Widening of Conrad Bridge, Randburg, Johannesburg, Gauteng

General wetland rehabilitation- and monitoring plan to mitigate construction related impacts

June 2015

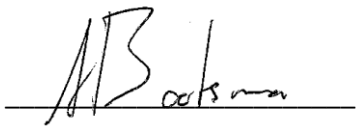
Drafted by
Limosella Consulting
P.O. Box 32733, Waverley
Pretoria, 0135
Email: antoinette@limosella.co.za
Cell: +27 83 4545 454

Drafted for Envirolution Consulting
PO Box 1898 Sunninghill 2175
Tel: 0861 444 499
Fax: 0861 626 222
Email: info@envirolution.co.za

Declaration of Independence

I, **Antoinette Bootsma**, in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member; and
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement.



2015.06.01

Antoinette Bootsma (PrSciNat) Date

Ecologist/Botanist

SACNASP Reg. No. 400222-09

Indemnity

This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information at the time of study. Therefore, the author reserves the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although the author exercises due care and diligence in rendering services and preparing documents, she accepts no liability, and the client, by receiving this document, indemnifies the author against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the author and by the use of this document.

TABLE OF SPECIALIST CONTRIBUTIONS

Report writing	Antoinette Bootsma Ecologist/Botanist/Wetland specialist SACNASP Reg. No. 400222-09
Field work and data analysis	Antoinette Bootsma Ecologist/Botanist/Wetland specialist SACNASP Reg. No. 400222-09 Rudi Bezuidenhoudt Wetland specialist / Ecologist SACNASP Reg. No. 500024/13

Table of Contents

Figures

Tables

1 INTRODUCTION

Limosella Consulting (Pty) Ltd was appointed to undertake the wetland/riparian delineation and functional assessment of watercourses affected by the proposed widening of Conrad bridge (inclusive of erosion protection along the Braamfontein Spruit, connecting roads and lanes), located in Randburg, City of Johannesburg, Gauteng Province.

Development that is within 500m of a water resource (wetlands, riparian areas) or situated within a watercourse requires a Water Use License (WUL) before construction can take place (DWA, 2010). Therefore, a general riparian rehabilitation and monitoring plan, to mitigate the potential impacts that the proposed road widening could have on watercourses, was needed. Limosella Consulting was appointed by Envirolution Consulting to develop a general riparian rehabilitation and monitoring plan for this proposed widening of bridge infrastructure, including erosion protection measures, connecting roads and lanes.

1.1 Assumptions and limitations

- This document is based on information as received by Envirolution Consulting
- The document takes into account likely impacts that can arise during construction, as well as impacts that could arise as a result of the completed construction and operational phase. However, some unique impacts may arise that must be recorded during monitoring and appropriate corrective actions taken.
- Engineering drawings and the specification of rehabilitation structures falls outside of the scope of this general rehabilitation plan.
- This report recognises that construction includes:
  - Erosion protection along the Braamfonteinspruit;
  - Upgrading of the current bridge crossing the Braamfontein Spruit (widening); and
  - Connecting roads and lanes.
- A water use licence might be required and the onus is on the client/applicant to do the necessary applications. The specialist input cannot be held accountable if a water use license is not granted as the assessment report and rehabilitation plan do not guarantee approval.
- The specialist cannot be held accountable if a water use license is not granted.

1.2 Objective and aims

The riparian rehabilitation and monitoring plan is specific to the proposed widening of Conrad Road and associated bridge crossing, the delineated riparian area forming the Braamfontein Spruit, its buffer zone, including construction upslope that could impact on the watercourse down the slope. In addition, the rehabilitation plan also applies to disturbances in wetlands and riparian areas where absolutely necessary in order to widen the road. Several existing impacts to the wetlands relevant to this project are described in Limosella Consulting (2015), including urbanization of the catchment and the alien invader plant density. The rehabilitation efforts proposed in the current document are unlikely to improve the Present Ecological State (PES) or the Ecological Integrity and Sensitivity (EIS) of the watercourses on site (e.g. improve the PES from E to a D). However, this document aims to limit localised impacts relating to the construction and to prevent further degradation of the watercourses in the catchment. It also aims to encourage local improvements on the study site and immediate surrounds.

The overall objective is to return the wetlands/riparian areas in and around the footprint of the road to a state as close to the state prior to construction and to limit or negate any construction and operational associated impacts by:

- Ensuring the footprint of the impact on the watercourses is as small as possible;
- Ensuring that the planning phase takes riparian rehabilitation and monitoring into account for both the construction and operational phase;
- Ensuring that the widening of Conrad road and bridge does not lead to any further degradation in the PES of the Braamfontein Spruit;
- Employing preventative measures during the construction phase;
- Providing guidance on rehabilitation of areas that are temporarily disturbed during construction;
- Reducing the likelihood of erosion and subsequent sedimentation during construction and operation; and
- Recommending monitoring and corrective actions in order to mitigate impacts as soon as they become apparent.

2 METHODOLOGY

In order to protect biodiversity and conserve sensitive environments during development, steps that should be followed are to firstly avoid, then minimize, then repair or restore, and finally compensate for, or offset the negative effects of any development on biodiversity (Figure 1) (Macfarlane *et al*, 2014). Thus where the impact is unavoidable, the impacts must be minimised and the unavoidable and unforeseen impacts restored or rehabilitated.

Figure 1: The mitigation hierarchy

Rehabilitation refers to the measures that are undertaken to return impacted areas to their pre-impact natural state and can occur as an on-going and integral activity during the construction activity. From the perspective of minimizing impacts on biodiversity and ecosystem services, on-going rehabilitation to

indigenous vegetation during the construction is preferred as it effectively reduces the time lag during which negative impacts endure. In order to realise the objective of the rehabilitation plan, it is necessary to limit the impact as much as possible to reduce the need for costly rehabilitation and corrective action. Therefore, mitigation should already start in the planning phase in order to direct construction to have the least impact possible, reducing follow-up rehabilitation and corrective actions. Therefore, this rehabilitation document comprises of three plans (Table 1):

1. Mitigation Plan: to focus pre-construction planning and activities on limiting the possible impacts that can arise during construction.
2. Rehabilitation Plan: aimed at rehabilitating the areas temporarily disturbed by the construction. This document recognises that construction will entail three phases.
3. Monitoring Plan: aimed at monitoring the success of rehabilitation as well as recording any impacts that may arise during the operational phase of the road (including maintenance), for which corrective action is needed.

Table 1: Plans in relation to the relevant project phases

Plan	Project Phases
1. Mitigation plan	• Pre-construction planning and activities • Construction • Operation
2. Rehabilitation plan	• Construction • Operation
3. Monitoring and corrective action	• Construction • Operation

3 DESCRIPTION OF ENVIRONMENT AND WATERCOURSES AFFECTED

The section of the Braamfontein Spruit that will be impacted by the widening of Conrad Road is classified as a riparian area. It lies in Quarternary Catchment A21C, Water Management Area 3 (Crocodile West Marico) and drains into the Jukskei River. It is likely that this riparian area previously had characteristics similar to a valley bottom wetland and that the increased urbanisation has led to an increase in water flow into the stream which ultimately reshaped the stream and now shares more characteristics with a river than a wetland.

The catchment area of the riparian area falls within an urban area and the main feeder to the system is storm water run-off from the Conrad Road and upstream areas. The Braamfontein Spruit flows through one of Johannesburg's most prominent greenbelts, starting in Melville Koppies in the south, and ending in Paulshof in the north. From south to north, the Braamfontein Spruit traverses the Emmarentia, Parkhurst, Craighall, Riverclub, Bryanston and Rivonia suburbs over a distance of approximately 25 km's and is a tributary of the Jukskei River.

The EIS score of 1.0 falls into a category characterised by **Moderate** ecological importance and sensitivity. These watercourses are considered to be ecologically important and sensitive on a provincial or local scale.

The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers.

Table 2: Combined EIS scores obtained for the Riparian area on the study site. (DWAF, 1999)

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	1.7	3.0
Hydro-functional importance	0.8	3.0
Direct human benefits	0.7	4.0
Overall EIS score	**1.0**	

The riparian area is greatly disturbed by current and historical anthropogenic activities as well as increased urbanisation and associated increased in hardened surfaces within the catchment. Consequently the vegetation cover of the riparian is very different from historical conditions and the majority of the woody and the non-woody species are exotic. The combined EC scores for the riparian area on the study site is an **E - Seriously modified**.

The tables (Tables 3 to 5) below show the results of the functional assessment. Figure 2 presents the delineated riparian area relative to Conrad Road.

Table 3: Results and brief discussion of the Ecosystem Services provided by the Non-Perennial areas on the study site (Kleynhans *et al*, 2008).

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	38.3	24.0	2.5	2.0	100.0
NON MARGINAL	23.3	8.8	2.5	1.0	60.0
	2.0				160.0
LEVEL 3 VEGRAI (%)				**32.7**	
VEGRAI EC				**E**	
AVERAGE CONFIDENCE				**2.5**	

The loss of natural habitat, biota and basic ecosystem functions is extensive. The combined QHI score for the riparian area on the study site is an **E - Seriously modified**. The loss of natural habitat, biota and basic ecosystem functions is extensive.

Table 4: QHI for the non-perennial riparian areas on the study site (Seaman *et al*, 2010).

QUATERNARY CATCHMENT	RIVER	Bed modification	Flow modification (0-5)	Introduced instream biota(0-5):	Inundation (0-5)	Riparian/Bank condition (0-5)	Water quality modification (0-5)	DESKTOP HABITAT INTEGRITY	INSTREAM EC%	INSTREAM EC	Vegetation Rating	ECOSTATUS %	ECOSTATUS_EC	CONFIDENCE (1-5)
A21C	**Non-Perennial 1**	**4**	**4**		**4**	**4**	**5**	**26.0**	**26.0**	**E**	**5**	**20.7**	**E**	**4:MODERATE-HIGH**

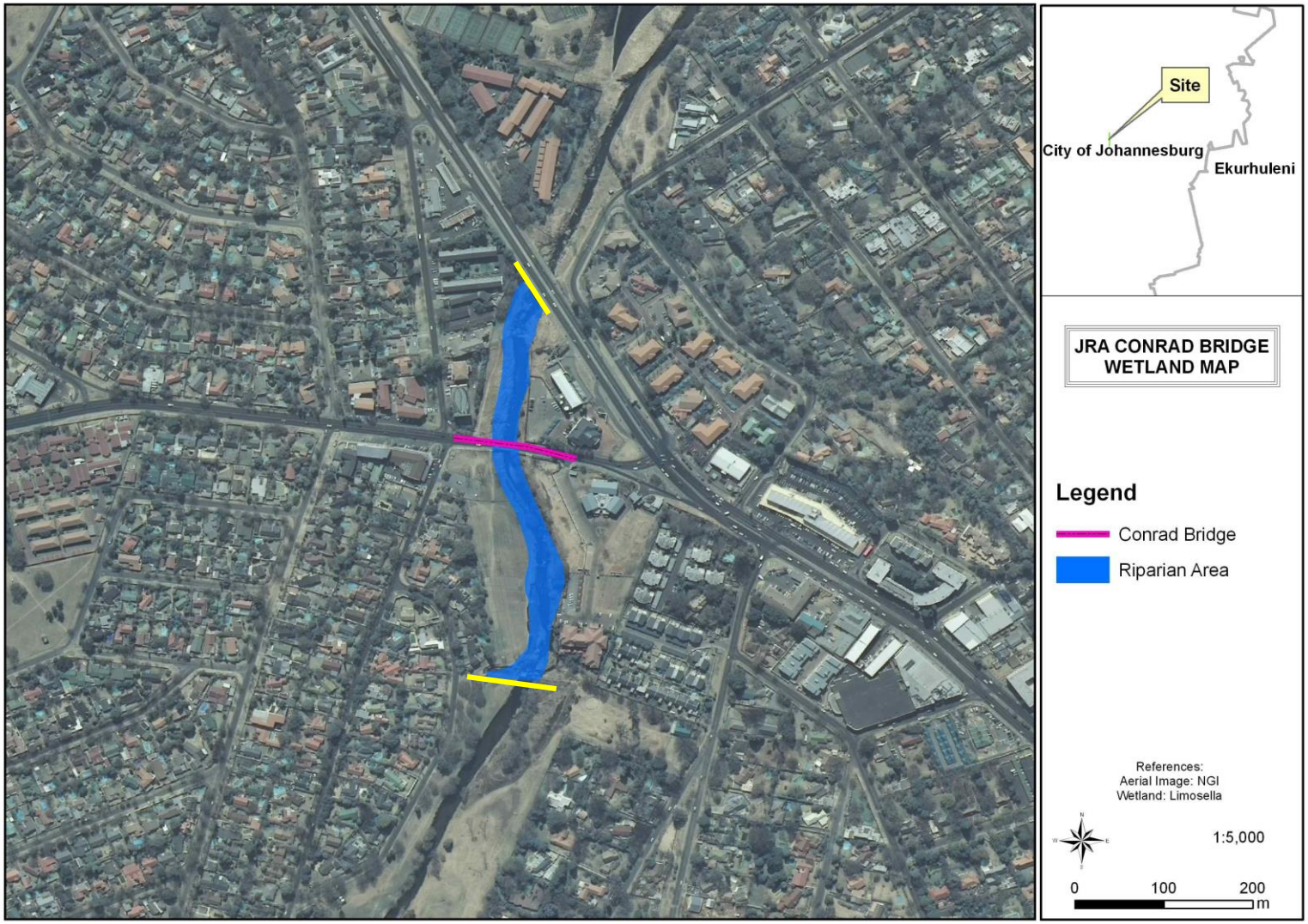


Figure 2: The riparian area delineated in proximity to the proposed road and bridge widening. Yellow lines demarcate the extent of delineation

4 EXPECTED IMPACTS

The proposed road and bridge widening will impact on the riparian components of the Braamfontein Spruit. If mitigation and rehabilitation is not done, a significant negative impact could result which can extend to downstream watercourses. The most important impact is related to how the watercourse is crossed by the road. If water is focused below the road by, for example should insufficient width be allowed for dissipated flow, the concentrated water flow will result in erosion and further channel straitening. It is therefore very important that this feature be incorporated into the design phase of the project and carefully monitored

Furthermore, disturbance of the soil layers and compaction of soil around the construction footprint as well as along servitudes may result in erosion and subsequent sedimentation of the Braamfontein Spruit. Therefore, the successful re-establishment of vegetation is imperative in order to limit impacts on the watercourse.

The following main impacts are expected to be associated with the road and bridge widening:

Changing the physical structure within a water resource: Construction of the proposed bridge will impact on the physical structure of the watercourse by disturbing the soil profile and the bed and banks of the riparian habitat. The planning process should ensure that the bridge is sufficiently wide to ensure diffuse water flow and that piped or *concentrated water flow be avoided at all cost*. Energy dissipaters downstream from the bridge should be applied should erosion resulting from high energy water flows become evident. Disturbance of the bed and banks of the Braamfontein Spruit will have to be carefully mitigated to minimize sedimentation and establishment of alien invasive plant species.

Changing or impeding the flow of water: It is imperative that the movement of water under the road be designed in such a way as to prevent increasing the velocity of water flow since this results in erosion downstream. For example, culverts under the road should allow for diffuse flow of water. The dispersive quality of soils should be investigated and form part of a monitoring plan to highlight the formation of erosion as it occurs in order to be appropriately addressed. Impeding water flow by for example temporary diversions during road building should be avoided as far as possible.

Clearing/removal of natural vegetation: The plants that grow in riparian areas are vital for preventing erosion, they play a role in the purification of water, reducing the severity of floods and regulating water, especially during droughts. The moment the vegetation is destroyed, these valuable functions disappear. In addition, vegetation around watercourses, especially upslope, holds soil in place and slows down water runoff during rainy events. The vegetation thus promotes groundwater recharge, while protecting soils from eroding, subsequently causing sedimentation in watercourses.

Compaction of soils: Construction activities may compact soils from heavy equipment access which could inhibit seed germination, reduce water infiltration, inhibit root establishment, and result in bare soil exposure. In particular, soil compaction can lead to an increase in runoff during rainy events, which in turn results in increased sedimentation.

Exposure to erosion: Removal of stream bank vegetation, vegetation against slopes and compaction of soils, expose the resulting bare soils to erosion during rainfall events. Erosion removes the top soil layer, thereby preventing the successful establishment of indigenous vegetation on eroded soils. Eroded areas are likely to be colonised by alien invasive and pioneer plants, or in severe cases, no vegetation will establish causing high velocity runoff during rainfall events and continuous erosion.

As discussed briefly above, the inappropriate movement of water under the road will result in downstream erosion. Water flow calculations taking into account the dispersive nature of soils should inform the width of the bridge in order to prevent erosive water flows. Furthermore, monitoring should form part of the project planning for the early detection and subsequent remediation of any erosion that may occur.

Sedimentation of watercourses: Soil erosion could lead to increased sedimentation and turbidity downstream of the activity, which in turn reduce the water storage capacity thereof, smother vegetation, and decrease oxygen concentration. Low oxygen environments are detrimental to invertebrate and fish species that may occur in these habitats.

Mobilisation of pollutants: Accidental pollution or illegal disposal and dumping of construction material such as cement or oil, as well as disposal or discharge of human (including partially treated and untreated sewage) into water resources will influence the water quality of watercourses, thereby influencing its functionality and the persistence of vegetation. Furthermore, the surrounding areas are already exposed to pollution which during high rainfall events could be washed into the watercourses – especially if vegetation cover is not sufficient to slow down water and filter pollutants.

Invasion by alien invasive vegetation: The plant species composition is already dominated by alien plants. These plants provide an important function in stabilizing soils and attenuating high energy surface water flows. However, plants listed as invader species (Category 1 and 2) as detailed in the Conservation of Agricultural Resources Act (Act 43 of 1983) and the proposed amendments of 2000, should be removed, and prevented from establishing. The seeds of these alien invasive species that occur on and in the vicinity of the construction area could spread into the disturbed or stockpiled soils. In addition, the construction vehicles and equipment were likely used on various other sites and could introduce alien invasive plant seeds to the construction sites. From these construction sites, alien invasive plant species can easily spread downstream, likely resulting in offsite impacts.

5 MITIGATION PLAN:

On site mitigation can limit the impact of construction activities and reduce the need for expensive rehabilitation and corrective action. In addition, sedimentation is very difficult and sometimes impossible to rehabilitate without further impacting on watercourses. Therefore, sedimentation should be prevented through mitigation. Table 3 list the mitigation measures that should be implemented during the planning and construction phase in order to limit the need for rehabilitation.

Table 5: Mitigation plan

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Pre-construction planning	Limit the footprint of construction as far as possible, thereby reducing compaction and destruction of natural vegetation	• Project engineers should compile a method statement, outlining the construction methodologies. The required mitigation measures to limit the impacts on the watercourse and associated buffers should be contained within the method statement. The method statement must be approved by the ECO and be available on site for reference purposes • Plan construction to take place during the drier winter months • Plan construction activities to have the smallest possible footprint • Minimise the width of the construction servitude across the riparian zone • Consider the various methods and equipment available to build the road and select whichever method(s) that will have the least impact on watercourses. • Demarcate the construction footprint prior to commencement of construction and ensure that all workers and contractors are aware that access beyond the demarcated areas are not allowed Where the road will affect riparian habitat, the edge / boundary of this riparian area must be clearly demarcated in the field with poles, sticks, or any solid structure that will last for the duration of the development. These indicators could be coloured as follows and communicated to workers **Red** – Indicating the edge / boundary of the riparian area **Orange** – Indicating the edge of the buffer zone • Ensure that a copy of this and other applicable documents are available on site and that all workers and contractors are aware of it. Implementation thereof should be monitored by the appointed Environmental Officer (EO) or Environmental Control officer (ECO) • Plan construction activities that necessitate water crossings to only cross watercourses at designated points • Avoid linear disturbances that run parallel to a watercourse
	Limit the footprint of access roads and constructing camps, thereby reducing compaction and destruction of natural vegetation	• Plan construction activities that necessitate water crossings to only cross watercourses at designated points • Plan construction camps to be placed outside of watercourses and their associated buffer zones

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
	Limit the impact on the hydrology and morphology of the riparian area	• Project engineers should compile a method statement, outlining the construction methodologies. The required mitigation measures to limit the impacts on the watercourse and associated buffers should be contained within the method statement. The method statement must be approved by the ECO and be available on site for reference purposes • 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 (DWAF, 2005) • Re-vegetation must be ongoing and relevant to terrestrial, wetness zone and slope
Construction	Limit the construction footprint and related impacts	• Minimise the width of the construction servitude across the riparian zone and demarcated the construction footprint prior to commencement of construction and ensure that all workers and contractors are aware that access beyond the demarcated areas are not allowed • Only use access roads as designated during the planning phase • Only cross watercourses at designated points should this be absolutely necessary • Limit the removal of indigenous vegetation in the construction footprint and do not remove vegetation outside of the construction footprint • Limit compaction by not working in wet conditions and limiting vehicular access. Ensure that all workers and contractors are aware of this • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005) • Only necessary traffic should be allowed within these demarcated areas • Contractors should refrain from impacting areas beyond the demarcated construction area • Minimise disturbance and loss of soil • The contractor must avoid traffic or storing of equipment and material in vegetated areas that will not be cleared
	Prevention of pollution	• The contractors must provide and maintain a method statement for “cement and concrete batching”. The method statement must provide information on proposed location, storage, washing & disposal of cement, packaging, tools and plant storage • Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area (outside of the riparian buffer), in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Construction		• The mixing of concrete should only be done at specifically selected sites on mortar boards or similar structures to contain run-off into drainage lines, streams and natural vegetation • Materials such as fuel, oil, and paint must be sealed and stored in bermed areas or under lock and key, as appropriate, in well-ventilated areas • These substances must be confined to specific and secured areas within the contractor's camp, and in a way that does not pose a danger of pollution even during times of high rainfall • Storage of materials as described above may not be within the 1:100 floodline, watercourses or associated buffer areas • In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water and Sanitation (DWS) must be informed immediately • All equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse • Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised. • Drip trays must be utilised during repairs and maintenance of all machinery. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle • Provision of adequate sanitation facilities located outside of the riparian area or its associated buffer zone • Remove all construction equipment and material on completion of construction • No water should be abstracted from the Braamfontein Spruit without DWS authorisation
	Prevent/limit sedimentation	• Increased run-off during construction must be managed using berms and other suitable structures as required to ensure flow velocities are reduced; this must be done in consultation with the ECO • The contractor shall ensure that excessive quantities of sand, silt and silt-laden water do not enter watercourses. Appropriate measures, e.g. erection of silt traps, or drainage retention areas to prevent silt and sand entering drainage or watercourses must be taken • Silt trenches between the works area and downstream riparian area could be used to trap any sediment washing off the works area and to prevent scouring of the stream line in case of heavy flows. This will provide protection for the downstream section of the watercourse for almost the entire length of road across a riparian area • Where wetlands or riparian areas are adjacent to the construction areas and these areas slopes toward the river, install sediment barriers along the edge of the construction areas as necessary to prevent sediment flow into the river • Sediment barriers must be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration of adjacent upland areas is complete

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Construction		• It is important that topsoil should be conserved in areas where bedrock is shallow to avoid sedimentation • Should water need to be pumped around the works area and discharged back into the river, care must be taken to ensure that the water is discharged in a manner that does not cause siltation or erosion downstream. As such it is recommended that any water to be discharged from pumping around the construction area or from dewatering operations be first discharged into a structure that allows the settlement of all suspended material, and which allows the diffuse discharge of water into the river. The water must be dissipated on re-entry into the watercourse, to reduce the changes of erosion
	Preventing spread of alien invasive	• Alien invasive species that are identified within servitudes should be removed prior to construction related soil disturbances. This will prevent seed spreading into disturbed soils • Appointment of alien plant working group / assign this duty to specific staff • If herbicide must be used it should be registered for aquatic use • Acquire the necessary equipment for removal and control • Planned sequence of areas to be cleared of invasive plants • A register of the methods used, dates undertaken, as well as herbicides and dosage used must be kept and available on site. The register must also include incidents of poisoning or spillage • Ensure that contractors can identify the relevant plants and are aware of the removal procedures • Construction equipment must be cleaned prior to site access. This will prevent alien invasive seed from other sites to spread into disturbed soils • Manual removal methods are preferred to chemical control
Operation	Prevention of pollution	• In the event that maintenance must be carried out, all equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse • Storage of maintenance materials / chemicals may not be within the 1:100 floodline, watercourses or associated buffer areas • The ECO must ensure that all construction equipment and material are removed on completion of construction
	Prevent/limit sedimentation	• The contractor shall ensure that a method statement is prepared prior to maintenance work to ensure that excessive quantities of sand, silt and silt-laden water do not enter watercourses. Appropriate measures, e.g. erection of silt traps, or drainage retention areas to prevent silt and sand entering drainage or watercourses must be taken • Plan monitoring during the operational phase to ensure that the construction footprint is adequately rehabilitated • Sediment barriers must be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration of adjacent upland areas is complete

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Operation		• Where maintenance work or emergency action must be undertaken and water needs to be pumped around the works area and discharged back into the river, care must be taken to ensure that the water is discharged in a manner that does not cause siltation or erosion downstream. As such it is recommended that any water to be discharged from pumping around the maintenance activity or from dewatering operations be first discharged into a structure that allows the settlement of all suspended material, and which allows the diffuse discharge of water into the river. The water must be dissipated on re-entry into the river, to reduce the changes of erosion
	Preventing spread of alien invasive	• Plan an alien invasive plant work group that can carry out follow-up alien plant control for at least three years after construction • Ensure that contractors can identify the relevant plants and are aware of the removal procedures

6 REHABILITATION PLAN

Rehabilitation in this document refers to the reinstatement of the temporarily disturbed areas affected by the construction or due to construction related activities, to a state that resemble the conditions prior to the disturbances. It therefore does not address the rehabilitation of the wetlands and riparian areas along the proposed road from example a management category E to a D (Kleynhans, 1996 & Kleynhans, 1999). In order to improve the management category, the current impacts due to urbanisation and increased stormwater energy should be address and these fall outside the scope of this document.

Table 4 list the rehabilitation measures that should be undertaken post construction as well as corrective action when monitoring has established that the listed impacts are taking place.

Table 6: Rehabilitation plan

Impacts	Rehabilitation	Time frame
Changing the physical structure of the riparian habitat / Impact on stream morphology Construction activities associated with the bridge infrastructure will likely include disturbance of the bed and banks of the Braamfontein Spruit	• Construction should ideally occur during the drier winter months • Other than approved and authorized structure, no other development or maintenance infrastructure is allowed within the delineated riparian area or associated buffer zones • Construct any necessary erosion protection works where the road intersects the channel of the wetland in order to prevent scouring or bank erosion. Gabions, reno mattresses or other stabilising structures and materials could be considered (Teixeira-Leite, 2009) • riparian sediments/debris are not to be used for construction (e.g.: rocks for use in gabion baskets/reno mattresses) or to be permanently removed from the system (Teixeira-Leite, 2009) • Removed sediment should be stockpiled for rehabilitation • 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 (DWAF, 2005) • During construction through a watercourse, the majority of the flow of the watercourse must be allowed to pass down the stream channel (i.e. damming must not be allowed to take place). In-stream diversions should be used rather than the construction of new channels (Teixeira-Leite, 2009)	• During construction - ongoing
Removal of vegetation	• Stripping of vegetation for construction must occur in a phased manner and must be restricted to the excavation footprint to reduce the risk of erosion during times of precipitation	• Immediately after construction

Impacts	Rehabilitation	Time frame
Areas where vegetation will be impacted include the area directly impacted on by the construction of the road, the temporary work area, and access roads. Areas where vegetation has been removed or destroyed should be kept to a minimum. Disturbance of slopes, for example by the removal of vegetation, may result in slope instability and erosion by rain and surface runoff.	• Where possible, remove vegetation as sods that can be replanted as part of the rehabilitation of vegetation within the construction footprint. Store sods in already cleared areas and water at least once week • Where soils are removed, the topsoil and subsoil must be stockpiled separately in low heaps (Topsoil are deemed to be the top layer of soil containing organic material, nutrients and plant grass seed. For this reason it is an extremely valuable resource for the rehabilitation and vegetation of disturbed areas) • After construction, compacted areas should be ripped and topsoil replaced from the areas where it was removed. Areas within the construction footprint can be re-vegetated using the sods that were removed prior to construction. The sods should be placed level, or slightly deeper than surrounding vegetation, on ripped soils. Against slopes, the sods should be pegged to ensure that it does not wash away before the roots establish • All sloped areas must be re-vegetated by either using removed sods or by seeding with a grass mixture containing species naturally occurring in the area. Sloped areas where vegetation has been removed or destroyed should be replanted immediately after completion of construction to avoid erosion • Badly damaged areas should be fenced in to allow for rehabilitation to take place without further impacts on these areas • The construction footprint must be revegeted using indigenous grass species such as *Themeda triandra, Cynodon dactylon* and *Eragrostis chloromelas* • All rehabilitated areas must be monitored for the presence of exotic and alien plant species during rehabilitation • All disturbed areas will requiring rehabilitation must be mulched to encourage vegetation re-growth. Mulch used must be free from alien seed. These areas must be cordoned off so that vehicles or construction personnel cannot gain access to these areas • Where earthworks will take place in riparian areas areas: Naturally occurring indigenous riparian plant species (e.g. *Typha capensis, Schoenoplectus sp,. Cyperus congestus* and grasses such as *Imperata cylindrica, Leersia hexandra, Phragmites australis)* must be identified prior to construction and shall be	• At any time during operational phase of the road or bridge, when maintenance activities might have destroyed natural vegetation • As and when monitoring indicate degradation of vegetation along the servitude

Impacts	Rehabilitation	Time frame
	removed appropriately with their root ball intact. riparian vegetation removed shall be stockpiled neatly on the periphery of the area being stripped, for use in wetland rehabilitation (Teixeira-Leite, 2009) • Where possible, cut vegetation to ground-level rather than removing completely, leaving root systems to ensure rapid re-colonisation (Teixeira-Leite, 2009)	
Soil disturbance The construction of the road and bridge will result in the disturbance to the riparian soils and alteration of riparian geomorphology.	• Stockpiled riparian soil should be demarcated, kept free of weeds and is not to be compacted or used for construction • Riparian soils are to be handled twice only, firstly to strip and stockpile, and secondly to replace, level, shape and reinstate riparian vegetation (Teixeira-Leite, 2009) • No activities are allowed outside of the demarked works area • No activities should take place in moist soils or at least 2 days after heavy rainfall	• During construction - ongoing
Alteration of hydrological functioning within the river channel Construction of watercourse crossings may temporarily change the hydrology of the riparian area, largely as a result of localised interception and/or disruption to flow and/or pumping of water from the works area	• Construction should ideally take place during the drier winter months • Rehabilitation must ensure that construction does not permanently alter the surface flow of water through the riparian area • Construction materials, including spoil material, are not to be stockpiled in the riparian area area • Any artificial channels/erosion gullies resulting from the construction, must be filled and stabilised once the construction complete • Water diversion needs to be temporary and preferably only one diversion made at a time	• During construction • Immediately after construction
Soil Compaction Soil compaction is likely to occur on access roads, and temporary work platforms where heavy vehicles and personnel move around. Soil compaction will decrease permeability of the soil, negatively impact the sub-	• Areas where soil has been compacted should be ripped to encourage vegetation growth • Do not rip and / or scarify areas under wet conditions, as the soil will not break up and compaction will be worsened • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005) • Rip and / or scarify all disturbed (and other specified) areas of the construction site, including temporary access routes and roads, compacted during the execution of the Works. (DWAF, 2005)	• Immediately after construction • As and when monitoring indicate severe compaction due to maintenance

Impacts	Rehabilitation	Time frame
surface flows and compromise vegetation establishment.		
Mobilisation of pollutants The mobilisation of sediments, excavations, removal and disturbances to vegetation, mobilisation of sulphur, hydrocarbon and pyrite compounds could have various negative impacts on riparian areas and their associated functionality.	• Remove all project-related material used to support equipment on completion of construction • Any contaminated soil from the construction site needs to be removed and properly disposed of • Implement preventative maintenance system to ensure that work vehicles are maintained in an acceptable condition. This would involve routinely checking vehicles for leaks before construction begins; and not allowing vehicles/equipment with significant leaks to operate or be repaired within the construction site. • Materials such as fuel, oil and paint must be sealed and stored in bermed areas or under lock and key, as appropriate, in well-ventilated areas • These substances must be confined to specific and secured areas within the contractor's camp, and in a way that does not pose a danger of pollution even during times of high rainfall • Storage of materials as described above may not be within the 1:100 floodline, watercourses or associated buffer areas • In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water Affairs (DWA) must be informed immediately • All equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse • Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised. • Drip trays must be utilised during repairs and maintenance of all machinery. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle • Provision of adequate sanitation facilities located outside of the riparian area or its associated buffer zone	• During construction – ongoing • Immediately after construction • At any time during operational phase when maintenance activities might have resulted in pollution

Impacts	Rehabilitation	Time frame
	• Any water discharged must comply with the relevant Water Quality limits/guidelines specified by DWA.	
Spread of Alien Invasive Species	• Appointment of alien plant working group / assign this duty to specific staff • Alien invasive species that were identified should be removed prior to construction related soil disturbances. This will prevent seed spreading into disturbed soils or to downstream areas • All alien seedlings and saplings must be removed as they become evident for the duration of construction • Manual / mechanical removal is preferred to chemical control • If herbicide must be used it should be registered for aquatic use • Acquire the necessary equipment for removal and control • Planned sequence of areas to be cleared of invasive plants • A register of the methods used, dates undertaken, as well as herbicides and dosage used must be kept and available on site. The register must also include incidents of poisoning or spillage • Ensure that contractors can identify the relevant plants and are aware of the removal procedures • All construction vehicles and equipment, as well as construction material should be free of plant material. Equipment and vehicles should be thoroughly cleaned other prior to access on to the construction site.	• During and after construction • As soon as monitoring recorded alien invasive species
Erosion Erosion and sedimentation is likely to occur where vegetation has been cleared and where excavated material is stored in close proximity to a watercourse. Disturbance of steep slopes by the removal of vegetation	• The contractor shall be responsible for rehabilitating all eroded areas in such a way that the erosion potential is limited after construction has been completed • All slopes that are disturbed during construction should be stabilised immediately to prevent erosion • Re-vegetation should be done immediately after construction, especially in sloped areas • Disturbances on site should be kept to a minimum to reduce the loss of material by erosion • Disturbed areas that require rehabilitation should be mulched to encourage vegetation re-growth • Stockpiled soil should be protected from erosion due to water runoff	• During and immediately after construction • As and when monitoring indicate erosion is taking place

Impacts	Rehabilitation	Time frame

may result in slope instability and erosion by rain and surface run-off.	• 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. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology. One or more of the following methods may be required:
	  • Retaining walls (loffel or otherwise) (DWAF 2005)
	  • Stone pitching.
	  • Gabions.
	  • Shotcrete.
	• Protect the slopes of all stream diversions. One or more of the following methods may be used, as specified by the EO / ECO: (DWAF, 2005)
	  • Sandbags.
	  • Reno mattresses.
	  • Plastic liners and / or coarse rock (undersize rip-rap)
	• Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within work areas
	• Where all preventative measures have failed and erosion persists soft and hard rehabilitation options, such as eco-logs or weirs, should be considered in conjunction with an engineer and wetland specialist
	• Erosion control of all banks must take place so as to reduce erosion and sedimentation into river channels or wetland areas.
	• Any erosion gullies/channels created during construction should be filled to ensure silt does not drain into the wetland (Teixeira-Leite, 2009)
	• Spoil from the construction zone should not be placed within the watercourse
	• Bare ground exposed after vegetation removal must be rehabilitated as soon as possible	

Sedimentation	• Sedimentation should be prevented though sufficient mitigation	• During and after construction

Impacts	Rehabilitation	Time frame
	• If structures are used on sensitive sloped areas it is important that sediment does not pass through these structures e.g. gabions should be lined • Should sedimentation be observed to accumulate and smother vegetation, a wetland specialist should be consulted to find a suitable solution for the specific watercourse and its species composition • Water discharged into the environment must be done so in a manner that is not conducive to erosion and does not result in heavily silt-laden water flowing into any watercourse. • Bare ground exposed after vegetation removal must be rehabilitated as soon as possible.	• As soon as monitoring records sedimentation

7 MONITORING PLAN

Monitoring refers to the repetitive and continued observation, measurement and evaluation of environmental criteria to follow changes over a period of time and to assess the efficiency of control measures. The monitoring plan aims to establish whether rehabilitation was successful, whether maintenance or related activities have impacts and whether the implementation of the proposed road has detrimental impacts on the riparian area after construction (Table 5). Five phases of monitoring is recommended:

Routine Monitoring:

1. Monitoring during construction: during construction, the mitigation measures put in place to limit or negate the construction related impacts on a watercourse must be monitored. Where these mitigation measures are not sufficient or breached, immediate corrective action should be taken.

2. Monitoring post construction phase: it is assumed that the construction will be phased and that rehabilitation is thus an ongoing effort as each phase is completed. For example, once a portion of road has been constructed and rehabilitated. Monitoring post construction is important to detect any erosion, sedimentation or faulty structures. As each phase is completed the area is monitored for impacts and corrective action taken where needed.

3. Seasonal monitoring: after construction is complete, rehabilitation success, as well as signs of erosion, sedimentation and the presence of alien vegetation should be monitored twice during the summer months: once at the start and once at the end of the rainy season. This should be continued for at least three years after construction was completed.

4. Rapid monitoring: For the first two years, monitoring should take place immediately after heavy rainfall to ensure that rehabilitated areas are intact and that no erosion and subsequent sedimentation took place.

5. Annual monitoring: after three years, provided that all rehabilitation where found to be successful and no additional problems arised, monitoring can take place once a year after the first seasonal rainfall.

Problems such as failed re-vegetation and erosion should be remediated as soon as it is recorded in the monitoring process. Corrective action should be taken and can include the re-initiation of rehabilitation in severe cases or by correction of the problem (e.g. mend broken fences).

It is recommended that fixed point photography is used to monitor vegetation and soil stability. This involves taking pictures of the areas monitored from the same point during each monitoring event. The images can be compared and serves as a record of the success of rehabilitation or the failure thereof.

Table 7: Monitoring plan

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
Hydrology of the river	• On-site inspection	• After construction and rehabilitation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Water flow is not interrupted, diverted, changed by the rehabilitated area • Water flows though the rehabilitated area, not causing erosion	• Re-landscape the disturbed area to a state prior to the disturbance • Energy dissipaters if required
Integrity of rehabilitation structures - where utilised	• On-site inspection • Fixed point photography.	• After construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Arresting of erosion/head cut. • Sedimentation behind structure • Elevated (to near normal) water table level behind structure	• Structures should be fixed where possible or new structures should be implemented
Vegetation cover	• On-site inspection • Assess landscape functionality • Monitor species cover abundance and ensure that natural species cover increase(compare to vegetation study results prior to construction) • Fixed point photography	• After re-vegetation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Spreading and distribution of dominant plant species in specified wet zones • Riparian re-vegetation shall be considered successful if the cover of herbaceous and/or woody species is at least 80 percent of the type, density, and distribution of the vegetation in adjacent wetland areas that were not disturbed by construction	• If natural re-vegetation does not occur replanting of indigenous plants should be done at sites of concern • If re-vegetation is not successful at the end of 3 years, develop and implement (in consultation with an ecologist) a remedial re-vegetation plan to actively re-vegetate the disturbed area. Continue re-vegetation efforts until wetland re-vegetation is successful • If riparian rehabilitation is successful at the end of 3 years, report on the status of the vegetation (e.g. using photographic record) and only monitor annually or if maintenance activities might have disturbed the area again

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
Plant species composition	• Fixed transect to determine the species composition	• Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Presence/absence of species in specified wet areas.	• If natural re-vegetation does not occur replanting of indigenous plants should be done at sites of concern
Erosion	• On-site inspection • Fixed point photography • Compare to adjacent land	• During and immediately after construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually.	• Areas where vegetation cover is limited or nil and where soil has started to erode • Bare soil patches or ditches • Stabilised head cut and gully erosion • Water table behind structure	• Should erosion occur, soft options such as hay bales, eco-logs and replanting should be considered, if erosion is too great for soft options then a rehabilitation method should be discussed with an engineer and wetland specialist
Sedimentation	• As determined by ECO • Visual observations and site inspections • Fixed point photography	• After construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Excess sediment in watercourses • Sediment behind structure	• Cause of sedimentation should be identified and dealt with appropriately • Should sedimentation be observed to accumulate and smother vegetation, a wetland specialist should be consulted to find a suitable solution for the specific riparian area and its plant species composition.
Alien Invasive Plant Species	• Monitor the emergence of alien invasive plant species in or around rehabilitated areas • On-site inspection • Fixed point photography	• After construction • After re-vegetation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Establishment of alien invasive plant species in rehabilitated areas or in watercourses	• Remove emergent invasive vegetation from the rehabilitated footprint and servitude as soon as it becomes apparent • Manual labour is preferred above chemical or manual removal. • Do not use herbicides or pesticides in or within 200 meters of watercourses

8 REFERENCES

Braack A.M, Walters, D. And Kotze D.C. (unknown): Practical Wetland Management. Mondi Wetlands Programme

Brinson, M. (1993). A hydrogeomorphic classification for wetlands. Prepared for US Army Corps of Engineers. 101pp. Wetlands Research Programme Technical Report WRP-DE-4

Cowden C, and Kotze D (2009) WET-RehabEvaluate: Guidelines for monitoring and evaluating wetland rehabilitation projects. WRC Report No.TT 342/09

Department of Water Affairs and Forestry, (2005): Environmental Best Practice Specifications: Construction for Construction Sites, Infrastructure Upgrades and Maintenance Works. Version 3

Department of Water Affairs (2010): National Water Act, 1998 (Act No 36 of 1998) S21(c) & (i) Water Uses. Version: February 2010. Training Manual.

Kotze D C, (1999): A system for supporting wetland management decisions. Ph.D. thesis. School of Applied Environmental Sciences, University of Natal, Pietermaritzburg.

Limosella Consulting, (2015): Widening of Conrad Road and Bridge, Randburg, City of Johannesburg, Gauteng: Wetland Delineation & Functional Assessment

Macfarlane D, Holness S.D, von Hase A, Brownlie S, & Dini J. 2014. Wetland offsets: a best practice guideline for South Africa. South African National Biodiversity Insitute and Department of Water Affairs. Pretoria

Marneweck G C, and Batchelor A L, (2002). Wetland classification, mapping and inventory. In: PALMER R W, TURPIE J, MARNEWECK G C, and BATCHELOR A L. Ecological and economic evaluation of wetlands in the upper Olifants River Catchment, South Africa. WRC Report No. 1162/1/02. Water Research Commission, Pretoria

Sieben E, Braack M, Ellery W, and Kotze D (2009) WET-RehabMethods: National guidelines and methods for wetland rehabilitation. WRC Report No. 341/09