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LESSON SERIES
June 2015

BUFFER ZONES

Ensuring rivers, wetlands and estuaries are protected and conserved

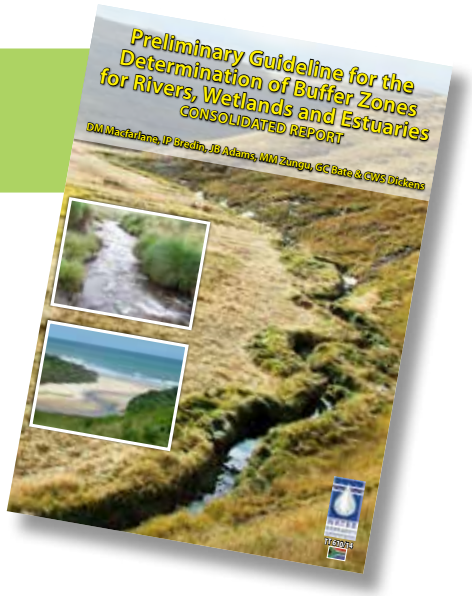
WATER RESEARCH COMMISSION

ABOUT THIS PUBLICATION

This publication is compiled from the Water Research Commission (WRC) Research Report entitled *Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries: Consolidated Report* (WRC Report No. TT 610/14, September 2014) by DM Macfarlane, IP Bredin, JB Adams, MM Zungu, GC Bate and CWS Dickens.

It repurposes the WRC Research Report for a wider audience comprising national, provincial and municipal planners, owners, developers, and environmental impact assessment consultants involved in buffer zone development.

It provides the context for developing buffer zones, the eight-step assessment procedure to determine appropriate buffer zones, and notes Buffer Zone Tools available from the WRC for undertaking the exercise.



To obtain the full WRC Report No. TT 610/14 contact:
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Cover photograph by Doug Macfarlane

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1 BACKGROUND

1.1 Context for the establishment of buffer zones

South Africa's water ecosystems are under increasing pressure, with impacts such as regulation of flow by impoundments, pollution, over-extraction of water, and the breakdown of natural bio-geographical barriers. All affect the ecological condition of these resources. Wetlands have been subject to widespread degradation with an estimated 50% of South Africa's wetlands already destroyed or converted. While reserve determination, resource classification and resource quality objectives are legislative tools developed to reverse or prevent these impacts, the implementation of these tools is still in the early stages, with costly implications for reversing existing impacts or rehabilitation. The need for measures to prevent further degradation is therefore critical.

It is in this context that the establishment of buffer zones to rivers, estuaries and wetlands can play a meaningful role in reducing impacts to aquatic resources and, in so doing, protect the range of services these resources provide to society. The research on which this document is based developed guidelines to determine appropriate buffer zones for different types of water resources. These zones were tested on a number of case studies, and will continue to be refined as implementation proceeds in an adaptive management approach.

1.2 What are buffer zones?

Buffer zones (or "setback areas") have been used in land-use planning to protect natural resources and limit the impact of one land-use on another. The WRC Research Report looks at aquatic (i.e. relating to water, marine, sea or river) buffer zones which are typically designed to act as a barrier between human activities and sensitive water resources, thereby protecting them from negative impacts. The importance of other functions, particularly the provision of habitat necessary for wetland-dependant species that require both aquatic and terrestrial habitats, is also catered for when establishing final setback requirements. For the purposes of the WRC Research the following working definition was used:

Buffer zone: A strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another.

1.3 Why are buffer zones important?

The primary roles of buffer zones include:

1. Maintaining basic aquatic processes, services and values.
2. Reducing impacts on water resources from upstream activities and adjoining land uses.
3. Meeting life need requirements for aquatic and semi-aquatic species.
4. Providing habitat for terrestrial species.
5. Providing a range of ancillary societal benefits.

1.4 Limitations of buffer zones

Despite the range of functions provided by buffer zones, buffer zones do not address all water resource related problems. So, for example, buffers can do little to address:

1. Impacts such as hydrological changes caused by stream flow reduction activities or changes in flow brought about by abstractions or upstream impoundments.
2. Point-source discharges (e.g. sewage outflows). This is more effectively managed by targeting these areas through specific source-directed controls.
3. Contamination or use of groundwater. This requires complementary approaches such as controlling activities in sensitive groundwater zones.

Annexure 3 of the WRC Research Report provides an overview of typical threats posed to water resources and the role that buffers and other management measures can play in addressing these concerns.

2 DESIGN CRITERIA FOR BUFFER ZONE DETERMINATION

The WRC Research developed the following broad set of criteria to inform the design of a conceptual framework and method for buffer zone determination in the South African context:

Levels of expertise: The method should be easy and quick to apply by personnel with little training or experience in ecology or water resource management.

Precautionary principle: Where insufficient information is available to inform the establishment of a buffer zone, a cautious approach is recommended; one that recognises potential shortfalls and inaccuracies of the assessment.

Predictability and administration: A level of predictability in model outcomes is preferred across different levels of assessment.

Data collection and assessment: Buffer width determination should rely as far as possible on existing information or information collected during current aquatic assessments to ensure that additional expenditure necessary to inform buffer determination is kept to a minimum.

Buffer widths should be tailored according to risk: Where risk or uncertainty is high, ecologically conservative buffers should be established; whereas less conservative buffers are appropriate for low-risk situations.

3 BUFFER ZONE FUNCTIONS AND IMPLEMENTATION APPROACHES

In terms of the five primary roles for buffer zones established around water resources, (identified in section 1.3 above), there is a wide range of functions and implementation approaches per role. The importance of each of these roles is likely to be case-dependent and, as such, the approach must be flexible to allow buffers to be tailored according to site-specific requirements.

The WRC Research had a specific focus on protecting water resources and associated biota. A brief description of the five primary roles, with associated functions and suggested implementation approaches – as they relate to the protection of the water resource and associated biota – is outlined in Table 1 below.

Table 1: Buffer zones: summary of five primary roles, associated functions, and suggested implementation approaches

PRIMARY ROLE	ASSOCIATED FUNCTIONS	SUGGESTED IMPLEMENTATION APPROACHES
1. Maintaining basic aquatic processes, services and values	• Maintains channel stability • Controls microclimate and water temperature • Provides flood attenuation • Maintains general wildlife habitat	As a minimum, this requires the maintenance of the water resource, including any riparian habitat. Delineation and protection of water resources, as defined in South African legislation, is regarded as mandatory to ensure no direct impacts to these areas. The method developed is therefore designed to ensure that such areas are identified, mapped and included within any recommended setback area. The need for additional management measures, including potential additional management buffers to safeguard intact riparian habitat, is also addressed.
2. Reducing impacts from upstream activities and adjoining land uses	• Provides storm water attenuation • Removes sediment • Removes toxins • Removes nutrients • Removes pathogens	Upstream: While buffer zones are not designed to specifically address impacts associated with upstream activities, they will help ensure these functions are retained. Managing catchment-level impacts should, however, be addressed through catchment management activities. Adjoining: This requires an understanding of specific risks associated with planned land-uses / activities, and the degree to which buffer zones can address these impacts. Aquatic impact buffers are therefore only proposed where appropriate, based on an understanding of specific risks and the ability of buffer zones to address potential impacts.
3. Meeting life-need requirements for aquatic and semi-aquatic species	• Provides habitat for aquatic and semi-aquatic species • Screens adjacent disturbances • Provides habitat connectivity	This requires an appropriate understanding of specific species habitat and protection requirements to safeguard important species present. This method has been designed to guide the identification of important biodiversity elements and to help ensure that appropriate steps are taken to adequately cater for the protection of important species and habitats. This moves beyond the simple concept of buffer zones and considers aspects such as core area requirements, connectivity and management.
4. Providing habitat for terrestrial species	• Provides habitat for terrestrial species • Provides habitat connectivity	Local protection requirements, including buffer zone establishment, may well be supported further by conservation objectives for terrestrial habitat and species which make use of habitat within delineated buffer zones. This requires an understanding of the conservation value of terrestrial ecosystems and the ecology of any terrestrial species of conservation concern.
5. Providing ancillary societal benefits	• Reduces flood risk • Enhances visual quality • Controls noise levels • Improves air quality • Provides recreational opportunities • Provides economic benefits	These can often be addressed through design and management of buffer zones. This links to building an understanding of the importance of the resource in more than ecological terms, and setting appropriate management objectives. Where societal benefits are particularly important, such as protecting people and property from flood risks, buffer zones may need to be enlarged to cater for these (e.g. by limiting development within flood zones). In other situations, manipulation of species composition and structure may add significantly to societal benefits without compromising desired ecological outcomes.

4 IMPLEMENTING BUFFER ZONES

The WRC Research Report refers to the implementation and management of buffer zones as the "assessment procedure", and defines an eight-step process as outlined in Figure 1 below.

Each step involves detailed work to be undertaken by water resource mangement specialists. Many of the steps include sub-steps.

The full WRC Research Report provides considerable detail for the entire process; and explicit instructions are provided for populating the Excel model used to determine buffer zone requirements. Those invovled in buffer zone determination and implemenation are strongly advised to consult the full Report.

This document provides an overview of this process – highlighting the main steps and processes.

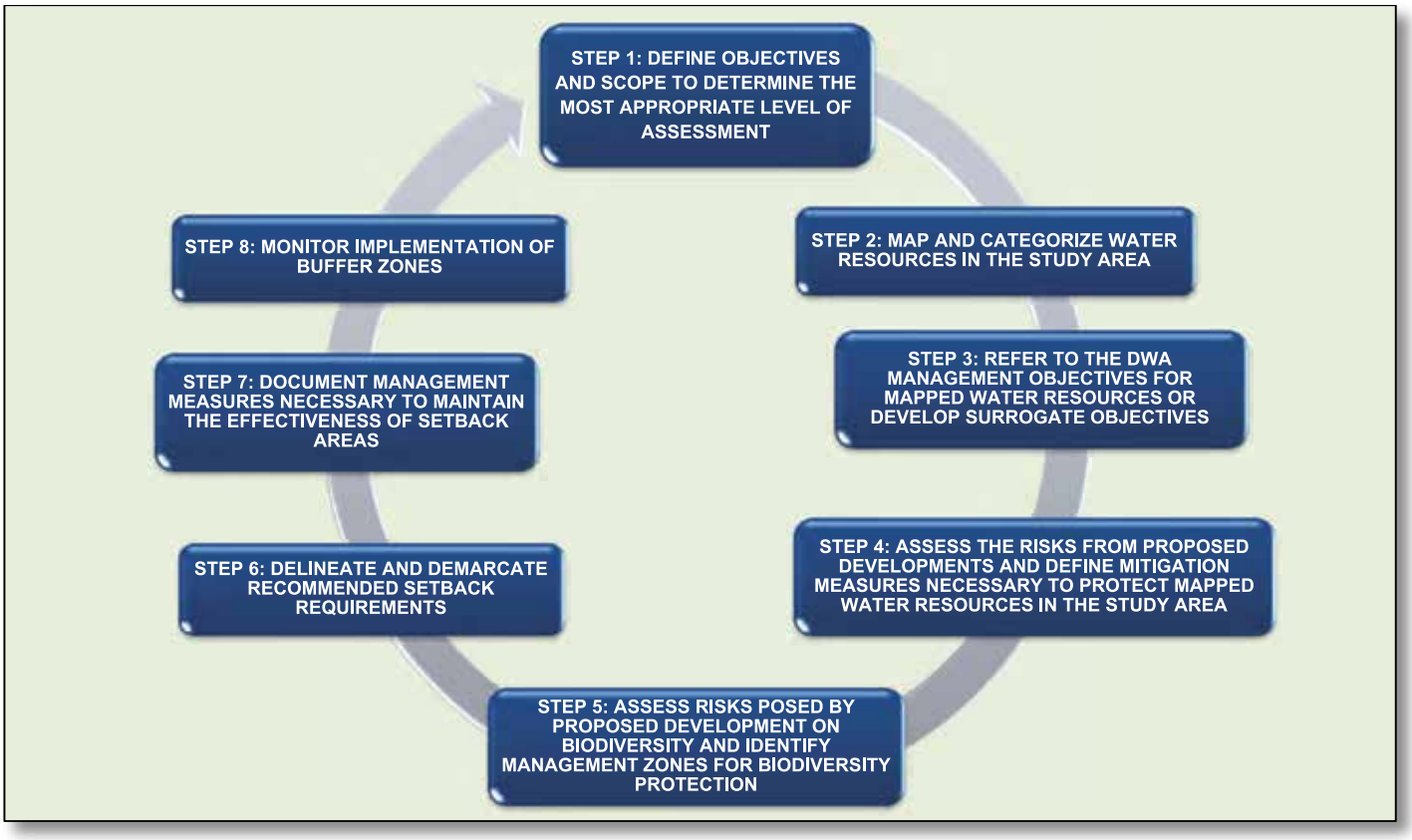

Figure 1: Overview of the step-wise assessment process

Step 1: Define objectives and scope to determine the most appropriate level of assessment

1.1 Define objectives and scope of the assessment	This is a desktop exercise. The specific objective and geographical area must be very clearly understood since there are diverse reasons for buffer zones which include assessing water use activities and identifying realistic and measurable mitigation measures for these impacts and compliance with Resource Quality Objectives (RQOs).
1.2 Determine the most appropriate level of assessment	This is both a desktop and site-based exercise. The desktop assessment is designed to characterise risks to red-flag land located adjacent to water resources that should be set aside and managed to limit impacts on water resources. This assessment also requires a site-based assessment to include a more detailed evaluation of risks and consideration of site-specific factors. There are different levels of assessment, and these will be should be informed by (i) the intended purpose of buffer zone determination, (ii) the approach to be followed, (iii) the level of expertise available to undertake the assessment, and (iv) the time and cost required to undertake the assessment.

The appropriate level of assessment is chosen and documented in the appropriate Buffer Zone Tool (separate tools have been created for wetlands, rivers and estuaries) which directs users to further data capture requirements. To help guide users through the document, a tab is included at the start of each step to indicate whether or not the step is relevant for the level of assessment to be undertaken. Where not required, the assessor can simply move on to the next step. The same colour scheme is included in the model to help guide the assessor through the process.

Buffer zone tool:

- Select the appropriate Excel tool based on the type of water resource under investigation (wetland, river or estuary).
- Select the appropriate level of assessment from the drop-down list provided.

Step 2: Map and categorise water resources in the study area

2.1 Map water resource boundaries	This is both a desktop and site-based exercise. A geographic information system (GIS), orthophotos or Google Earth may be used. Mapping requirements are tailored according to the level of assessment. For the desktop assessment, water resources are mapped using available, often low resolution data. Where site-based assessments are required, accurate mapping of water resources is essential. Guidelines for minimum mapping requirements for different levels of assessment are provided in the Research Report.
2.2 Map the line from which aquatic impact buffer zones will be delineated	This is both a desktop and site-based exercise. While the edge of the water resource must be accurately delineated, the starting point used for delineating aquatic impact buffer zones varies according to the water resource type under consideration: • Rivers and streams – the outer edge of the active channel, and incorporating riparian habitat; • Wetlands – the edge of the temporary zone (water resource boundary); and • Estuaries – the upper edge of the supratidal zone.
2.3 Identify water resource type	This is both a desktop and site-based exercise. Once water resources have been mapped, they should be fully identified in line with the level of assessment being undertaken. Hydro-geomorphological classification schemes exist to enable the full description and identification of wetlands, estuaries and river types. For the purposes of this assessment, the refined National Wetland Classification System for South Africa is recommended.

Buffer zone tool:

- Clarify the approach used to delineate the water resources in the study together with the water resource type based on drop-down lists provided.

Step 3: Refer to the Department of Water and Sanitation (DWS) management objectives for mapped water resources or develop surrogate objectives

The level of reserve determination or classification required for a particular site is determined by DWS based on criteria including type of proposed development; anticipated impact of the proposed development; ecological importance and sensitivity of the resource; degree to which the catchment is already utilised; existing developments; and socio-economic importance.

In the absence of guidance from DWS (e.g. in the case of small streams or wetlands), it may be necessary for provincial or local authorities to evaluate development applications and determine the need for specialist investigations. Once the appropriate level of assessment has been defined, it will guide the level of data collection required in order to set the management objective for the water resource.

In the absence of classification, this requires an assessment of Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and Social Importance (SI). However, where impacts are likely to be low, it may be appropriate to simply set a management objective to "Maintain" the status quo.

3.1 Determine the PES and anticipated trajectory of water resource charge	This is a site-based exercise. The PES refers to the current state or condition of the water resource and reflects the change from its reference condition. This is expressed in terms of its bio-physical characteristics and ecological categories (where "A" represents the unmodified state and "F" being critically modified). A range of tools has been developed to determine the present state of different water resources and associated components at a site or reach level. Trajectory of change is relevant to understand how the current PES is likely to change, and so helps determine what may be attainable as a future management class.
3.2 Determine the EIS of the water resource	This is a site-based exercise. It helps highlight functions that need to be maintained or enhanced, and will determine the appropriate management objective. Where importance is regarded as high, this may provide an appropriate motivation to improve management of the water resource, while simply maintaining the status quo may be acceptable where importance is moderate to low. Three areas are assessed: 1. Ecological importance and sensitivity; 2. Social importance; and 3. Economic importance.

3.3 Determine the management objectives for water resources	This is a site-based exercise. The process to determine Management Objectives is dependent on whether or not the Water Resource Classification System (WRCS) has been applied and, consequently, if RQOs have been determined. Where the WRCS has been undertaken, and especially where RQOs have been set, then both ecological and user requirements have been considered and a management class and associated Nested Ecological Categories (NECs) have been agreed. In the absence of classification, the precautionary principle is applied, and the management objective for the water resource is based primarily on ecological criteria. The management objective will thus be either to improve the ecological class or to maintain the ecological class.

Buffer zone tool:

- Select the appropriate "PES" and "EIS" classes based on assessments undertaken on the water resource from the drop-down list provided.
- Select the "Management Objective" for the water resource under consideration from the drop-down list provided.

Step 4: Assess the risks from proposed developments and define mitigation measures necessary to protect mapped water resources in the study area

This step includes a wide spectrum of risks posed by diffuse lateral surface inputs to ensure that a wide range of risks are evaluated and appropriately considered as part of a development application. It is a flagging tool and does not replace comprehensive risk assessments (specifically relevant to mining operations and groundwater impact).

4.1 Undertake a risk assessment to assess the potential impacts of planned activities on water resources	This is both a desktop and site-based exercise. The risk of a proposed activity on water resources is used as the primary driver for defining the level of mitigation required. A risk assessment is a process of gathering data and making assumptions relating to the probable effects on the environment based on the probability of an event occurring, the factors that could bring about that event, likely exposure levels, and the acceptability of the impact resulting from exposure. Where risk is high, a more conservative approach (e.g. larger buffer zone) is recommended. A risk score is used to inform the level of mitigation required.

4.2 Evaluate the threats posed by land use / activities on water resources	This is both a desktop and site-based exercise. A basic threat assessment is initially undertaken at a desktop level to inform decision making. This relies on generic threat tables developed to inform development planning. Threat ratings must, however, be reviewed by an aquatic specialist as part of the site-based assessment. Generic threat tables have been developed for both construction and operational phases across a wide range of sectors and sub-sectors ranging from agriculture to industry and mining activities. Annexure 6 of the Research Report provides a full description of these. Threat ratings must be reviewed based on specialist input for the site-based assessment, and a justification for any changes must be documented.

Buffer zone tool:

- Depending on the level of assessment, select the "Sector" and / or "Sub-sector" for the activity being investigated.
- For the site-based assessment, review desktop threat ratings and capture specialist threat ratings based on best available information.
- Provide a justification for any deviations to desktop threat ratings.

4.3 Integrate climatic factors into the threat assessment	This is both a desktop and site-based exercise. In areas of higher mean annual precipitation (MAP) and characterised by more intense rainfall events, the frequency and intensity of surface overland flow will be higher than in climates characterised by low rainfall and less intensive rainfall events. This is accounted for in the buffer zone model which calculates a 'Climate Risk Score'.

Buffer zone tool:

- Select the appropriate MAP class for the area under investigation.
- Select the appropriate rainfall intensity zone for the region.
- Based on this information, threat scores are automatically adjusted to account for climatic factors.

4.4 Assess the sensitivity of water resources to threats posed by lateral land-use impacts	This is a site-based exercise. The sensitivity of water resources to lateral impacts is another factor that affects the level of risk posed by a development. A more conservative approach is therefore required when proposed developments take place adjacent to water resources which are sensitive to lateral impacts. The assessment of sensitivity is based on key attributes of different water resources that act as easily measurable indicators. The sensitivity assessment has therefore been tailored for wetlands, rivers and estuaries. Where important biodiversity elements are present, buffer requirements must be adjusted to account for these features.
4.5 Assess the sensitivity of important biodiversity elements to threats posed by lateral land-use impacts	This is a site-based exercise. While the sensitivity of the water resource to threats posed by lateral inputs may be low, specific important biota or habitats may be sensitive to such impacts. Where relevant, it is therefore important to consider the sensitivity of any important biodiversity elements identified in Step 5, and to adjust the sensitivity scores accordingly. See Step 5.4 below for further guidance on how biodiversity considerations should be incorporated into an assessment of aquatic impact buffer requirements.
4.6 Determine the risk posted by proposed activities on water resources	This is both a desktop and site-based exercise. Once both threats posed by potential land-uses / activities, and the inherent sensitivity of receiving water resources have been assessed, this information is used to evaluate the risks posed by such activities on the water resource. In the case of a desktop assessment, water resources are assumed to have a very high sensitivity to the full suite of potential impacts evaluated. Risk scores are calculated by multiplying threat and sensitivity scores to obtain a risk score for each impact type evaluated.

Buffer zone tool:

- For site-based assessments, collect the information necessary to assess the sensitivity of the water resource using acceptable methods (see Annexures 12-14 of the WRC Research Report).
- Review sensitivity scores and select a sensitivity class for biodiversity where this is likely to be higher than that for the water resource.
- Risk scores are automatically calculated by the Buffer Zone Tool based on threat and maximum sensitivity score.

4.7 For selected impacts, determine desktop aquatic impact buffer requirements	This is a desktop exercise. This step requires identification of relevant mitigation measures to address the risks identified. Although a range of mitigation measures can be applied to address risks, there is good evidence to indicate that the establishment of vegetated buffer zones can be very effective at addressing a number of these impacts. As such, buffer zones are advocated as a standard mitigation measure to reduce the impact of pollutants entering the water resource via diffuse surface runoff. It must be noted that buffer zones can only assist in mitigating some of the risks identified and that other mitigation measures may be necessary. While the risk assessment has been undertaken for a wide suite of potential impacts, buffer zone requirements are only advocated where scientific studies have shown that they can be an effective mitigation measure. Buffer zone recommendations are therefore calculated for the following potential impacts associated with diffuse lateral surface water inputs: • Increased sedimentation and turbidity; • Increased nutrient inputs; • Increased organic contaminants; • Increase toxic contaminants (heavy metals); and • Increased pathogen inputs. A buffer zone identified to perform these functions is referred to as an Aquatic Impact Buffer Zone.
4.8 Determine preliminary aquatic impact buffer zone widths required to mitigate risks identified	This is both a desktop and site-based exercise. Determining the required buffer width is largely about assessing the situation and linking it to an acceptable level of risk. In this approach, threats have already been defined for each of the required buffer functions with reference to existing standards. The determination of buffer zone widths is therefore guided by the level of effectiveness required to mitigate risks to acceptable limits. Rule-curves have been developed based on the best available science to link buffer width and buffer effectiveness. These relationships and additional information is provided in Annexure 15 of the Research Report. Desktop aquatic impact buffer zone requirements are automatically calculated in the buffer zone model based on the level of risk. The aquatic impact buffer zone width required is then taken as the maximum of the buffer zone widths proposed for each of the potential impacts evaluated.

Buffer zone tool:

- Preliminary buffer zone requirements for construction and operational phases are automatically calculated for each threat type based on risk ratings already calculated.
- The maximum of the buffer widths for construction and operational phase can be used to define desktop buffer requirements.

4.9 Refine preliminary buffer requirements based on site-based investigations	This is a site-based exercise. While buffer width is widely regarded as the most important factor in determining the level of effectiveness of buffer zones, large variations in effectiveness can be explained by site-specific differences. For the site-based assessment, site-specific buffer characteristics are included and used to adjust preliminary buffer requirements already calculated. Four buffer zone attributes are used to refine buffer zone requirements at a site level. These are: • Vegetation characteristics; • Slope; • Soil permeability; and • Topography. This site-based assessment must focus on buffer characteristics within 50 m of the delineation line from which aquatic impact buffer zones are determined. In the case of small sites, it should be feasible to describe buffer attributes that reflect typical buffer characteristics for the site as a whole. The buffer zone model calculates a modifier rating for each buffer zone function which is used to adjust the preliminary buffer zone recommendation for each of the buffer segments identified.

Buffer zone tool:

- Capture the site attributes for each buffer segment identified.
- Site-based modifier scores are used to automatically refine the preliminary buffer requirements for each potential threat considered.
- Site-based aquatic impact buffer requirements for construction and operational phases are then automatically calculated based on the maximum of the buffer width requirements for all the threat types considered.

4.10 Where appropriate, identify additional mitigation measures and refine aquatic impact buffer width accordingly	This is a site-based exercise. Buffer zones are only one of a suite of mitigation measures. Indeed, pollution prevention and on-site mitigation (e.g. water treatment / water reuse and reclamation) are regarded as preferable. To help identify suitable additional complimentary mitigation measures, a range of potential mitigation options has been consolidated into an Excel-based "Mitigation Measures Tool". An overview of the tool is provided in Annexure 17 of the WRC Research Report, and the tool itself is included in the CD. Based on an understanding of the effectiveness of proposed mitigation measures, refined threat ratings are selected for the affected risks, together with appropriate justifications. For risks that have a bearing on buffer zone width, buffer zones are adjusted accordingly to obtain a revised aquatic impact buffer zone requirement.

Buffer zone tool:

- Consult the "Mitigation Measures Tool" and supporting references to identify potential mitigation measures that could be used to reduce the key risk(s) identified.
- Where relevant, describe additional mitigation measures to be implemented to address risks associated with construction and operational phases of the proposed development / activity.
- Where appropriate, select a refined threat rating and document the justification for the revised ratings based on an understanding of the effectiveness of mitigation measures proposed.
- A refined risk rating is automatically calculated, and is used to update buffer zone requirements.

4.11 Evaluate aquatic impact buffer zone requirements in light of Management Objectives	This is a site-based exercise. These mitigation guidelines have been developed to reduce potential risks to a desirable level such that water resource quality should not be compromised. There may however be an argument to increase or reduce mitigation requirements in line with Management Objectives or special local circumstances for the water resources. While not advocated, where relaxation of buffer widths is proposed, the potential reduction in buffer zone effectiveness can be estimated based on an understanding of the relationship between buffer width and buffer zone effectiveness.

Step 5: Assess risks posed by proposed development on biodiversity and identify management zones for biodiversity protection

While the protection of riparian areas and aquatic impact buffer zones may be adequate to protect many aquatic species, such buffers may be insufficient to protect a range of aquatic and semi-aquatic species that rely on terrestrial habitat for their survival. While this may be acceptable for species that are not at risk, further interventions are required to ensure that important biodiversity elements are not adversely impacted by planned land-uses or activities.

This assessment should be undertaken in parallel with the assessment of risks posed to the state and functionality of the water resource in Step 4.

5.1 Undertake a desktop assessment to determine whether important biodiversity elements are likely to be present	This is a desktop exercise. The first step is to determine the potential occurrence of important biodiversity elements that could be impacted by the proposed development. Important elements may include threatened vegetation types, animal or plant species. For a list of important biodiversity elements, users should liaise with provincial conservation bodies to obtain a list of priority species and ecosystems requiring protection. This assessment must include consultation with local stakeholders (e.g. landowners, conservancies, birding clubs, etc.) on issues such as: • Existing biodiversity surveys undertaken in the area; • Provincial and local conservation plans for the area; and • Maps of national freshwater priority areas. If no biodiversity elements have been flagged, no further assessment may be required unless specifically requested by a key stakeholder (i.e. provincial conservation body or interested and affected parties). Where important elements have been flagged, further effort is required to determine whether or not they occur at the site and, if so, what mitigation measures are necessary. Information sheets must be generated for all relevant biodiversity features. Provincial conservation bodies should be responsible for drafting and maintaining these.

5.2 If important biodiversity elements are likely to be present, undertake a survey to verify and establish need for site-based conservation efforts	This is a site-based exercise. Where the desktop assessment has flagged the potential occurrence of important biodiversity features, a survey must be undertaken to assess whether or not the species occurs at or near the proposed development site. The scope, timing and survey methods should be guided by an understanding of the ecology of the species being investigated. Where possible, such information should be included in species information sheets. Depending on the potential importance of connectivity, consideration should also be given to extending surveys beyond the immediate site location to assess whether corridor design is likely to be necessary.
5.3 Identify core areas required to protect any important biodiversity features	This is a site-based exercise. The primary role of identifying areas of core habitat is to ensure that such areas are set aside and managed to ensure the continuance of important biodiversity elements. This requires a sound understanding of living needs of important species and processes required to ensure the maintenance of important ecosystems and habitats. This knowledge is typically only privy to a small number of experts which, if not captured in a meaningful way, would require specialist input wherever such species were identified. Guidelines for identifying and mapping such areas are included in information sheet templates.
5.4 Adjust aquatic impact buffer requirements based on sensitivities of any important biota identified	This is a site-based exercise. Once core areas have been established, it is important to assess threats posed by planned land-uses / activities on the species and associated core areas. The first step is to re-assess the sensitivity scores used to define aquatic impact buffer requirements for the water resource. While aquatic impact buffers may be appropriate to reduce impacts to the functioning of the water resource, more stringent mitigation measures may be necessary based on the sensitivity of biodiversity elements to lateral impacts. This is accounted for in the Buffer Zone Tool by selecting a sensitivity class for biodiversity where this is likely to be higher than that for the water resource. This refined sensitivity score is used to refine aquatic impact buffer requirements.

5.5 Identify any additional biodiversity buffer requirements	This is a site-based exercise. While identification of areas of core habitat is necessary to ensure the persistence of important biodiversity elements, these areas may be prone to disturbance and degradation from adjacent land-use / activities. Adjacent land-use / activities could disrupt natural wildlife activities or may affect habitat quality. There may therefore be a need to apply additional biodiversity buffers to important biodiversity features including core areas and corridors to ensure that these areas continue to provide valuable biodiversity functions. The width of the biodiversity buffer should be informed by the specific threats identified and the sensitivity of the species or habitat to disturbance. In the case of species of conservation concern, the need for additional biodiversity buffers should be informed by species information sheets, where available, or with appropriate specialist input.
5.6 Assess the need for connectivity and identify suitable fine-scale corridors where appropriate	This is a site-based exercise. In some instances, persistence of a species may be significantly improved by increasing the level of connectivity between available patches of suitable habitat. Biodiversity corridors should therefore be introduced, where possible, to increase the viability of species populations which are dependent on dispersal between sub-population nodes for long-term persistence. The need for establishing biodiversity corridors will depend on characteristics of the species concerned. As a result, the need for establishing such areas is included in the species information sheets, together with guidelines regarding the nature of such a corridor required to meet the needs of the particular species concerned. A basic guideline document outlining guiding principles for corridor design is included as Annexure 19 of the Research Report.

Step 6: Delineate and demarcate recommended setback requirements

Now that protection requirements for water resources and associated biodiversity have been established, the next step is to finalise and delineate setback requirements on a layout plan and in the field. In doing so, it is also important to ensure that setback requirements also cater for a range of other potentially important management, functional and legal requirements.

6.1 Delineate the boundary of water resources	This is both a desktop and site-based exercise. Water resource boundaries must be mapped according to the guidelines provided in Step 2.1 above. This area represents the preliminary 'no-go' area for development.

6.2 Map required for aquatic impact buffer zones	This is both a desktop and site-based exercise. Once the starting point for mapping aquatic impact buffers has been delineated (Step 2.2 above), aquatic impact buffer requirements must be mapped to indicate the implications of buffer requirements for development planning. In most cases this will simply entail mapping the maximum of buffers recommended for construction and operational phases. There may be instances, however, where a narrower buffer is permissible during the construction phase (e.g. to account for sediment risk associated with site clearing) and should be mapped separately from a larger operational buffer (defining setback requirements for actual infrastructure).
6.3 Map setback requirements for water resource protection	This is both a desktop and site-based exercise. Setback requirements are not only dictated by requirements for minimising impacts of pollutants on the water resource. No development is typically permitted within the water resource boundary. As a consequence, setback requirements are effectively determined by the maximum distance of the water resource boundary or the aquatic impact buffer zone required to protect the water resource.
6.4 Map zones for biodiversity protection	This is a site-based exercise. Once zones for biodiversity protection have been identified these must also be included on a map, together with the proposed layout plan. This includes the extent of core areas, biodiversity buffers, and proposed biodiversity corridors.
6.5 Ensure that any additional factors have been considered before finalising setback requirements	This is a site-based exercise. There may be additional factors that have a bearing on where developments may take place around targeted water resources. While considerations will vary from case to case, the following key aspects should be considered: • Hydrological buffers; • Flood risk; • Aesthetic considerations; and • Recreational use. Additional buffer zone guidelines may also be applicable for particular habitats.

6.6 Map recommended setback requirement based on the maximum width for water resource, biodiversity protection and additional considerations	This is a site-based exercise. Final recommended setback requirements should be delineated on the layout plan based on the maximum widths required for water resource or biodiversity protection and any other local considerations.
6.7 Finalise proposed setback requirements with motivations for any deviations from recommended requirements	This is a site-based exercise. There may be instances where strong motivations can be made for encroaching on recommended setback areas. These may be linked to the Management Objectives of the water resource (see Step 4.10 above) or directly to aspirations of a development proposal. Any plans of such a nature should be appropriately assessed, motivated and indicated on a revised layout plan.

Step 7: Document management measures necessary to maintain the effectiveness of setback areas

Once a setback area has been determined, appropriate management measures need to be determined and documented. Key aspects of the setback requirements will include:

- An aquatic impact buffer zone;
- Possible core habitat requirements;
- Possible corridor requirements; and
- Any additional aspects requiring consideration to ensure effective management of setback areas.

All of these must be taken into consideration in determining and documenting management measures necessary to maintain or enhance the effectiveness of the setback area. To do this, a buffer zone management plan is required.

7.1 Document management measures to maintain or improve the functionality of aquatic impact buffers	This is a site-based exercise. Once an aquatic impact buffer zone has been determined, management measures need to be tailored to ensure buffer zone functions are maintained for effective mitigation of relevant threat(s). Management measures must be tailored to ensure that buffer zone functions are not undermined. Aspects to consider include: • Aquatic impact buffer zone management requirements; • Management Objectives for the aquatic impact buffer zone; and • Management actions required to maintain or enhance the aquatic impact buffer zone in line with the Management Objectives. Annexure 16 of the Research Report provides characteristics that are particularly important in ensuring that aquatic impact buffer zones function effectively.
7.2 Document management measures to safeguard species and habitat over the long-term	This is a site-based exercise. Many aquatic and semi-aquatic faunal species depend upon water resources for only portions of their life cycles, and they require terrestrial habitats adjacent to the water resources to meet all their life needs. Without access to appropriate terrestrial habitat, and the opportunity to move safely between habitats across a landscape, it will not be possible to maintain viable populations of many species. Therefore, core habitats and corridors need to be developed for the protection of species or habitats of conservation concern. Once protection zones for important biodiversity elements have been identified, the next step is to define specific management measures to ensure that these features persist over the long term. Annexure 18 of the Research Report provides examples of key management considerations and information sheets. These should be used to develop core habitat and ecological corridor management plans. Guidelines on biodiversity conservation management are available in South Africa. And the seven step approach, as described in Annexure 19 of the Research Report, should be used as a guideline for the ecological corridor design.

7.3 Additional aspects requiring consideration to ensure effective management of setback areas	This is a site-based exercise. There are many aspects that need to be considered to ensure that, once established, setback areas do not degrade over time, but continue to provide their required functions. These include: 1. Regulating aquatic impact buffer zones; 2. Aquatic impact buffer zone demarcation; 3. Aspects that may require the expansion of the aquatic impact buffer zone; 4. Maintenance of supporting mitigation measures; 5. Buffer zones in urban areas; 6. Rehabilitation or enhancement of buffer zones; and 7. Buffer zones and climate change. The Research Report considers each of the above in detail.

Step 8: Monitor implementation of buffer zones

Monitoring the effectiveness of determined setback areas and the recommended management measures for the relevant aspects of the setback area are vital for ensuring effectiveness. Monitoring implementation should include:

- Determining monitoring objectives and indicators of buffer zone effectiveness; and
- Designing a monitoring programme (e.g. timing, methods, etc.) to achieve the monitoring objectives.

Monitoring implementation and management should be undertaken throughout the duration of construction activities to ensure that the effectiveness of the setback areas are maintained and that management measures are appropriately implemented. Regular inspections during the operational phase should also be undertaken to ensure that functions are not undermined by inappropriate activities. Where relevant, inspections may also be required during the closure phase.

In compliance with the requirements of an Environmental Management Plan the Environmental Officer and / or the Environmental Control Officer should be checking that the following aspects are being implemented:

- The setback area has been demarcated clearly;
- Disturbances are being managed effectively;
- Possible rehabilitation is being successfully implemented; and
- Required management measures are being effectively implemented.

Where concerns are noted, appropriate actions must be taken to ensure that the functions of setback areas are not undermined.

A monitoring / maintenance programmme must include evaluation of the rehabilitation measures and provide for alternative mitigation measures to aid the buffer in achieving its required function. The developer or landowner is responsible for maintenance and monitoring.

5 CONCLUSION

The WRC Research Project's comprehensive literature review provided the platform to develop the conceptual framework and step-wise approach to determining buffer zones (also called setback ares) which takes the following into account:

- The aquatic impact buffer zone;
- Potential core habitats;
- Potential ecological corridors; and
- Possible additional aspects that will influence the final setback area or the management of the setback area.

The Buffer Zone Tools developed as part of the Research, and contained in the WRC Research Report, provide the user with the primary tools and extensive additional information for determining appropriate buffer zones.

Those involved in the development and management of aquatic buffer zones are strongly encouraged to access the full WRC Research Report TT 610/14.

Repurposed for a broader audience by

Kerry Barton-Hobbs (Harris):
project integrator | development practitioner | writer | editor

TOOLS FOR IMPLEMENTING AND MANAGING BUFFER ZONES: ANNEXURES TO WRC RESEARCH REPORT TT 610/14

Please note that the Annexures are provided EITHER in electronic format on the CD attached to the inside back cover of the WRC Research Report OR they are provided in hard copy at the end of the WRC Research Report.

Annexure 1	Research literature review	Electronic copy
Annexure 2	Practical testing	Electronic copy
Annexure 3	Range of management measures available to address threats posed to water resources	Hard copy
Annexure 4	National and/or sub-national (CAPE) priority estuaries	Electronic copy
Annexure 5	Estuary importance scores for all South African estuaries	Electronic copy
Annexure 6	Description of sectors and sub-sectors included in the threat assessment	Hard copy
Annexure 7	Specific limits set for evaluating different threat types assessed	Electronic copy
Annexure 8	Summary of Average Event Mean Concentrations (EMCs) for sectors & sub-sectors	Electronic copy
Annexure 9	Event Mean Concentrations (EMCs) for sectors & sub-sectors obtained from international literature	Electronic copy
Annexure 10	Initial desktop threat ratings based on expert workshops	Electronic copy
Annexure 11	Hydrological sensitivity analysis	Hard copy
Annexure 12	Guidelines for assessing the sensitivity of wetlands to lateral land-use inputs	Hard copy
Annexure 13	Guideline for assessing the sensitivity of rivers and streams to impacts from lateral land use inputs	Hard copy
Annexure 14	Guidelines for assessing the sensitivity of estuaries to lateral land-use inputs	Hard copy
Annexure 15	Development of rule-curves to link buffer efficiency to buffer width	Hard copy
Annexure 16	Guidelines for refining buffer requirements based on site characteristics	Hard copy
Annexure 17	Overview of the mitigation measures tool	Hard copy
Annexure 18	Examples of biodiversity information sheets	Electronic copy
Annexure 19	Guidelines for corridor design	Electronic copy
Annexure 20	Useful data layers	Electronic copy

SOME RELATED REPORTS FROM THE WRC:

- **Wetlands and Wellbeing: A Decision Support System** (Report No.TT 591/14)
- **Wetlands and Well-being: Getting more out of South Africa's wetlands** (Report No.TT 605/14)
- **Tools to determine enforcement driven rehabilitation objectives on urban river reaches - Guideline** (Report No.TT 594/14)
- **Tools to determine enforcement driven rehabilitation objectives on urban river reaches** (Report No.TT 593/14)
- **Manual for ecostatus determination (Version 2) Module B Geomorphology Driver Assessment Index (GAI)** (Report No.TT 551/13)

Notes

The WIN-SA lesson series aims to capture the innovative work of people tackling real service delivery challenges. It also aims to stimulate learning and sharing around these challenges to support creative solutions. To achieve this, the lessons series is supported by ancillary learning opportunities facilitated by WIN-SA to strengthen people-to-people learning.

To find out more about these and other WIN-SA services go to the WIN-SA portal at www.win-sa.org.za or contact the Network directly.

This document hopes to encourage ongoing discussion, debate and lesson sharing. To comment, make additions or give further input, please visit www.win-sa.org.za or send an email to info@win-sa.org.za.

Our mission is to ensure the body of knowledge in the sector is well managed, readily accessible and applied, leading to improved decision-making and performance, especially of local government.

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