or a borehole which is utilised for drinking water or stock watering;
    - within a drainage line or identified wetland;
    - on land that overlies a Major Aquifer (identification of a Major Aquifer will be provided by the Department upon written request).

4.14.1 Sewage treatment

<u>a) Sewage treatment plants:</u>

- Design, construct, maintain and operate any clean water system so that it is not likely to spill into any dirty water system more than once in 50 years.
- Allow for wetland creation in sludge dams and beyond discharge points.
- Define services zones, in which services can be consolidated, thereby reducing the need for services being installed over large areas.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.
- Grass the slopes of water treatment plants, especially for balancing and sludge dams. A 1:1 rock:topsoil mix may be used.
- Utilise the landscape for filtration of grey water (for irrigation and aesthetic / functional water features, e.g. wetlands) where feasible.

<u>b) Pit latrines:</u>

- Pit latrines should only be considered on a small scale application or for domestic use.
- Locate pit latrines outside of watercourses at a sufficient distance from any buildings to minimise bad odours.
- Avoid soils which are water logged (clay) and soils which diffuse the effluent immediately (sand). Soils should be loamy and deep.
- Avoid areas with high water tables.
- The installation of ventilation improved pit latrines is preferred. The vent pipe should be higher than the superstructure.
- Were the soil is unstable the sides should be lined and stabilised (brick walls). Openings should be provided to allow for infiltration.
- Dry toilets (sealed systems) can be used in areas where soil and / or groundwater contamination is a problem. When using sealed units, these must be emptied regularly and the material disposed of at a suitable waste storage facility or when used as compost hygienic standards must be adhered to.

<u>c) Toilet farms:</u>

- The potential polluting impact of toilet farms on the soils and ground water is significant. Alternatives to toilet farms must be given careful consideration before opting for this system.
- Undertake a geohydrological survey of the area, including the determination of aquifers, aquicludes, water table levels and ground water movement trends.

- Do not locate toilet farms in areas with high water tables and areas of extensive ground water movement.
- Undertake soil analyses to determine the water logging and diffusing capacities of the soil. Do not locate toilet farms in areas soils which are water logged (clay) and soils which diffuse the effluent immediately (sand). Soils should be loamy and deep.
- Develop a surface water management plan to ensure that overflows and spillages do not occur, especially during storm conditions. Use excavated soil to shape the surface accordingly.

d) Alternative systems:

- An alternative system such as the *Hybrid Toilet System*[21] should be considered as an alternative to any conventional sewage disposal system, but especially in areas where soil and / or ground water conditions are unsuitable for pit latrines and where dry toilets are undesirable.
- The system is self contained and water based and requires that the primary tank be halfway filled only once. No additional water is required thereafter, and no connection to bulk service reticulation (water and sewage) is required.
- The system makes use of anaerobic water to treat the waste. After about three to six years, the sludge may need to be pumped out.
- The system can be installed within a day.
- A system taking up 1,5m² can serve 10 people.
- The waste enters into the primary sludge tank where it undergoes primary treatment. Gravity pulls the faeces t he bottom of the tank where anaerobic bacteria begins to digest it. The liquid substances flow to a secondary filtration tank (clarifier), which consists of several tanks nested together and filled with bio-media.
- The incoming waste will spend up to 90 days in the primary tank, and the liquid waste will take up to 40 days to travel through the clarifier. This gives a total detention time for the waste of about 130 days.
- The final elimination of water is from the clarifier, and routed into the ground through a French drain or holding tank. The effluent may be used for irrigation.

4.14.2 Waste water disposal

a) Constructed wetlands:

- The first stage and a pre-requisite for the installation of constructed wetlands to process black water / sewage is a correctly installed septic tank where settlement of solid matter takes place. Grey water may be passed directly through a constructed wetland.
- The septic tank must be a watertight receptacle with access for maintenance from the top.
- Constructed wetlands should only be considered if the flow of effluent is consistent.
- Constructed wetlands need about 1 to 10 m² of land per person depending on the strength of the wastewater and which type is constructed.
- Grease traps should be considered when the effluent contains high levels of oils.
- Select the type of constructed wetland based on the environment and project specific requirements:

[21] This is a complete treatment system as offered by the company *SA Biotech.* Website: www.sabiotech.co.za

- A *free water surface wetland* typically includes metered inflow through flow-diffusing inlets into basins or channels with soil bottoms, underlain by some form of seepage barrier, filled with shallow water and supporting emergent wetland vegetation. An operable control structure typically regulates water level while inflow rate, system volume and configuration, emergent plant stalks, precipitation and evapotranspiration dictate residence time[22]. Drawbacks are all related to the fact that the system relies on open standing water in ponds.
- The *subsurface reedbed system* uses a combination of mechanical and biological resources to process the water. The system consists of a vertical filter system with a subterranean flow. The mechanical pre-purification of waste water takes place in a multi chambered pit. The subsequent transport of waste water to the reedbed is brought about by a pressure pipe system which guarantees an even distribution of effluent over the filtration bed. The bed consists of layers of sand and gravel and is planted mainly with reeds. The root system of the plants ensures a constant aeration of the soil. Soil aeration results from the oxygen inflow via the vascular system of the roots and the loosening of the soil by root development. A layer of micro-organisms forms on the roots and nitirifiers and denitrifiers break down organic components to such an extent that even benzols and phenols are decomposed. No accumulation of substances occur in the plants, neither does any adsorption to the soil particles take place. The purified water is then collected in pipes, from where it flows to a control tank, where it can be monitored and tested. After that it is discharged to a river, pond, or allowed to infiltrate the ground[23].
- A biological filter system, such as the *Scarab and Eco-Scarab (Ozone) Treatment Plant*[24] may be considered as an alternative to a reedbed. The Scarab Biological Filter is comprised of 5 sections for the processing of the sewage effluent. This unit performs the function of controlling the flow of sewage effluent through the biological filter. The sewage effluent is introduced into the biological filter and is mixed constantly with pre-oxygenated effluent. The circulation chamber circulates the effluent from the pressurisation chamber back into the mixing chamber. Each litre of effluent is re-oxygenated at least once every hour thereby creating the highest possible concentration of oxygen in the effluent at all times. A standard water pump circulates the effluent through the pressurisation chamber, where the effluent is oxygenated by mixing it with air, under high pressure, to allow for the maximum absorption of oxygen. The media chamber is packed with Bio-Pak to allow for the highest possible surface area. It is on these surfaces that BioMass form. BioMass is responsible for biological refinement of the effluent to a stage where the final output is as clear as drinking water and odourless. Before final discharge it is imperative to disinfect the clear water effluent for any remaining pathogens or other bacteria. The purified water can then be discharged into the environment.

[22] http://h2osparc.wq.ncsu.edu/estuary/rec/septic.html
[23] "SUBTERRA" Reedbed Purification Systems brochure.
[24] This is a complete treatment system as offered by the company *Eco-logical Technology.* Website: www.eco3.co.za

- Another alternative is the *Lilliput* Bio-Reactor system[25]. From conventional septic tanks (predigestion), the liquid is balanced into an aerobic environment for carbonaceous removal, nitrification and denitrification, and finally disinfection before discharge into the environment. The effluent enters the bio-reactor below a fixed growth media where it mixes with an air diffuser. The effluent then rises through the media where the microbial population attached to the media removes and aerobically degrades the organic material contained in the aerated effluent. A degree of nitrification takes place in the upper layers of the media. Once it has passed through the media, the treated effluent is pumped through a disinfecting chlorine contactor and can be discharged to the garden or rivers, streams and dams. Disinfection is achieved by in-line chlorination or ozonation of the treated effluent. The incorporation of the biocatalyst Alpha Biotech enhances the rate and degree of biodegradation of solids in the septic tank thereby extending the intervals between desludging. It also reduces the negative impact of kitchen wastes of which cooking oil is the worst culprit. The Alpha Biotech catalyst has been successfully applied to sewage treatment. Sludge production is reduced, COD removal in the septic tank is enhanced and plant performance is generally enhanced, particularly in periods of abnormal load peaking.

- Locate constructed wetlands outside of watercourses at a sufficient distance from any buildings to minimise bad odours.
- Ensure that no stormwater is allowed to enter the installation.
- Define services zones, in which services can be consolidated, thereby reducing the need for services being installed over large areas.
- The wetland must be secured (fenced) to keep out vehicular traffic, people and animals.
- The use of indigenous plant material is preferred. Most effective is the use of *Phragmites spp* which may be harvested from permitted water courses. No listed invasive species may be used.
- Allow for a transitional wetland (tertiary treatment) creation beyond discharge points where possible.

b) French drains / soak-aways:

- French drains should only be considered on a small scale application or for domestic use. Consider the cumulative impact of existing French drains in use in the area before opting for this system.
- Locate French drains outside of watercourses at a sufficient distance from any buildings to minimise bad odours.
- The septic tank must be a watertight receptacle with access for maintenance from the top.
- Grease traps should be considered when the effluent contains high levels of oils.
- Avoid soils which have a low percolation rate (clay) and soils which have a high percolation rate (sand). Soils should be loamy and deep.
- Avoid areas with high water tables and steep gradients.
- The percolation area of the soakaway should be maximised.
- Allow for the establishment of plants (preferable indigenous) at the soakaway.
- The system should be demarcated to keep out vehicular traffic.

[25] This is a complete treatment system as offered by the company *Beyond Blue Design Projects (Pty) Ltd).* Website: www.beyondblue.co.za

4.15 Borrow areas

- Prospecting boreholes and test pits fall within the definition of a prospecting activity, and in terms of Minerals and Petroleum Resources and Development Act (Act No. 28 of 2002), would therefore require the acquisition of a Prospecting Right from the relevant Provincial Department of Minerals and Energy before works may commence.
- Borrow pits, sand mines and quarries fall within the definition of a mining activity, and in terms of Minerals and Petroleum Resources and Development Act (Act No. 28 Of 2002), would therefore require the acquisition of a Mining Permit (for operations not exceeding 1,5 Ha or 2 years in duration) or Mining Right (for larger operations of longer duration) from the relevant Provincial Department of Minerals and Energy before works may commence.
- Mining Permit and Prospecting Right applications are to be accompanied by an Environmental Management Plan, but a Mining Right application requires the compilation of an Environmental Impact Assessment (EIA) as part of an Environmental Management Programme (EMPR).
- Allow time to obtain all necessary authorisations by planning borrow areas well in advance.
- Negotiate royalties with the land owner / local chief, if he has mineral rights.
- Communicate with the landowner as to alternative future land uses after borrowing (e.g. wetland creation, drinking water or agricultural usage).
- According to the Regulations on the Use of Water for Mining and Related Activities, aimed at the Protection of Water Resources (National Water Act 36 of 1998), the area between the 1:100 and 1:50 year floodline of a watercourse is considered sensitive to mining, precluding mine residue disposal and storage, but allowing for excavation. No mining or associated activity may take place under or within the 1:50 year flood-line however or within a horizontal distance of 100 metres from any watercourse. This excludes specifically permitted river sand mining operations.

Borrow pits / rock quarries:

- Avoid large and prominent trees, plant communities and natural features: it may only be possible to identify these on site, at which time the location of the borrow pit may be altered to avoid these features.
- Avoid cultivated lands, orchards, graves and other sensitive features that would lead to costly compensation.
- Borrow pits required for the construction of dams must be located below the full supply level of the future dam.
- Plan for cut and fill slopes not exceeding a gradient of 1:3 (V:H) wherever possible.

Sand mining:

- Ensure that sand borrow areas in rivers are planned to include a 10m natural barrier between the operation and the active stream flow.

4.16 Buildings and structures

- The construction of buildings and structures may require a change in zoned land use. In this respect, the following changes in land use are listed activities in terms of the Environmental Conservation Act (Act No. 73 Of 1989) and is subject to Environmental Authorisation from DEAT:

- o Residential use to industrial or commercial use.
- o Light industrial use to heavy industrial use.
- o Agriculture or undetermined use to any other land use.
- o Use for grazing to any other form of agricultural use.
- o Use for nature conservation or zoned open space to any other land use.

- Placing permanent or temporary buildings and structures to respect natural drainage lines and significant (large) trees. Avoid the Riparian zone wherever possible.
- Development within a defined wetland or riparian zone may need to apply under Section 21 of the ECA for reclamation of land below the high water mark.

- Plan housing facilities, the positions thereof and the treatment thereof so as to have the least possible environmental impact.
- Plan housing and recreation facilities in conjunction with local stakeholders and Interested and Affected Parties. This includes permanent structures as well as construction buildings, which may be planned with future uses in mind.

- Locate permanent offices and houses where they will have the best potential for re-use (i.e. at a dam, these must be so positioned as to overlook the dam and to be relatively close to the buffer line). The SUP and permanent structures are to enjoy preference of position.
- Ensure that social and environmental ethics are addressed during the planning and design phase regarding the size of houses and stands as well as the finishes.

- Avoid locating buildings under trees wherever possible. Where this is unavoidable, screen corrugated iron roof surfaces with shade net suspended 1m above the roof to protect the tree from the damaging reflection.
- Where permanent structures are obtrusive, paint them using non-reflective colours which blend in with the dominant colours of the surrounding environment.
- Where concrete structures are obtrusive, treat them to match the colours of the surrounding landscape (i.e. with a staining or coloration compound).
- Treat packed rock and exposed rock cuttings to match the colours of the natural weathered rocks of the adjacent environment.

5. SPATIAL DESIGN GUIDELINES

A comprehensive and detailed planning exercise entails the consideration of not only salient environmental principles, but also the basic principles of spatial design.

This section draws extensively from the document entitled *Introduction to Landscape Design*[26].

5.1 Responsiveness

5.1.1 The environment

- Integrate the architectural design of structures as well as the landscape with the aesthetics of the area.
- Design in response to the natural and created environment of the area, including buildings and structures, roads, the surrounding development areas and infrastructure.

5.1.2 Human needs

- Design in response to the needs of the users in terms of activities, facilities, and the relative locations of these within the design.
- Design in response to the needs of users in terms of sensual perception (sight, hearing, touch, taste and smell) and experience (interest and emotion).
- Design in response to the needs of users in terms of safety and security. Avoid the use of potentially dangerous materials (such as poisonous plants) or potentially dangerous situations).
- Allow for the accommodation of disabled access and use where necessary.
- Allow for the incorporation of child friendly designs where necessary.

5.1.3 Micro-climate

- Propose a design that will assist in the manipulation and control of climatic conditions as and where required. Take into consideration diurnal and seasonal changes and the problems and opportunities that these rhythms present.
- Provide for shelter from and exposure to the elements, as the anticipated use of the area requires:
  - o Accommodate the need for shade in the summer and sunny areas in the winter.
  - o Provide shelter from rain and protection form lightning where necessary.
- Create varied micro-climates and solve problems related to micro-climate as and where required, making use of appropriate materials and elements:
  - o Landscape elements may be used to deflect or shield problem winds, while making the most of cool, refreshing breezes.

[26] MOTLOCH, J L. 1991. VAN NOSTRAND REINOLD: NEW YORK.

  - Tree canopies provide protection from the overhead sun, while low branching trees provide protection from the late afternoon sun.
  - Materials such as concrete, brick and stone absorb and reflect heat, making them cold in winter and hot in summer.

5.2 Functionality

5.2.1 Circulation

- Address circulation systems in terms of three components:
  - Traffic generators.
  - Connectors.
  - Events en-route.
- The generators serve as goals, which by their presence create a certain number of trips along the connectors. The number of trips, and the condition under which they need to function will affect the size, design and material of the connectors.
- Events usually occur along the connectors, most commonly where connectors cross (intersection points). At special points, status may be awarded or emphasis placed by increasing space.
- Note that the circulation system does not occur in a spatial vacuum, and that visual perception of place is primarily a spatial experience. Circulation spaces must therefore place the viewer in an appropriate relationship to site spaces and must establish compatible circulation and spatial character.
- The pedestrian moves relatively slowly and in close contact with the environment. Thus visual characteristics are quite important.
- Once vehicles, such as bicycles come into play, then attention moves away from sensual stimuli, and practical aspects such as the surface treatment becomes important, especially in terms of ease of movement and safety.
- Quick movement allows little time for noticing details, while slower movement allows for such.
- Design and plan circulation with due cognisance of the way in which people move, the surface over which they move and the visual, spatial and temporal influences. Appreciate the fact that people will use a preferred route, even if this is not the designed path.
- Make use of surface changes to communicate a change in intended use (i.e. on a subliminal level). Materials may also be used in this manner.
- Make use of material to convey right of way (i.e. a walkway across a street implies pedestrian priority). In such instances, accepted norms should be used – do not jeopardise safety through ambiguous signs.

5.2.2 Space

- Make use of scale to evoke the desired feelings and facilitate intended behaviours through the definition of size or space relative to human size:
  - Intimate scale is the space within which facial expression is visible.
  - Social scale is the space within which an individual’s face is recognisable.
  - Public scale is the space within which the human form is discernable in terms of gender, age and activity.

  - In general, dimensions of up to 12m to 25m are still on an easy human scale, with the former being more intimate. Dimensions smaller than 12m could become uncomfortably small.
- The vertical edge is the most visually dominant stratum and determines the size and basic character of a space.
  - Flat, level areas evoke a feeling of expansiveness.
  - Smaller enclosed spaces contribute to intimacy.
- Make use of enclosure to evoke the desired feelings and facilitate intended behaviours. Enclosure is a factor of the height of the form and the position of the observer:
  - 1:1 (V:H) feels fully enclosed.
  - 1:2 (V:H) feels partially enclosed.
  - 1:3 (V:H) feels minimally enclosed.
  - 1:4 (V:H) feels unenclosed, but the termination of sightline allows for the determination of absolute space.
- Allocate a design identity (style or feel) to spaces where it is necessary to support legibility and / or clarify the functional purpose.

5.3 Aesthetic function

5.3.1 Line

- Make use of thick lines to convey a feeling of strength.
- Make use of thin lines to convey a feeling of delicacy.
- Make use of angular lines to impart a feeling of energy, power and boldness.
- Make use of straight lines to direct movement and draw the eye, to reinforce the linear character of a feature.
- Make use of curved lines to evoke a sense of calm, passiveness and restfulness.
- Make use of lines that are not horizontally or vertically aligned evoke an unbalanced feeling and a sense of tension.
- Make use of right angles echo architectural construction and impart an architectonic quality to form.

5.3.2 Form

- Make use of vertical elements to draw attention and create focal points.
- Make use of rounded forms to create non-directional unifying elements.
- Opaque and / or solid objects (as opposed to transparent or perforated objects) contribute to the feeling of enclosure:
  - Features that block vision provide enclosure.
  - Features that do not block vision imply enclosure.
- Make use of tall features (i.e. above eye level) to create a feeling of enclosure and to screen unsightly features.
- Make use of low features (i.e. below eye level) to separate space physically, but not visually. The lower the feature, the weaker the separation.
- Make use of intermediate features that ‘top out’ at eye level to cause tension.

5.3.3 Texture

- Make use of texture manipulation to enhance spatial definition.
  - Rough or coarse textures are highly visible and feel bold, sure, aggressive and sometimes rustic or crude. They also appear to advance toward the viewer.
  - Use coarse textures carefully in small spaces, as they could become overwhelming.
  - Medium textures tend to be neutral and do not demand attention.
  - Fine or smooth textures are refined, sophisticated and delicate. They also appear to recede from the viewer.
- Make use of fine textures to make small spaces seem larger.
- Make use of fine textures of certain elements to offset the coarse texture of others.
- Make use of coarse texture contrasts to create focal points.

5.3.4 Colour

- Make use of colour contrast manipulation to enhance spatial definition.
  - Contrasting colours (i.e. those lying on opposite sides of the colour wheel) appear more separate from one another.
  - Reds, oranges and yellows are 'warm' colours and appear to advance toward the viewer.
  - Blues and greens are 'cool' colours and appear to recede from the viewer.

5.3.5 Rhythm

- Use rhythm to unify a composition through repetition and / or the recurrence of similar items. Create rhythm through the use of line, form, colour or texture:
  - Legato rhythms are flowing and connected, (i.e. like a tree lined walkway).
  - Staccato rhythms are agitated.
- Take cognisance and advantage of perceived changes resulting from diurnal (day-night) rhythms:
  - At midday, the sun is overhead, shadows are short, the light is harsh, colours are at their brightest and distances seem shorter.
  - At dusk and dawn, the landscape seems flatter as a result of longer shadows, and the diffuse light results in paler, leached colours. At this time non-visual stimuli become more apparent (i.e. such as scent and sound).
  - At night the entire landscape is recreated as distances seem greater and attention is directed to the sky.
- Take cognisance and advantage of changes resulting from seasonal changes:
  - The lifecycles of all plants relate to the seasons in terms of budding, flowering and fruit production. Different species may be used for different effects at different ties of year.
  - Deciduous trees and shrubs exhibit full leaf during summer, autumn displays of colour, and naked branches during winter.
  - Evergreen species create a feeling of constancy and security.
  - Annual and perennial herbaceous species exhibit cycles of flowering and complete die-back.

5.3.6 Variety

- Use principles of contrast in terms of form, texture and colour to add variety to boring compositions and create interesting design planning and design solutions.

5.3.7 Harmony

- Use continuity and repetition to increase harmony and consolidate disparate elements.

5.3.8 Composition

- Use the relative placement of elements within the landscape to determine the formality of the space:
    - o Arrangement of elements in straight lines, geometric layouts and in grid formation creates a formal feeling.
    - o Arrangement of elements (especially trees) as they appear in nature creates an informal feeling.

5.4 Spatial elements

5.4.1 Street furniture

- Consider the interaction between the intended use of the area and the prospective users when incorporating street furniture into a space:
    - o Allow for seating where people may be expected to congregate or wait, at points where people may need to rest after a long walk, and where the design allows or calls for people to linger.
    - o Provide adequate numbers of dustbins in all public spaces, but especially in areas where food is prepared and / or consumed. Ensure that dustbins are visible and accessible.
    - o Make use of bollards to regulate and / or separate pedestrian and vehicular traffic. Ensure that the spacing of bollards allow for their effective function. Ensure that they are clearly visible and do not constitute a danger to people or property.
    - o Incorporate lighting wherever night use is anticipated or required. Lights must provide illumination to a safe and convenient level without being a nuisance in terms of glare. Consider the orientation and height of the light fitting in this respect.
- Ensure that all street furniture is robust, easy to clean and maintain, preferably vandal proof.
- Favour street furniture that is aesthetically integrated with the rest of the design. Avoid choosing street furniture that clearly looks like an afterthought.

5.4.2 Signage

- In terms of overall planning, the aim is to avoid having to use signage by planning a legible design. Most situations will however require some degree of signage to aid the user and avoid irritation and delays. This may include, but is not necessarily limited to:

- o Directional signage to parking areas, reception areas, and housing. This signage is to be in accordance with the regional restrictions as defined in SAMOAC[27].
- o Restrictive signage directing unauthorised access away from service areas, offices and construction areas.
- o Informative signage indicating the name of the development and any information or history that may be of interest.

- Provide signage required in terms of legislation, municipal bylaws and SABS safety standards. This may include, but is not necessarily limited to:
  - o Traffic signs indicating junctions, stops, yields speed limits etc.
  - o No smoking signs.
  - o Gender signs on ablutions.
  - o Fire hose, fire extinguisher and emergency exit signs.
  - o Construction site safety signs indicating 'hard hat' and 'construction boot' signs.

5.4.3 Pathways

- Make use of direct, narrow paths to facilitate quicker, goal orientated movement.
- Make use of broad, meandering paths to facilitate slower and more relaxed movement.
- Make use of indirect paths to create a feeling of mystery or tension.
- When large public spaces need to be traversed, circulation will be more comfortable along the edge of the space.
- Make use of practical requirements such as expansion joints in a manner that supports the design (i.e. these could become directional lines).
- Materials used in a certain way can support or detract from directionality (e.g. bands across the path as opposed to along the path).

5.4.4 Roads

- Allow for the quantities and sizes of vehicles (at the correct speeds) anticipated to move through the routes.
- Design for speeds that will minimise travel times and maximise safety at all times. Be aware of bylaw requirements and SABS safety requirements at all times (this includes the provision of sightlines).
- Organise the circulation system hierarchically in order to facilitate legibility.

5.5 Sustainability

5.5.1 Robustness and resilience

- Designs must be such that they are to withstand pressures resulting from utilisation, changes in needs, trends and fashions.
- Build a degree of flexibility into all designs, appreciating the fact that the needs of the operator and the user could change over time.

[27] DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM AND THE DEPARTMENT OF TRANSPORT. *South African Manual for Outdoor Advertising Control (SAMOAC).* April 1998.

5.5.2 Maintenance

- Materials should be appropriate for their intended use under the various weather conditions that occur.
- Materials must be selected according to the maintenance they will require and the degree of available maintenance:
  - o Lawn and groundcovers fertilising, weeding and irrigation, and exposed soil requires raking. Lawn can tolerate limited pedestrian use only before the grass dies and the soil erodes.
  - o Paving, which is hard wearing and durable, generally has a higher capital cost, but is largely maintenance free once laid.
  - o Unpaved surfaces are generally considered fair-weather ones.
  - o Paved surfaces are durable all-weather ones.
  - o Make use of materials suited to their application: (e.g. use hard wearing surfaces for high traffic areas):
  - o Base material selection on longevity, enabling long-lasting designs.
  - o Favour the use of materials and components that will age gracefully, and not become tacky.
  - o Avoid the use of loose material such as gravel in areas where the material is likely to perpetuate problems (i.e. such as near to drains, sliding gates, pedestrian pathways etc.).
  - o Make use of low-tech materials (such as wood, stone and clay) if a subtle, natural effect is desired.
  - o Make use of high-tech materials (such as glass, concrete, metals and plastics) to create a more prominent and dramatic effect.
- Make use of materials and components of high quality, but avoid creating a blatantly artificial environment unless this is the aim.
- The trend is to propose designs of minimal maintenance, as this negates unnecessary operational costs. Minimal maintenance is an aspect that must be planned for, however:
  - o Avoid maintenance intensive designs in remote areas where proper maintenance is unlikely to take place.
  - o Favour materials that do not require periodic applications of paint or preservation treatments.
  - o Propose a landscape that will essentially be of low water requirement, even if an irrigation system is to be installed.
  - o Favour tree and shrub species that do not have to be intensively pruned (i.e. fruit trees, roses etc.).
  - o Favour plant species that are able to thrive under the local climatic conditions without having to be protected from sun, wind, frost etc.
  - o Select plant species able to thrive on local rainfall wherever possible.
  - o Avoid the use of plant species that tend to spread aggressively, unless that is the express purpose.
  - o Utilise plant species within the micro-climate suited to their growth requirements (i.e. full sun, semi-shade and deep shade conditions).
  - o Take the macro-climate into consideration when selecting plants. Use species resilient to frost, wind, sea-spray, drought or extremes of temperatures as required.

- Take soil conditions into consideration when selecting plants. Use species adapted to the relevant soil depth (i.e. deep soil or shallow, rocky soil), soil texture (clay soil or sandy soil), fertility.
- Take ground water conditions into consideration when selecting plants. Use species adapted to saturated conditions when planting in areas with high water table.
- Take existing vegetation and wildlife into consideration when selecting plants, as the landscape will eventually form a habitat. Avoid creating short term habitats.

6. MASTER PLAN DEVELOPMENT

6.1 General requirements

The compilation of an overall Master Plan for a development is standard planning practice for projects of all scales and types, and ultimately contributes to a more environmentally friendly, cost effective and aesthetically pleasing product for users, operators and the public at large. To be meaningful, Master Planning must reflect communication and decision making on all levels.

Such Master Planning comprehensively considers not only the salient environmental principles (addressed in Chapters 2 and 3) and the project component specifications (addressed in Chapter 4), but also the basic principles of spatial design (addressed in Chapter 5).

A Master Plan also aids in providing clarity to the Implementing Agent, Stakeholders, Interested and Affected Parties and the Contractor in terms of the holistic planning goals. In addition, it forms the basis from which more detailed plans and details are developed.

Ideally, the Master Plan is to be developed early enough in the project planning phase to be available for prospective tenderers during the tender phase, and for inclusion in the project specific Environmental Management Plan (EMP).

6.2 Specific requirements

- Draw up a Master Plan for every new development and upgrade project. Depending on the type and complexity of the project in question, it may be necessary for the Environmental Planner[28] to develop the Master Plan incrementally:
  - o A Zoning Plan (ZP) delineates the various proposed development zones, activity areas and functional links (see Figure 2), ahead of allocating a spatial design dimension to the project components. The purpose of the Zoning Plan is to explore and illustrate the compatibility and interaction between the development components with one another and with the existing land uses.
  - o A Master Plan (MP) details the spatial arrangement of the various activities, facilities, access routes and support services making up the proposed development (see Figure 3). The purpose of the Master Plan is to indicate the position, shape, scale and aesthetic quality of all aspects of the project, both temporary and permanent, and to ensure that the relationships between these are acceptable and functional. This plan must show all planning and design components of the project in terms of space and time, including the following:
    - ❖ Buildings and other structures
    - ❖ Essential services and service systems

[28] The role of Environmental Planner must preferably be filled by a person suitably qualified to undertake the work, such as a Landscape Architect, professionally qualified in holistic and responsive planning and design. At the very least, the input of such a person must be sought during the planning process.

- ❖ Other infrastructure
- ❖ Roads and parking areas (primary and secondary)
- ❖ Pedestrian pathways and routes (primary and secondary)
- ❖ Sports fields and recreation areas
- ❖ Public landscapes and landscape components
- ❖ Private landscapes and landscape components

- Depending on the nature and scale of the project in question, separate plans for Permanent and Temporary Infrastructure may be required. The Environmental Planner will take this decision on a project specific basis.
- Depending on the project specific requirements, Sketch Plans (large scale plans depicting design detail for a specific area of the Master Plan), Sections, Elevations and Perspective Sketches may be required to support the Master Plan. The Environmental Planner will take these decisions on a project specific basis.
- Depending on the project specific requirements, Plant Plans indicating plant species, quantities, sizes and positions, as well as grassed and seeded areas may be required. Such plans and associated specifications are not only necessary during planting works, but should also be used to determine maintenance requirements and costs.

- Draw up an Environmental Site Management and Rehabilitation (ESM&R) Plan for every new development and upgrade project, for issue to prospective tenderers during the Tender Phase. This plan, initially developed by the Environmental Planner, is essentially a refined Master Plan which details and quantifies all construction aspects related to the project (see Figure 4). This plan must therefore show the positions and extent of all permanent and temporary site structures and infrastructure, including:
  - Buildings and structures
  - o Contractors’ accommodation.
  - o Contractors’ camp and laydown areas.
  - o Site offices.
  - o Site laboratories.
  - o Batching plants.
  - o Crusher plants.
  - o Sand washing plants.
  - o On site nurseries.
  - o Roads and access routes
  - o Gates and fences.
  - o Essential services (permanent and temporary water, electricity and sewage)
  - o Substations.
  - o Rubble and waste rock storage and disposal sites.
  - o Solid waste storage and disposal sites.
  - o Site toilets and ablutions.
  - o Hazardous waste storage and disposal sites.
  - o Firebreaks.
  - o Prospecting boreholes, excavations and test pits.
  - o Borrow areas.
  - o Excavations and trenches.
  - o Cut and fill areas.
  - o Sand extraction points.
  - o Topsoil stockpiles.

- o Spoil areas.
- o Sludge dams.
- o Construction materials stores.
- o Vehicle and equipment stores.
- o Workshops.
- o Wash bays.
- o Fuel stores.
- o Hazardous substance stores.
- o Site weather stations.
- o Features and plants to be conserved.

- For smaller projects, or as specified by the Environmental Planner, the ESM&R Plan may be incorporated into the Master Plan.
- Ensure that the planning, location and design of the construction site is done in such a way that it does not compromise the positioning of permanent houses, offices, dam operator boat slipway or the SUP. Permanent structures must get preference of location.
- Ensure that all areas likely to be affected by construction are indicated on the ESM&R Plan.
- The ESM&R Plan must be such that both the tender document and the Environmental Bill of Quantities may be more easily understood.

- Draw up a Water Management (WM) Plan[29] for every new development and upgrade project, for issue to prospective tenderers during the Tender Phase (see Figure 5). This plan, initially developed by the Environmental Planner, must show the positions, extent and specifications of all temporary and permanent water management structures and infrastructure, including:
  - o Taps, pipelines and irrigation systems.
  - o Underground drains.
  - o Grass drains.
  - o French drains.
  - o Trench and berm systems.
  - o Deflection berm systems.
  - o Bunds and sumps.
  - o Settlement ponds.
  - o Water discharge points (including energy dissipation specifications).
  - o Water testing points.
  - o Sewage water management systems.]
  - o Grey water management systems.
- For smaller projects, or as specified by the Environmental Planner, the Water Management Plan may be incorporated into the ESM&R Plan.

- The Master Planning Process must be undertaken by a multi-disciplinary team consisting essentially of the Environmental Planner, Design Engineer and Social Officer.
- Desktop planning must be supported by ground truthing and detail planning on site. Such final planning must be undertaken on site by the multi-disciplinary team, assisted by the surveyor, and where relevant, the contractor.

[29] To be compliant with SABS 1200

6.3 Development within floodplains

- Draw up the necessary Master Plan and Water Management Plan outlining proposals for the mitigation of increased runoffs and potential water quality impacts. These are to be submitted to the relevant authority for approval.
- Indicate the 20 year, 50 year, 100 year floodlines and Danger Flood Level (if applicable) on all plans. Building floor levels to be above the 100 year flood level.
- Ensure that a registered professional civil engineer quantifies and certifies the potential impact of the development on either upstream or downstream flood levels or flood hazards. Approved compensatory works may be required.
- Ensure that buildings are flood proofed and constructed of flood compatible materials, particularly in the case of basements. Details to be provided to the relevant authority for approval.
- Ensure that detailed flood management, warning and evacuation plans are prepared and submitted to the relevant authority for approval.
- Submit construction method statements and Environmental Management Plans (where applicable) to the relevant authority for approval.
- Buildings (where applicable) are to be orientated towards the watercourse, no perimeter walls either perpendicular or adjacent to watercourse.
- Where the development or components thereof fall within the ecological buffer width, detailed impact studies must be submitted to the relevant authority for consideration.

7. ENVIRONMENTAL CODE OF CONDUCT

In an effort to avoid unnecessary environmental damage which may be sustained during on-site reconnaissance, survey and investigation work undertaken during the pre-feasibility and planning phases of a project, the following code of conduct should be adhered to by any person or organisation accessing the site.

7.1 General conduct

- Use plant and equipment which is appropriate to the task in order to minimise the impact on and extent of damage to the environment.
- Normal work hours will apply (i.e. from 06h30 to 16h15, Mondays to Fridays).
- Ensure that employees and staff conduct themselves in an acceptable manner while on site, both during Work hours and after hours.
- No loud music is permitted on site.
- Maintain professional conduct at all times, addressing all role players with respect and refraining from foul language and abuse.
- Ensure communication and consultation with relevant managers, PSP's and internal directorates at all times.
- Ensure that complaints are addressed and disputes resolved as soon as possible without victimisation. Where necessary, management should be involved.

7.2 Health and safety

- Ensure that all the Regulations as included in the Occupational Health and Safety Act (Act 85 Of 1993) are complied with. Reference is made to this Act and all its regulations.
- The land owner is responsible for maintaining the site and upkeeping general site safety requirements until such a time that the site is handed over to a contractor (during construction), or an operator.
- Control access onto and off the site by means of a register system. This includes visitors.
- Ensure that first aid / emergency facilities / procedures are in place.
- Ensure that all personnel are trained in basic site safety procedures.
- Keep a register with contact numbers of all people employed and one relative for each.
- Keep a list of all relevant emergency numbers in an easily accessible location on site.
- Keep a record of all incidents, accidents and illnesses on site and make the information available at meetings.
- Ensure that proper footwear is worn by employees at all times.
- Ensure that employees are issued with and make use of the necessary safety equipment when working in dusty, noisy and / or dangerous situations. Such equipment may include, but is not necessarily limited to hardhats, goggles, masks, earplugs, gloves, safety footwear and safety ropes as required.

- Ensure that adequate drinking water, wash water and ablutions are available at all times and on all work sites.
- Where necessary, provide a designated place for food storage, preparation and consumption on site. This should be a shaded area.
- Ensure that personnel are transported legally, and in a safe and responsible manner.
- Ensure that all vehicle and machine operators are qualified and licensed to operate their vehicles / machines.
- Protect dangerous excavations or Works that may pose a hazard to humans and animals. Demarcate these areas with hazard tape or fencing as required and post the appropriate danger signs.
- Respect workers' right to refuse work in unsafe conditions.

7.3 Safeguarding sensitive environments

- Recognize and protect sensitive environments and sites of social and / or cultural historical significance. Such features include, but are not limited to, riparian vegetation, wetlands, drainage lines, ridges, inhabited houses, graves, historical structures, culturally significant sites (such as initiation schools) and archaeological finds.
- Where damage to sensitive environments and protected features is a problem, then these should be demarcated with danger tape and steel droppers, or a fence for protection.
- Do not disturb deface or destroy sensitive environments and protected features, whether fenced or not, unless otherwise specified by the EM.
- If any chance archaeological finds, graves or skeletal material are unearthed, halt Works in that area immediately and inform the EM[30].
- Do not resume Works in the area in question without permission from the EM[31].

- Avoid access into seasonally wet areas and / or turf soils during and immediately after rainy periods, until such a time that the soil has dried out.
- Utilise only light equipment for access and deliveries into areas of unstable soils, in areas where erosion is evident, and at stream and river embankments.
- Limit vehicular access into rocky outcrops and ridges.

- Do not permit any fires or open flames in the vicinity of a wetland, especially during the dry season[32].

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[30] The EM must contact the closest museum or the Cultural Historical Museum for record keeping and conservation / preservation actions and / or follow-up

[31] A Phase 2 archaeological investigation must be undertaken and a permit must be obtained from SAHRA regional office before any archaeological site can be destroyed. In addition, exhumation and reburial of graves must conform to the standards set out in the Ordinance on Excavations (Ordinance no. 12 of 1980). Permission must be obtained from the descendants (where known), the National Department of Health, Provincial Department of Health, Premier of the Province and the local police. In addition, permission must be obtained from the landowners (where the graves are located and where the graves are going to be relocated) before exhumation can take place. Human remains can only be handled by a registered undertaker or an institution declared under the Human Tissue Act (Act 65 of 1983 as amended). The ECO will co-ordinate

[32] To be indicated by the ECO as referenced in the Environmental Impact Assessment or Project Screening Exercise, whichever is relevant

7.4 Safeguarding flora

- Limit de-bushing as far as possible.
- Protect plants and natural features of significance. These plants and features include, but are not limited to, Red Data Species, Protected Plants, Sensitive Communities, Riparian Vegetation, Wetlands, Drainage Lines and Aesthetically Significant Areas.
- Where damage to plant specimens and communities is a problem, then these should be demarcated with danger tape and steel droppers, or fenced at the distance of the outermost dripline.
- Do not disturb, deface, destroy or remove Protected plants and features, whether fenced or not, unless otherwise specified by the Environmental Manager.
- Do not remove any large tree without the permission of the EM.
- No open fires are permitted under trees.
- No material storage or laydown is permitted under trees.
- Avoid locating buildings and structures (temporary or otherwise) under trees wherever possible. Where this is unavoidable, screen corrugated iron roof surfaces with shade net suspended 1m above the roof to protect the tree from the damaging reflection.
- Where possible, avoid parking heavy equipment, machinery and vehicles under any tree.
- No vegetative matter may be removed for firewood.

- No open fires are permitted anywhere on site.
- Ensure that the Work Site is equipped with adequate fire fighting equipment[33]. This includes at least rubber beaters when working in veld areas, and at least one fire extinguisher of the appropriate type irrespective of the site.
- Take immediate steps to extinguish any fire which may break out on site.
- Restrict contained fires for heating and cooking (i.e. in a fire drum) to designated areas on site. Prevent employees from creating fires randomly outside designated areas.
- Do not store any fuel or chemicals under trees.

7.5 Safeguarding fauna

- No wild animal may under any circumstance be handled, removed or be interfered with.
- No wild animal may be fed on site.
- No wild animal may under any circumstance be hunted, snared, captured, injured or killed. This includes animals perceived to be vermin. The penalty clause associated with the needless destruction of wildlife is a fine of R2 000 and / 12 months imprisonment[34]
- Regularly undertake checks of the surrounding natural vegetation, in fences and along game paths to ensure no traps have been set. Remove and dispose of any snares or traps found on or adjacent to the site.

[33] In terms of SABS 1200
[34] In terms of the Animals Protection Act (Act 71 of 1962) Section 2

- Ensure that the site is kept clean, tidy and free of rubbish that would attract animal pests.
- Have problem animals and vermin removed by an appropriate organization or authority (i.e. such as the Parks Board, the SPCA or a registered exterminator).
- Ensure that domesticated animals belonging to the local community are kept away and are safe from any unprotected Works.
- Do not make use of any pesticides, unless approved by the EM.

7.6 Managing waste and pollution

- Do not dump waste of any nature, or any foreign material into any drainage line or wetland.
- Do not allow the use of any drainage line or wetland for swimming, bathing, or the cleaning of clothing, tools or equipment.
- Prevent the discharge of water containing polluting matter or visible suspended materials directly into drainage lines or wetlands.

- Keep all sites tidy and litter free at all times. Where necessary, provide litter bins equipped with a closing mechanism for the collection of domestic waste.
- Unless otherwise specified by the EO / ECO, remove all domestic waste to the nearest registered solid waste disposal facility.
- Ensure that solid waste is transported properly, avoiding waste spills en-route.
- Where solid waste disposal is to take place on site, ensure that only non-toxic materials which have no risk of polluting the groundwater, are buried in designated approved areas at acceptable depths below ground level[35].
- No solid waste disposal site may be located below the full supply level of any existing or prospective dam.
- No solid waste may be burned on site.

- Ensure that adequate numbers of conveniently located site toilets are available on all Work Sites at all times in quantities related to the number of users (1 toilet per 30 users is the norm).
- Do not locate any site toilet, sanitary convenience, septic tank or French drain within the 1:100 year floodline, or within a horizontal distance of 100m (whichever is greater) of a watercourse, drainage line or identified wetland.
- Maintain and clean site toilets regularly as is required to keep them in good, functional working order and in an acceptable state of hygiene.
- Combine drinking water facilities with hand washing facilities near site toilets.

- Provide drip pans for generators, or any machinery that will be in position for longer than one day.
- Servicing of vehicles and equipment is not permitted on site. Ensure that drip trays are provided for all emergency repairs required on site.
- Drip trays are to be watertight, and must be emptied regularly and before rain events. The contents of drip trays are to be treated as hazardous waste.

[35] The necessary approvals and permits are to be in place before any such disposal takes place

- Do not locate any fuel depot within the 1:100 year floodline, or within a horizontal distance of 100m (whichever is greater) of a watercourse, drainage line or identified wetland.
- Store fuel at temporary depots within a bunded area, or alternatively in an area underlain by heavy duty PVC sheeting and covered with 100mm of sand. This is to include an area adjacent to the tanks upon which vehicles must park during refuelling.
- The only permitted method of fuel transfer is by means of a pump / controlled valve / tap / hose / funnel.

- Immediately clean any accidental oil or fuel spills or leakages.
- Do not hose oil or fuel spills into a storm water drain or sewer, or into the surrounding natural environment.
- Clean small oil or fuel spills with an approved absorbent material, such as 'Drizit' or ‘Spill-sorb’.
- Contain oil or fuel spills in water using an approved oil absorbent fibre.
- Treat soil contaminated by oil or fuel using one of the following approved methods, as per instruction of the RE / EO / ECO:
    - o Remove the soil to the depth of the contamination and dispose of at a registered Hazardous Waste Disposal Site.
    - o Remove the soil to the depth of the contamination, and regenerate using approved bio-remediation methods.
- Report major oil or fuel spills to the provincial Department of Water Affairs and Forestry, as well as to the relevant Local Authority.

7.7 Managing roads and access

- Make use of existing roads and tracks where feasible, rather than creating new routes.
- Limit the number of temporary access routes required, and ensure that these are direct, linking all the necessary components.
- Plan temporary access routes to avoid duplex soils, sodic patches, Red Data Plants, large trees, bird nesting areas, animal dens and rock outcrops, graves and structures.
- Plan temporary access routes to avoid large and prominent trees, communities, natural features and sites of cultural and historical significance[36].
- Plan temporary access roads so that excessive bush clearing is avoided, especially in sensitive areas (refer to section 2.1).
- Temporary access routes should not traverse slopes with gradients in excess of 8%. Where this is unavoidable, stabilise the road surface.
- Avoid temporary access routes through wetlands: seek an alternative route.
- Avoid temporary access routes through drainage lines and riparian zones wherever possible. Where access through drainage lines and riparian zones is unavoidable, only one road is permitted, constructed perpendicular to the drainage line. Avoid routes that follow drainage lines within the floodplain.

[36] As referenced in the Environmental Impact Assessment or Project Screening Exercise, whichever is relevant

- Ensure that causeways result in minimal disruption to flow patterns, both upstream and downstream of the crossing, and do not cause damming of the water at the crossing.
- Institute adequate sedimentation control measures at river crossings when excavation or disturbance within of riverbanks, or the riverbed takes place.

- Enforce speed limits at all times, both on public roads and on site roads. Unless otherwise specified, the speed limit on site (dirt tracks) is 50km/h.
- Ensure that only authorised roads and access routes are used.
- Vehicles may not leave the designated roads and tracks and turnaround points will be limited to specific sites.
- Maintain all access routes and roads adequately in order to minimise erosion and undue surface damage. Repair rutting and potholing and maintain stormwater control mechanisms.
- Clean and make good any damage to public or private roads in use.
- No offroad driving is permitted, unless authorised by the EM.
- Do not permit vehicular or pedestrian access into natural areas beyond the necessary work site.
- Allow for safe pedestrian and cycling access and crossing where necessary.
- Plan for proper access control where routes pass through pristine / sensitive areas, to prevent unauthorised and potentially environmentally destructive access by locals.
- The Project Manager will indicate whether or not it is necessary to keep a photographic record of temporary or permanent rights of way over private property as permitted during construction[37].

7.8 Managing prospecting boreholes, excavations and test pits

- Do not commence with prospecting work before the necessary DME approvals are in place[38].
- Mark and clear any required route, allowing for the minimum width required for the rig. Ensure that adequate turnaround space is allowed for the rig at the drill site (as required).
- Only the necessary vehicles are permitted along the new route.
- A drill rig may only travel the route once in and once out.

- Undertake excavations carefully, incorporating appropriate drainage.
- Do not allow excavations to stand open for longer than 2 days where at all possible. Excavations should preferably be opened and closed on the same day.
- Excavations within wetlands and drainage lines may only be undertaken upon instruction by the EM. In such a situation be sure to return the profile of the wetland / drainage line to one similar to the pre-construction profile. No ridge or channel feature may remain.
- Ensure that topsoil is stored separately to spoil (excavated subsoil).

[37] In terms of SABS 1200 AD 5.3.1, the acquisition of such permission is the responsibility of the Project Manager

[38] In terms of the requirements of the Minerals and Petroleum Resources Development Act of 2002

- Ensure that all stockpiles material is stored in such a way and in such a place that it will not cause the damming up of water, erosion gullies, or wash away itself.
- Do not stockpile material in drainage lines.
- Do not stockpile material in heaps exceeding 2m in height.
- Protect stockpiles from erosion.
- Access routes may only remain open for as long as testing takes place at a site. Thereafter the route must be closed off and rehabilitated.
- Once testing is complete, ensure that all pits and holes are backfilled, stabilised, made safe and rehabilitated.
- Backfill all prospecting boreholes, excavations holes and test pits with insitu material.
- Where possible, programme the backfill of excavations so that subsoil is deposited first, followed by the topsoil. Compact in layers for best results.
- Monitor backfilled areas for subsidence (as the backfill settles) and fill depressions using available material.
- Dismantle and flatten temporary drifts and river crossings, reinstating all drainage lines to approximate their original profile.
- Shape all disturbed areas to blend in with the surrounding landscape.
- Ensure that no excavated material or stockpiles are left on site and that all material remaining after backfill is smoothed over to blend in with the surrounding landscape.

7.9 Rehabilitation

- Rip[39] and / or scarify[40] all disturbed areas, including temporary access routes and roads, compacted during the execution of the Works (preferably before the rainy season).
- Rip and / or scarify along the contour to prevent the creation of down-slope channels.
- Do not rip and / or scarify areas under wet conditions, as the soil will not break up.
- Cordon off areas that are under rehabilitation as no-go areas using danger tape and steel droppers. If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access.
- Delay the re-introduction of stock to all rehabilitation areas until an acceptable level of re-vegetation has been reached. Fencing may be used, or the area may be covered by branches.
- Monitor all disturbed sites for colonisation by exotics or invasive plants and control these using appropriate methods. Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion.

7.10 Interaction with landowners and stakeholders

- Protect and maintain existing private property, fences and gates.
- Respect the open or closed status of gates.

[39] Loosening of the soil to a depth of 300mm.
[40] The roughening of the surface of the soil to a depth of approximately 50mm, creating a smoother surface than ripping.

- Prevent unnecessary vehicular and personnel access into adjacent undisturbed areas.
- If fencing and or gates are removed for whatever reason, then these areas must be reinstated and rehabilitated as soon as practicable, unless otherwise agreed upon by the relevant landowner.

- Allow for the establishment of a Community Action Committee and Project Steering Committee as required.
- Keep lines of communication open, and keep relevant stakeholders informed of Strategic Programming (i.e. in terms of the anticipated project programme), planning submissions and proposals as these are developed.
- Notify adjacent landowners of after-hours work and of any other activity that could cause a nuisance.
- Allow for information sessions and educational tours as required.
- Respond to community complaints, taking reasonable action to solve the problem.

8. MONITORING AND AUDITING

8.1 Introduction

In keeping with current environmental and associated legislation, all environmental management procedures and actions should be reviewed and refined on an on-going basis. This is in accordance with the dynamic nature of environmental management and allows for the timeous identification and mitigation of issues as they come to light. The process of review and refinement, built into the requirements of the IEMF, is known as Monitoring and Auditing.

8.2 Roles and responsibilities

Efficient implementation of the Best Practice Guidelines, effective Monitoring and Auditing, as well as clear Responsibility and Accountability allocation requires that various role-players be defined during the planning stages of a development project. Depending on the nature and scale of a project, project planning teams could be composed of any number of role-players, each with their own specified responsibilities.

Therefore, for the purpose of this document, the following role-players are defined, based purely on Responsibility and Accountability allocation. The actual designation of role-players may vary from project to project, but the responsibilities will largely remain as stated.

8.2.1 Land owner or Custodian of the Land

The Land Owner or Custodian of the Land is the person or organization with decision making capacity for the land in question, and thus ultimately accountable for what takes place on that land.

8.2.3 Developer or Implementing Agent

The person or organisation who funds the implementation of the project or activity is the Implementing Agent.

8.2.3 Environmental Consultant

The person or organisation, usually an independent PSP, who undertakes the initial preparation and submission of Impact Reports, Management Plans[41] and Environmental Management Programme Reports[42]. Often this person undertakes a degree of environmental planning as well.

[41] Required for environmental authorizations as required by the Environment Conservation Act (Act No. 73 Of 1989).
[42] Required for environmental authorizations as required by the Minerals and Petroleum Resources and Development Act (Act No. 28 of 2002).

8.2.4 Project Manager

The Project Manager represents the Implementing Agent, and co-ordinates all aspects of the project, streamlining planning and implementation. All members of the Planning Team as described hereunder report to the Project Manager, who in turn provides feedback to the Implementing Agent.

8.2.5 Design Engineer

The Design Engineer is involved during the planning and design phase of a project, and must ensure that relevant environmental planning and design considerations are taken into account during these phases. In this respect, the Design Engineer will usually work in conjunction with the Environmental Planner.

8.2.6 Environmental Planner

In addition to working with the Design Engineer to generate Zoning Plans, Master Plans, Plant Plans and associated detail designs, the Environmental Planner is also responsible for drawing up the provisional Environmental Site Management and Rehabilitation Plan and the provisional Water Management Plan. These plans are attached to the tender documents for inclusion in the pricing structure, as well as to the project specific EMP.

8.2.7 Contractor

The Contractor is the successful tenderer, appointed by the Implementing Agent to undertake the construction works as specified in a Construction Contract. The Contractor will ordinarily not be involved during the Planning Phase of a project.

8.2.8 Site Engineer

Also referred to in some instances as a Resident Engineer, the Site Engineer is responsible for construction site supervision and quality control during Construction. In some instances the Site Engineer may also assume the responsibilities of the Project Manager.

8.2.9 Environmental Officer

The Environmental Officer is responsible for managing the day-to-day on-site implementation of the Construction Contract and the Operational life of the project as required.

8.2.10 Environmental Control Officer

An Environmental Control Officer will undertake environmental audits for the duration of the Construction Contract and the Operational life of the project as required.

8.2.11 Independent Environmental Control Officer

An Independent Environmental Control Officer or External Auditor is an unaffiliated party who will undertake environmental audits for the duration of the project as required. Not all projects require and IECO as the inclusion of such an appointment is ordinarily specified for high profile projects and projects undertaken in sensitive areas.

8.2.12 Operator

The Operator is the nominated agent who will undertake to Operate and Maintain the relevant Water Supply and / or Water Resource Infrastructure Works once construction has been completed.

8.2.13 Environmental Manager

The role of Environmental Manager is one of strategic management of all issues pertaining to environment, not limited to any single project. The Environmental Manager is responsible for ensuring that the above Environmental roles are filled for all projects under his / her jurisdiction, and will be required to provide guidance, assistance and input as required during project lifecycle. In this respect, the Environmental Manager must be well versed in the minimum standards and responsibilities for each of the Environmental roles.

From time to time, the Environmental Manager will also be called upon to resolve conflicts and disputes.

Ordinarily, the Environmental Manager will undertake environmental audits for the duration of the planning process as required.

Decisions regarding environmental procedures, specifications and requirements which have a cost implication (i.e. those that are deemed to be a variation, not allowed for in the Performance Specification) must be endorsed by the Project Manager.

8.3 The Monitoring Procedure

Environmental Monitoring is the continuous evaluation of the planning process, and whether or not proper environmental planning processes have been followed.

To these ends, the Environmental Manager will monitor the project for compliance (i.e. Compliance Monitoring) with the Best Practice Guidelines. Many techniques for Environmental Monitoring have been proposed, each detailing a specific protocol. Regardless of which technique is used, the ultimate aim is that each environmental management specification be checked by means of a system in which a score may be allocated for:

- Full compliance,
- Satisfactory performance,
- Unsatisfactory performance and
- No action.

Refer to Appendix J of the following document for a pro-rata template according to which such Compliance Monitoring Reports may be prepared:

Department of Water Affairs and Forestry, February 2005. ***Environmental Monitoring and Auditing Guideline****. Integrated Environmental Management Sub-Series No. IEMS 1.7. Third Edition. Pretoria.*

Monitoring will take place at specified intervals during the Project Planning Phase (refer to IEMS Sub-Series 1.4). Monitoring Reports will be submitted to the Project Manager, who will attend to issues and keep the reports on record, to be made available upon request by the Land Owner / Custodian of the Land and any Environmental Authority or I&AP requesting such.

8.4 The Auditing Procedure

Environmental Auditing is the process of comparing the impacts predicted with those which have actually occurred during implementation. An Environmental Performance Audit examines and assesses practices and procedures which, in the event of failure, would cause an environmental impact or result in an environmental risk. During each of the lifecycle phases of a development project, various issues will be monitored (see section 8.3). The Performance Audit will ensure that the monitoring was correctly undertaken and that compliance was achieved.

To these ends, the Environmental Manager will audit the project and its environmental management system for effectiveness. Many techniques for Environmental Auditing have been proposed, each detailing a specific protocol. Regardless of which technique is used, the ultimate aim of an Environmental Audit entails the following:

- The review of Monitoring Reports for the time elapsed,
- The verification of recorded monitoring results on site,
- The examination and evaluation of environmental management actions in terms of achieving responsible environmental management and the identification of deficiencies.
- The evaluation of the environmental management structure in terms of achieving responsible environmental management and the identification of deficiencies.
- The recommendation of amendments to the specifications, actions and management structure as deemed appropriate.

Refer to Appendix K of the following document for a pro-rata template according to which Audit Reports may be prepared:

Department of Water Affairs and Forestry, February 2005. ***Environmental Monitoring and Auditing Guideline****. Integrated Environmental Management Sub-Series No. IEMS 1.7. Third Edition. Pretoria.*

Audits will be undertaken at the end of the Planning Phase. Audit Reports will be submitted to the Project Manager, who will attend to issues and keep the reports on record, to be made available upon request by the Land Owner / Custodian of the Land and any Environmental Authority or I&AP requesting such.

9. CONCLUSION

The Guidelines and Code of Conduct included in this manual will help to ensure that all projects are planned within the ambit of sound environmental standards and norms and to ensure that these standards are given due consideration during the necessary stages of project planning.

It should however be borne in mind that all the guidelines are not relevant to every project in the same capacity, and the relevant environmental guidelines will have to be extracted for each project. In addition, reference to this guideline document should never be used at face value without first adapting the guidelines to the specific environment and project at hand. In this way a great step will be taken towards truly integrated environmental planning, with a better chance at a sustainable and successful project result.

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FIGURES

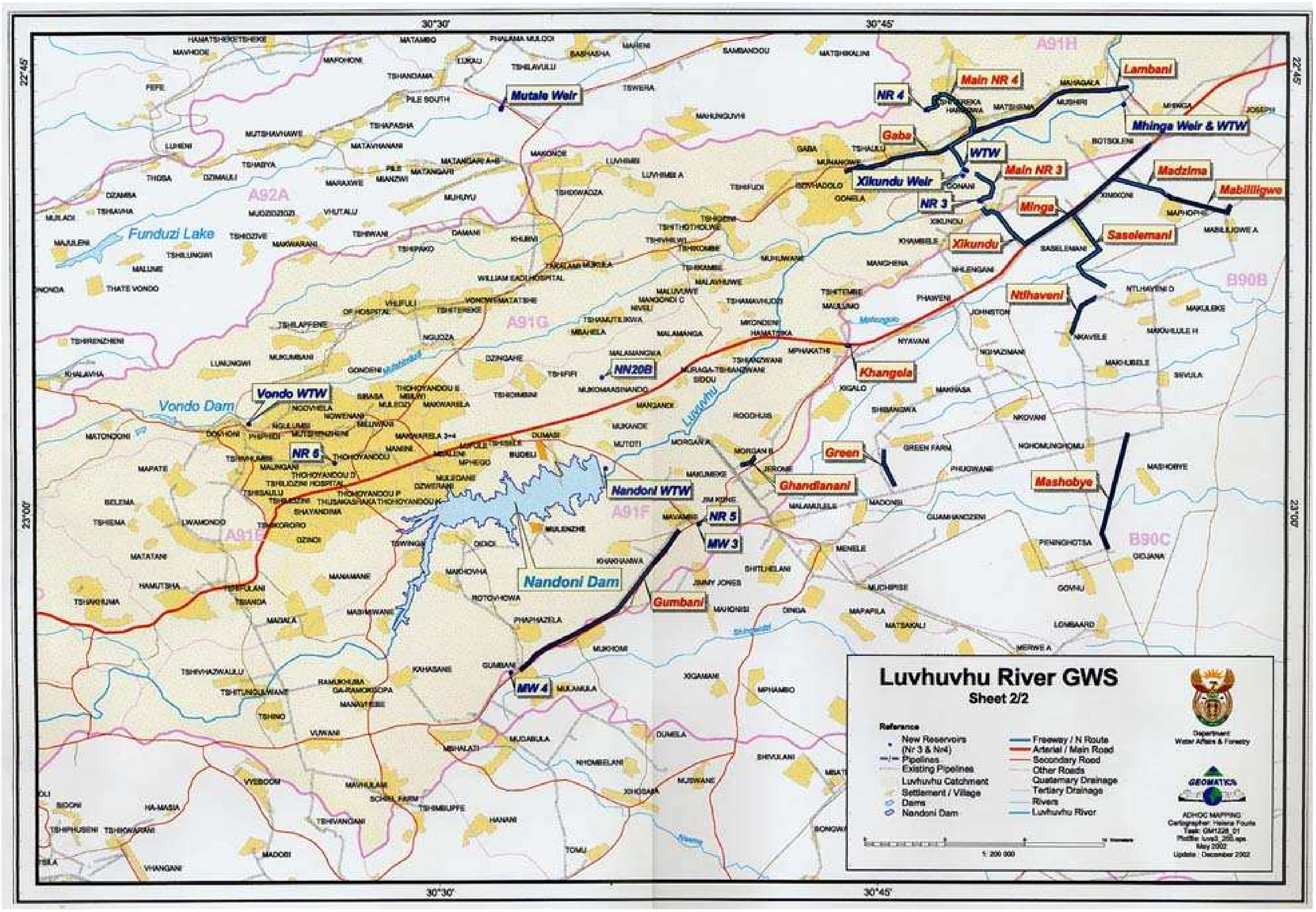

Figure 1: A typical Strategic Development Plan

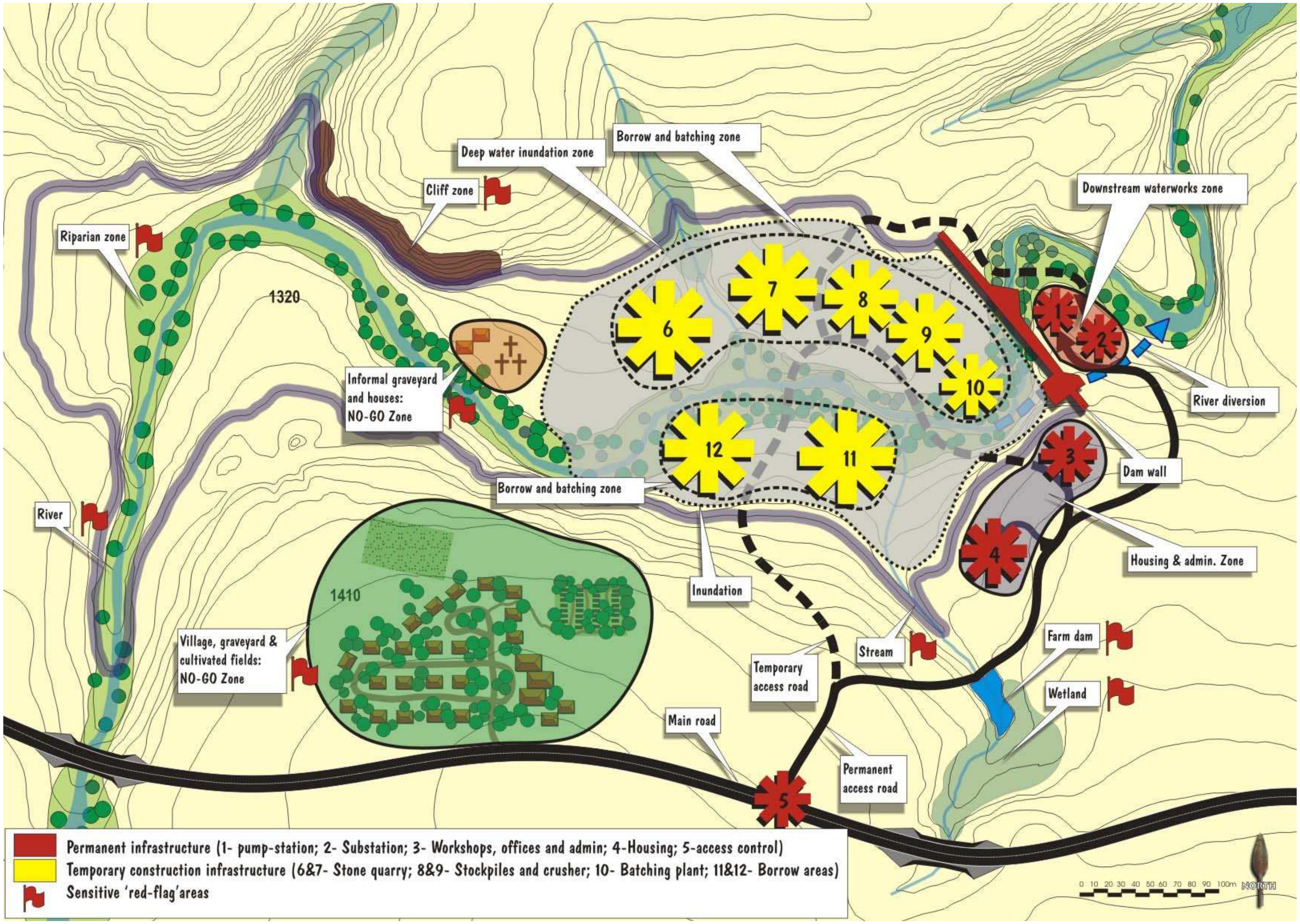

Figure 2: A typical Zoning Plan

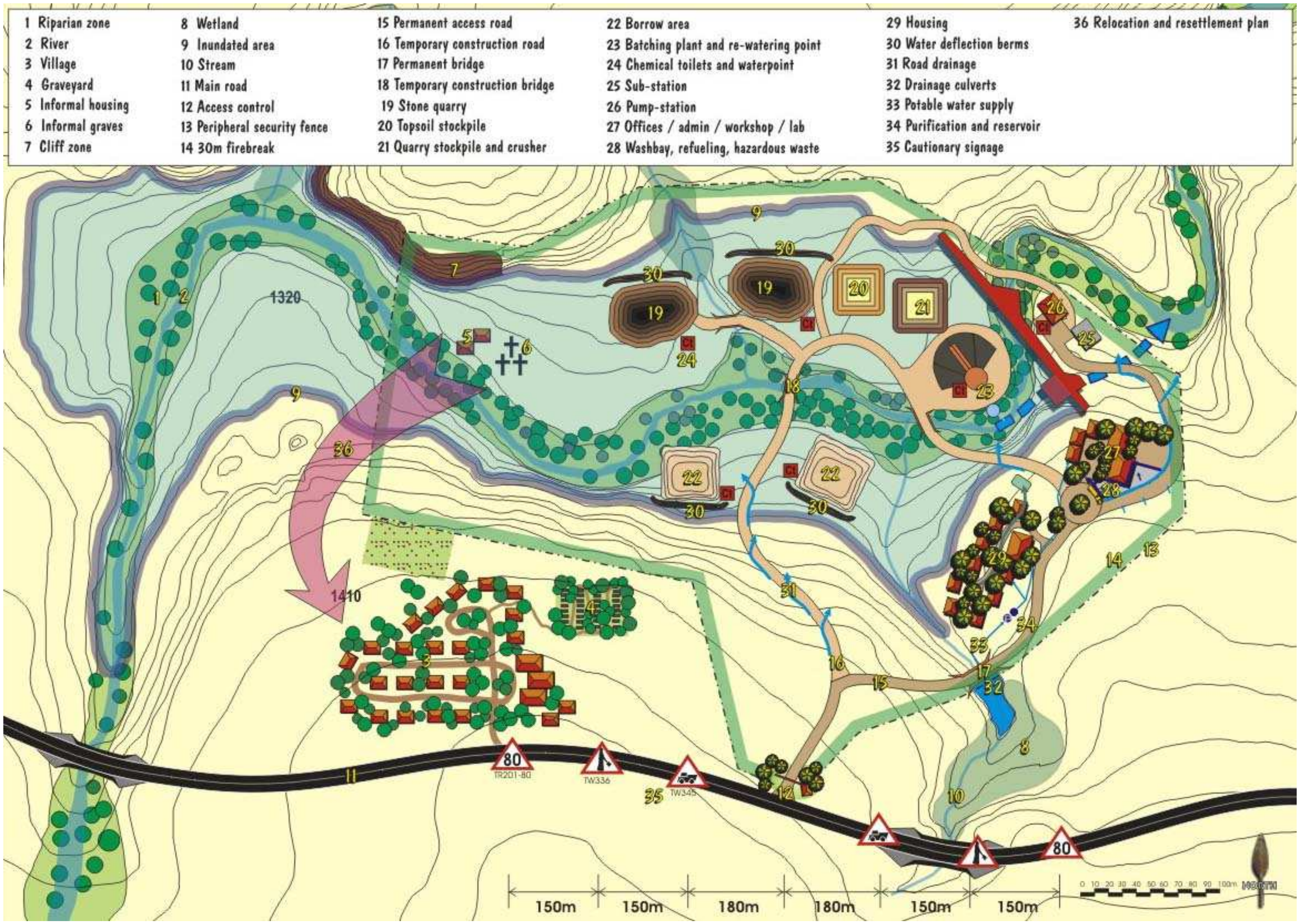

Figure 3: A typical Master Plan

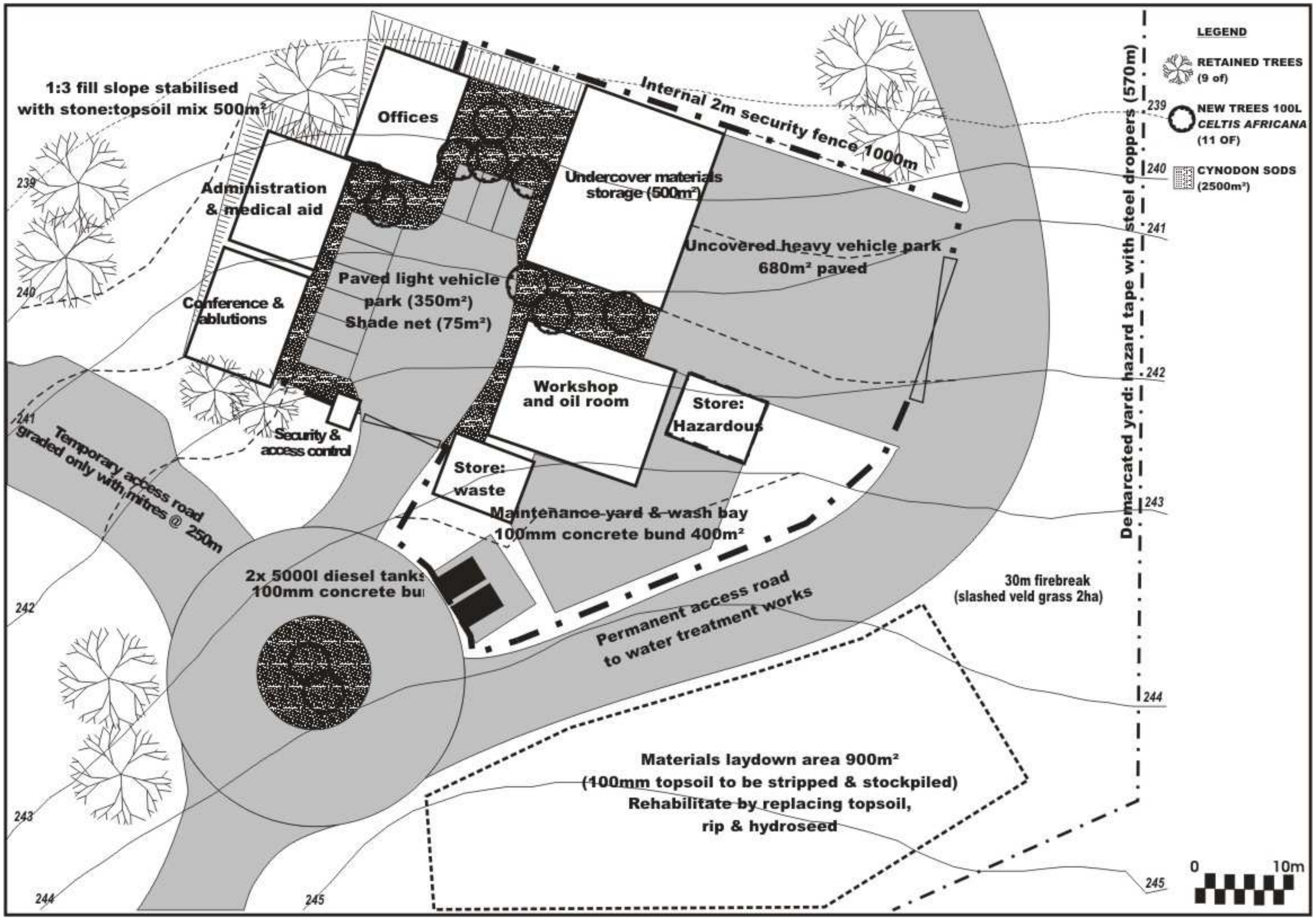

Figure 4: A typical Environmental Site Management and Rehabilitation Plan

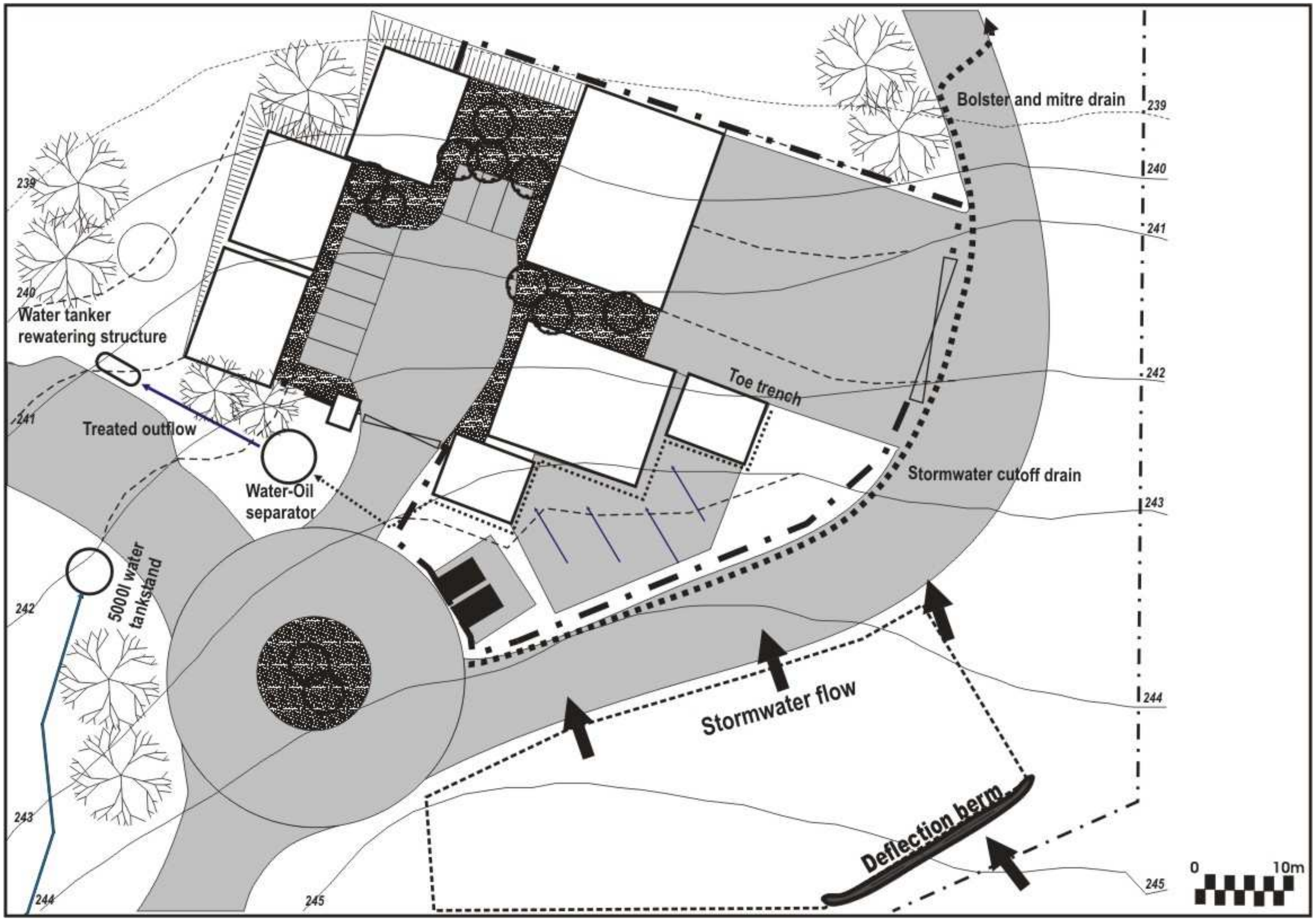

Figure 5: A typical Water Management Plan