Proposed Shangoni Gate and associated Infrastructure, Kruger National Park, Limpopo Province

General wetland rehabilitation- and monitoring plan to mitigate the construction related impacts
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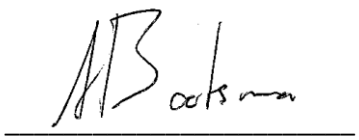
Declaration of Independence

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.



2016.09.05

Antoinette Bootsma (PrSciNat) Date

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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.

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1 INTRODUCTION

Envirolution Consulting is facilitating the environmental authorization process for the proposed new Kruger National Park Shangoni Gate and associated infrastructure including a high water bridge, a reception / education building, a picnic site, a tented camp, a camping terrain, and a 50km road upgrade to connect the access gate with the H1-6 Road between Shingwedzi and Mopane Rest Camps.

The general rehabilitation and monitoring plan is written as a supporting document to the delineation and functional assessment report (Limosella, 2016).

The proposed development falls within the Shingwedzi/Gyiani district in the Limpopo Province. The project comprises a new entrance gate, a high-water bridge over the Shingwedzi River, a new reception centre with education facilities, a picnic site, a camp site, a tented camp and a ca. 50 kilometer black-topped road routed parallel to the Shingwedzi River which connects with the H1-6 Road linking Shingwedzi and Mopane Rest camps. The new road will be an upgrade of a suitable portion of the gravelled S52 route to Bataleur camp and the graded Shangoni Ranger patrol track. To the east the upgraded road will again cross the Shingwedzi River as well as the Tshanga tribuatary across low water bridges. Most of the distance the upgraded road will be parallel to the Shingwedzi River and within the riparian area or the buffer area in numerous areas. Most of the the road will be north of the Shingwedzi River, and the section between the Shingwedzi Low Water bridge and the H1-6 will traverse through mopane veld south of the river. A short alignment has to be constructed to connect the western terminal end of the Shangoni Ranger patrol road with the reception centre. The upgraded road will be six meters wide with a one meter shoulder on each side.

The main watercourse likely to be affected by the proposed activities is the Shingwedzi River. This river is classified as a non-perennial river, ephemeral in nature. Non-perennial ephemeral rivers are defined as rivers that have no active water flow for between 3 – 6 months in a year. A large number of smaller non-perennial rivers are also likely to be impacted by the proposed activities. The majority of these smaller rivers are also classified as non-perennial rivers although they are more likely to be episodic in nature. Episodic rivers are defined as rivers without active water flow for 9 months of the year or more. Both Ephemeral Rivers and Episodic Rivers are further characterised by high variability and high unpredictability as is evident in the occasional flooding of the Shingwedzi River.

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 the construction of the new structures. 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 rehabilitation plan does not include reference to fauna and flora.
- This report recognises that construction includes:
    - Construction of a high water bridge over the Shingwedzi River

- Upgrade of a road running parallel to the Shingwedzi River from a dirt road to a black-top road
- Construction of low water bridges across the Shingwedzi River and Tshanga River tributary
- Construction of reception, picnic and camp sites adjacent to the Shingwedzi River

- The specialist cannot be held accountable if a water use license is not granted.

Coordinates for some of the bridge crossings are presented in Table 1 below

Table 1: Coordinates for the various activities proposed

FACILITY	COORDINATES
Gate preferred site	23° 8'42.79"S 30°55'55.47"E
Gate alternative 1	23° 8'51.55"S 30°55'55.87"E
Shingwedzi bridge site	23°08'37.0"S 30°56'07.7" E
Reception preferred site	23° 8'42.05"S 30°56'38.56"E
Reception alternative 1	23° 8'34.78"S 30°56'13.67"E
Western end new alignment	23°09'14.5"S 30°56'56.2" E
Eastern end new alignment	23°09'14.5"S 30°56'56.2" E
Picnic site preferred	30°56'13.67"E 31° 2'22.19"E
Picnic site alternative 1	23°10'30.69"S 31° 1'22.73"E
Picnic site alternative 2	23°10'49.76"S 31° 2'10.96"E
Camping site preferred	23°11'6.60"S 31° 1'16.49"E
Camping site alternative 1	23°11'48.99"S 31° 2'10.13"E
Tented camp preferred	23°11'23.40"S 31° 2'19.28"E
Tented camp alternative 1	23°11'35.27"S 31° 1'34.79"E
S52 crossing Shingwedzi	23°12'32.9"S 31°14'0.1" E
S52 crossing Tshanga	23°12'28.1"S 31°14'18.1" E
H1-6 and S52 T-junction	23°10'46.0"S 31°19'20.9" E

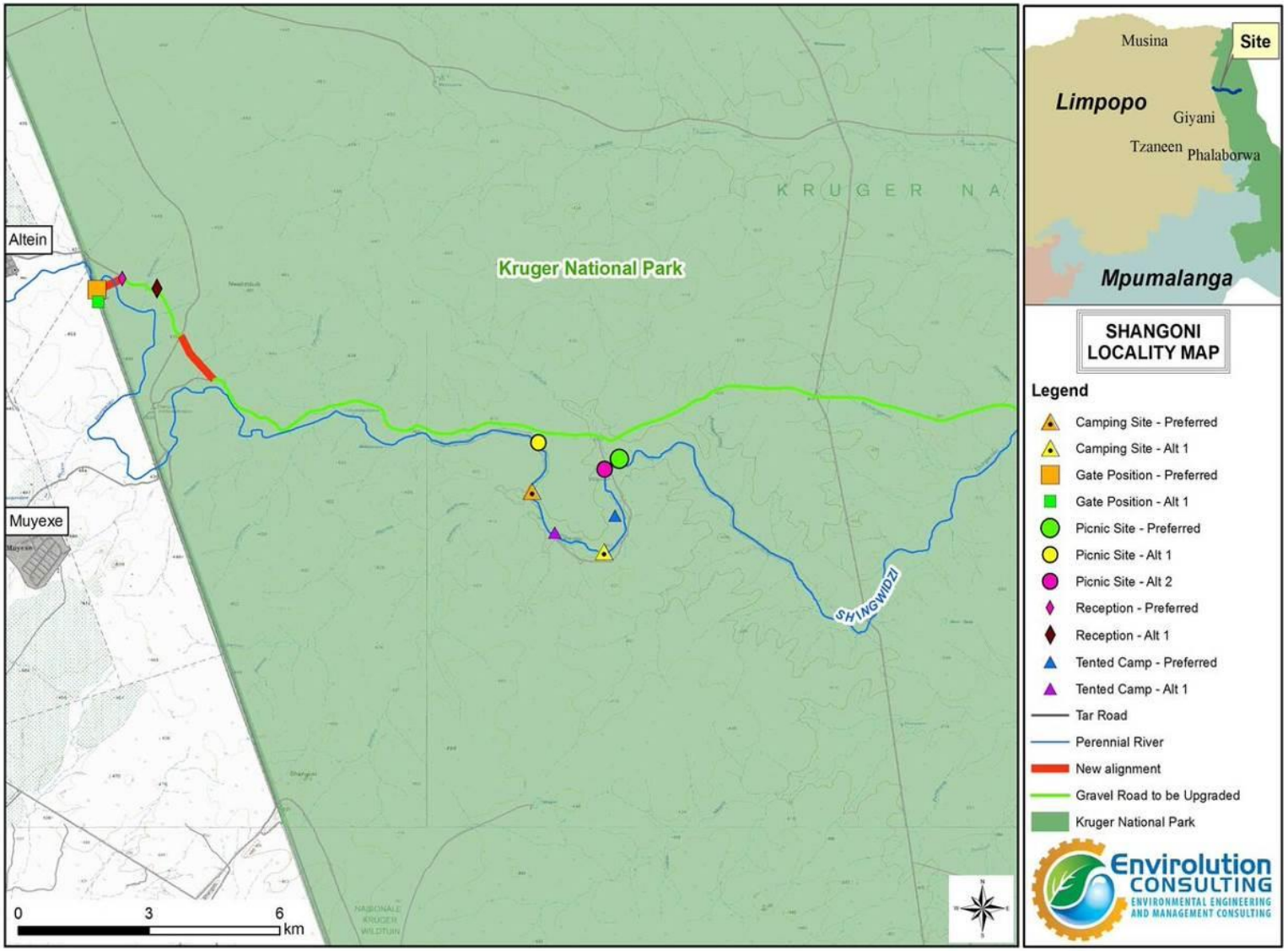

Figure 1: Locality Map

1.2 Objective and aims

The wetland rehabilitation and monitoring plan is specific to the construction of infrastructure within the watercourses or within the protective buffer thereof, within close proximity to watercourses (within 500m) and structures that are situated on slopes and could impact on watercourses or drainage lines down slope. In addition, the rehabilitation plan also applies to disturbances in rivers where absolutely necessary in order to remove or upgrade existing infrastructure. The rehabilitation efforts that form part of the proposed infrastructure 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 F to an E). 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 environment in and around the conduit positions and construction areas to a state as close to the state prior to construction and to limit or negate any construction associated impacts by:

- Ensuring the effective design of culverts and river crossings;
- Ensuring the footprint of the impact on the watercourses is as small as possible;
- 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 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.
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, river crossings or other infrastructure (including maintenance), for which corrective action is needed.

Table 2: Plans in relation to the relevant project phases

Plan	Project Phases
1. Mitigation plan	• Pre-construction planning and activities including design of structures • Construction phases
2. Rehabilitation plan	• Construction: New infrastructure • Construction: Road upgrade • Operation
3. Monitoring and corrective action	• Construction: New infrastructure • Construction: Road upgrade • Operation

3 DESCRIPTION OF ENVIRONMENT AND WATERCOURSES AFFECTED

3.1 Background

3.2 Delineated Water Courses

The study area falls into the second Water Management Area (WMA), Levuvu and Lethaba. The eastern section of the site in which the new gate and reception infrastructure is located, falls in Quarternary Catchment B90F. The eastern section falls in Quarternary Catchment B90G. The catchment of the Shingwedzi River is relatively small comprising of approximately 5300 km^2, the Shingwedzi sub-catchment has a natural MAR of 90 and an ecological reserve of 14 million m^3 a-1 (Fouché & Vlok, 2012; DWAF 2004a). The Shingwedzi River is located in one of the drier sub-catchments of the South African component of the Limpopo River Catchment (Fouché & Vlok, 2012).

The Shingwedzi River (which originates near the town of Malamulele) is a dominant feature of the study site. It arises about 40 km to the North West near Thohoyandou. It is along this river that the road upgrades will occur and the picnic site and rest camp constructed. This river flows from west to east. It confluences with the Tshange River downstream from the Bateleur Bushveld Camp and later drains into the Olifants River which in turn drains into the Limpopo River which drains into the Indian Ocean. No major tributaries enter the Shingwedzi upstream from the KNP and there are no dams. The catchment of the Shingwedzi River is well populated with village settlements with no significant industrial development other than scattered mines, most of which are no longer operational (Shangoni Gate Pre-feasibility Study, 2013).

Figures 2 and 3 below show the delineated riparian areas relative to proposed infrastructure.

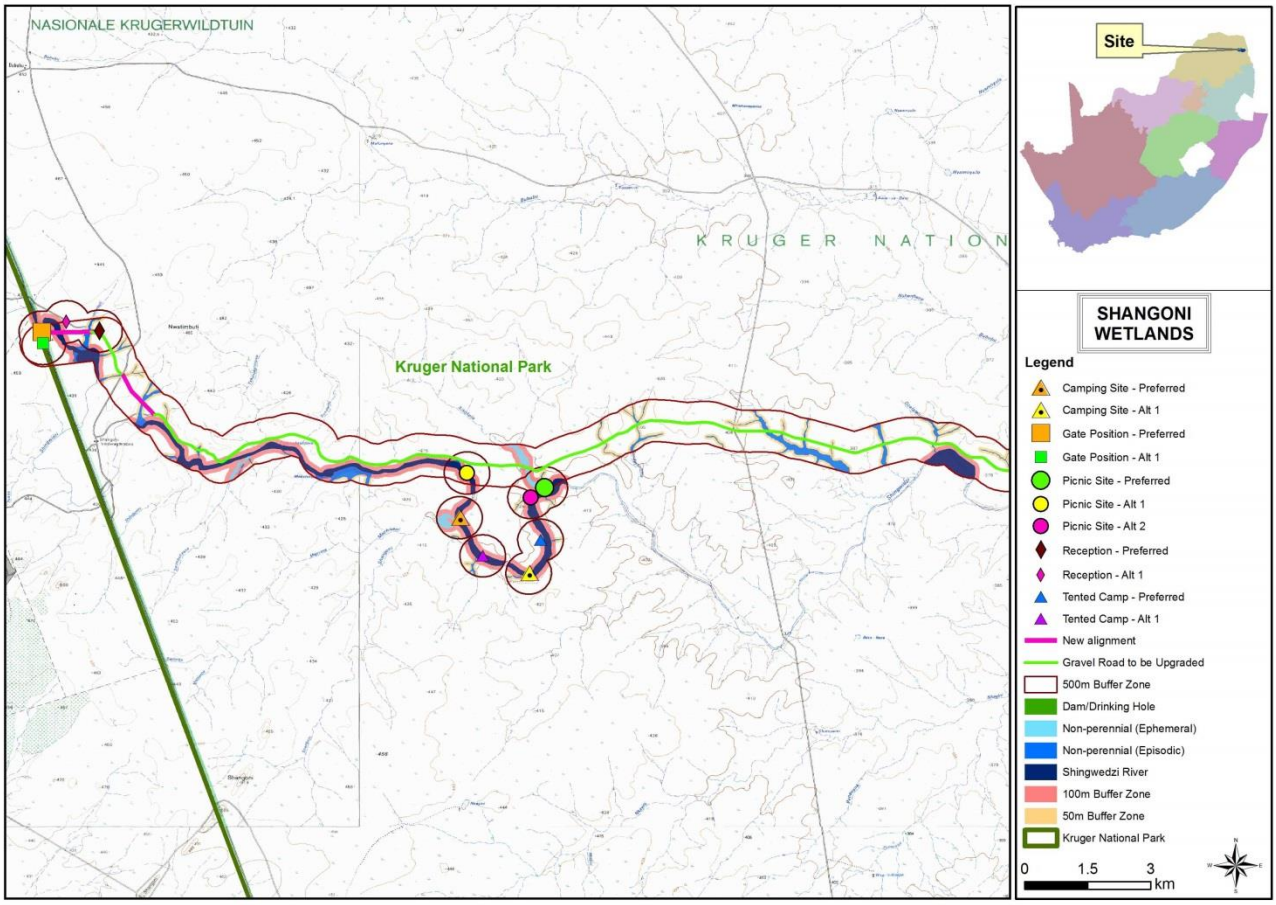

Figure 2: Wetland areas associated with the proposed development – western section.

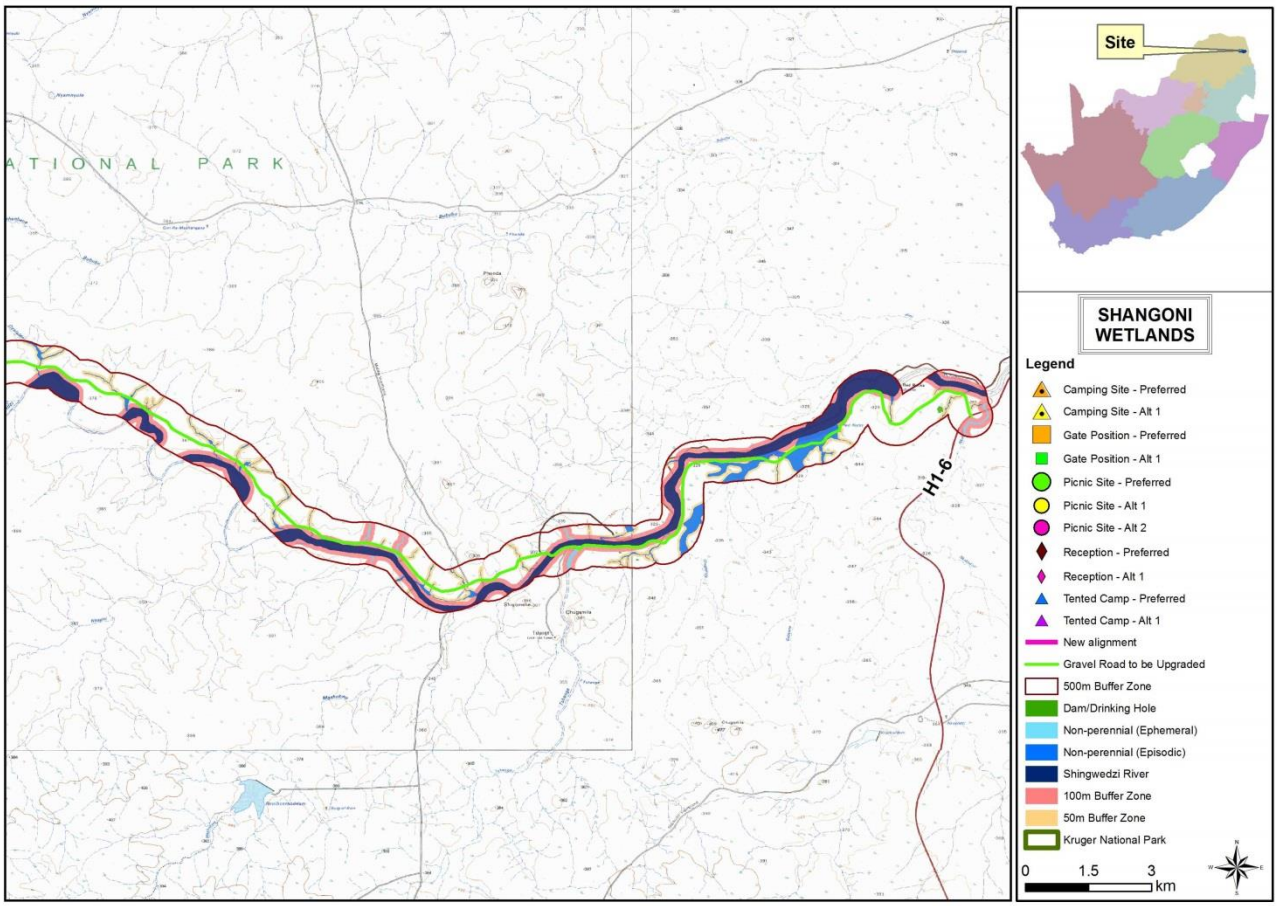

Figure 3: Wetland areas associated with the proposed development – eastern section.

3.3 Wetland Integrity and Function

The biggest current impact associated with the study area and the river in this sub-catchment (DWAF, 2004b), is phosphates from diffuse sources including agricultural run-off and domestic waste-water from the informal settlements. Furthermore, several abandoned mines are located in the catchment some of which have dysfunctional slimes dams that are severely degraded and the run-off could potentially enter the river systems during rain fall events (Fouché & Vlok, 2012)

Although the Kruger National Park was established in 1926 and is therefore not greatly impacted by anthropogenic activities, the presence of some artificial dams such as the Kannidood Dam near the Shingwedzi Rest Camp and the Sirheni Dam near the Sirheni Rest camp has had an impact on the natural flow regime of the river. The majority of the study area can only be accessed by private ranger roads not accessible to the general public and is therefore less impacted than other main roads within the park. Currently the low water bridges located on the smaller episodic streams is inadequate to allow uninterrupted flow of water and has led to erosion at numerous areas. Cognisance should be taken of the extreme flow fluctuations of the rivers in this catchment resulting in regular flooding often exceeding the flood lines up to 200 m and more. Such floods could have devastating impacts on infrastructure located within the flood range.

Riparian Vegetation Response Assessment Index (VEGRAI and the Quick Habitat Integrity (QHI) assessment was done do determine the Ecological Category (EC) on sections of the Shingwedzi River and random smaller episodic rivers (Table 3- 5).

Table 3: Results Ecosystem Services provided by the Shingwedzi and other ephemeral rivers of the study area (Kleynhans *et al*, 2008).

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	80.0	22.9	2.5	2.0	40.0
NON MARGINAL	85.7	61.2	2.5	1.0	100.0
	2.0				140.0
LEVEL 3 VEGRAI (%)				84.1	
VEGRAI EC				**B**	
AVERAGE CONFIDENCE				2.5	

Table 4: Results Ecosystem Services provided by the episodic rivers of the study area (Kleynhans *et al*, 2008).

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	80.0	22.9	2.5	2.0	40.0
NON MARGINAL	80.0	57.1	2.5	1.0	100.0
	2.0				140.0
LEVEL 3 VEGRAI (%)				80.0	
VEGRAI EC				**B/C**	
AVERAGE CONFIDENCE				2.5	

Table 5: QHI for the non-perennial and drainage areas on the study site (Seaman *et al*, 2010).

QUATERNARY CATCHMENT	RIVER	Bed modification (0-5)	Flow modification (0-5)	Inundation (0-5)	Riparian/Bank condition (0-5)	Water quality modification (0-5)	DESKTOP HABITAT INTEGRITY	INSTREAM EC%	INSTREAM EC	Vegetation Rating (0-5)	ECOSTATUS %	ECOSTATUS EC	CONFIDENCE (1-5)
B90F	& Shingwedzi Ephemeral	1	1	1	1	2	**82.0**	**82.0**	**B/C**	1	**83.0**	**B**	**3:MODERATE**
B90 G	Episodic Rivers	2	3	1	1	1	**75.0**	**75.0**	**C**	1	**78.3**	**B/C**	**3:MODERATE**

4 EXPECTED IMPACTS

The following relevant potential impacts are listed in the Shangoni Gate Pre-feasibility Study (2013).

For the bridge:

- Creation or exacerbation of water turbulence causing bank or channel scouring and erosion.
- Impedance of water velocity and debris causing backup and flooding.
- Ecological disturbance to aquatic and bank biodiversity.

For the visitor centre:

- The substrate is susceptible to erosion.
- Solid waste will accumulate and will need to be managed.

For the Tented camp and camping area:

- The habitat is critically endangered and susceptible to damage during construction and by visitors when occupied.
- The substrate is highly friable and susceptible to erosion.
- Sewage treatment will need to be managed to avoid contamination of the river system.
- Solid waste will accumulate and will need to be managed.

For the Picnic sites:

- The habitat is critically endangered and susceptible to damage particularly by picnickers.
- The substrate is highly friable and susceptible to erosion.
- Sewage treatment will need to be managed to avoid contamination of the river system.
- Solid waste will accumulate and will need to be managed.

For the road upgrade:

- Borrow pits for road construction materials would damage the landscape of the Park.
- Large areas of indigenous vegetation would be removed or damaged along the verges of the road.
- Storm water runoff from the impervious surface would need to be managed.

The flowing mitigation measures are recommended in the Shangoni Gate Pre-feasibility Study (2013)

For the Bridge:

- Mitigation of the possible impacts will require engineering design in collaboration with river basin hydrologists and ecologists. In particular, the hydrological disturbance around anchor points in the river basin will need to be avoided.

For the visitor centre:

- Water-wise plumbing and landscaping.
- Aesthetic architectural design to accommodate visual impacts.
- The design of systems for the control of storm water runoff from hard surfaces (paving and roofs).
- Solid waste will need to be stored in a container out of sight and protected from scavengers. Waste should be removed from the site to a central facility or an approved municipal dump on a routine basis, e.g. once a week.

For the Tented camp and camping area:

- Careful siting of tents to minimise disturbance to trees.
- Construction of boardwalks for all pedestrian traffic.
- Good information and control of behaviour by contractors and visitors.
- Water-wise plumbing, sewage treatment and landscaping.
- Aesthetic architectural design to accommodate visual impacts.
- Solid waste will need to be stored in a container out of sight and protected from scavengers. Waste should be removed from the site to a central facility or an approved municipal dump on a routine basis, e.g. once a week.

For the picnic site:

- Careful siting of picnic sites to minimise disturbance to riparian habitat.
- Construction of boardwalks for all pedestrian traffic.
- Good information and control of visitor behaviour, especially with regard to wild animals.
- Water-wise plumbing, sewage treatment and landscaping.

- Solid waste will need to be stored in a container out of sight and protected from scavengers. Waste should be removed from the site to a central facility or an approved municipal dump on a routine basis, e.g. once a week.

For the road upgrade:

- Only the minimum amount of vegetation should be removed to allow for the road alignment. Construction vehicles and machinery should not be driven outside of the road alignment footprint.
- Culverts and drainage systems must be constructed to specification standards that avoid concentrations of flow energy and erosion of drainage line banks. Protective gabions or other structured should be used to prevent turbulence and undercutting.

The flowing recommendation is recommended (Shangoni Gate Pre-feasibility Study, 2013)

- Lodges and other permanent structures should not be constructed on or near the river banks. Development should be confined to tented camps on timber platforms with inter-leading boardwalks
- Cognizance should be taken of recent flood impacts – not merely the flood levels but also silt deposits, scouring, vegetation damage, etc.
- Trails and other public access along the banks should be on boardwalks.
- Bridges should be designed in consultation with specialist river basin hydrologists.
- The development of the gate could be used to initiate opportunities for community education on water and river use.

The impacts relevant to the proposed activities are likely to include:

- Changing the quantity and fluctuation properties of the watercourse by for example restricting water flow. The sources of these impacts include the compaction of soil, the removal of vegetation, surface water redirection and construction of infrastructure.
- Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount). Construction and operational activities will result in earthworks and soil disturbance as well as the removal of natural vegetation. This could result in the loss of topsoil, sedimentation of the wetland and increase the turbidity of the water.
- The moving of soil and vegetation resulting in opportunistic invasions after disturbance and the introduction of seed in building materials and on vehicles. Invasions of alien plants can impact on hydrology, by reducing the quantity of water entering a watercourse, and outcompete natural vegetation, decreasing the natural biodiversity.
- Loss and disturbance of wetland/riparian habitat and fringe vegetation due to direct development on the watercourse as well as changes in management, fire regime and habitat fragmentation.
- Construction and operational activities may result in the discharge of solvents and other industrial chemicals, leakage of fuel/oil from vehicles and the disposal of sewage resulting in the loss of sensitive biota in the wetlands/rivers and a reduction in watercourse function as well as human and animal waste. Could possibly impact on groundwater.

5 MITIGATION PLAN:

On site mitigation can limit the impact of construction activities and reduce the need for expensive rehabilitation and the need for 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 6 lists the mitigation measures that should be implemented during the planning and construction phase in order to limit the need for rehabilitation.

Table 6: Mitigation plan

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Pre-construction planning	Bridge and culvert design	• Confirm the presence of dispersive soils and ensure appropriate design of structures • Care should be taken at the design phase that bridges allow for unrestricted water flow, also during flooding and effective anchor points in the river basin banks • Ecologically friendly erosion control structures should form part of the design phase • Ensure that culverts are sufficient in number and width to allow for energy dissipation and not concentrate water flow into the watercourse
	Design of the camp, picnic and reception sites	• Design an environmentally friendly stormwater system that does not contribute to increased high energy surface water flow by considering (Armitage *et al,* 2013): o Permeable paving in parking areas and driveways o Infiltration – the soaking of stormwater runoff into the ground thereby physically reducing the volume of stormwater runoff on the surface. o Detention – the slowing down of stormwater runoff before subsequent transfer downstream; o Conveyance – the transfer of stormwater runoff from one location to another; o Long-term storage – the volumetric control of stormwater runoff in a specified infiltrating area that will drain very slowly; o Extended attenuation storage – the retention of stormwater runoff to protect receiving watercourses in the event of flooding if long-term storage and additional infiltration are not feasible on site. • Ensure a design of structures that blends in with the environment to mitigate the visual impact • Camp layouts should accommodate potential seasonal flooding
	Limit the footprint of access roads and constructing camps and borrow pits, thereby reducing compaction and destruction of natural	• 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

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
	vegetation	• Avoid linear disturbances that run parallel to a watercourse • Plan access roads in such a way as to minimise impact on watercourses • 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 • Planning of construction site and borrow pits must include eventual rehabilitation / restoration of indigenous vegetative cover
	Limit the footprint of construction thereby reducing compaction and destruction of natural vegetation	• Construction within the riparian zone and buffers must be planned to take place in the drier winter months • Plan construction activities to have the smallest possible footprint • No stockpile areas should be located within riparian boundaries, or within the associated buffer zone. • No vehicles and access of persons should be allowed through any wetland, except where approved by the relevant authority
Construction phases **Construction phases**	Limit the construction footprint and related impacts	• Only use access roads as designated during the planning phase • Only cross watercourses at designated points • Crossings to be undertaken with only one vehicle that have the minimum footprint as decided on during planning • Limit the removal of indigenous vegetation around the construction footprint • Limit compaction by not working in wet conditions and limiting vehicular access • 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) • Watercourse boundaries and buffers must be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete • Only necessary traffic should be allowed within these demarcated areas • Limit clearing of vegetation between servitude and construction camps • Contractors should refrain from impacting areas beyond the demarcated construction area • Minimise disturbance and loss of soil • No materials are allowed to be stored in riparian habitat or buffer areas • The contractor must avoid traffic or storing of equipment and material in vegetated areas that will not be cleared

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Construction phases	Prevention of pollution	• Contractors responsible for installing structures in close vicinity to riparian habitat must sign a declaration stating that they will adhere to all stipulations of the Environmental Management Plan relating to river / stream crossings as well as measures as set out by this report • 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, also including tar and other material required for surfacing the black-top road • Cement should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area, in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase • 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, paint, herbicide and insecticides 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 and corrective action taken • 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 wetland/riparian area or its associated buffer zone • Remove all construction equipment and material on completion of construction • No water should be abstracted from any river / wetland

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
		• Run-off from the camp site must not discharge into neighbours' properties or into adjacent wetlands, rivers or streams • Management of on-site water use and prevent stormwater or contaminated water directly entering the watercourse • Management of point discharges
	Prevent/limit sedimentation	• Contractors responsible for constructing conduits in close vicinity to wetland areas along the route must sign a declaration stating that they will adhere to all stipulations of the Environmental Management Plan relating to wetland / stream crossings as well as measures as set out by this report • 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 • Storm water shall be allowed to soak into the land and natural attenuation areas. Special care must be given to ensure velocity is slowed before reaching the attenuation area • 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 • Sediment barriers should be installed immediately after initial disturbance of the watercourse or adjacent upland • Where wetlands 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 • It is important that topsoil should be conserved in areas where bedrock is shallow to avoid sedimentation • Run-off from the camp site must not discharge into neighbours' properties or into adjacent rivers or streams.
	Preventing spread of alien invasive plants	• Construction equipment must be cleaned prior to site access. This will prevent alien invasive seed from other sites to spread into disturbed soils • Alien invasive species that were identified within servitudes should be removed prior to construction related soil disturbances. This will prevent seed spreading into disturbed soils • Manual removal methods are preferred to chemical control • Landscaping should be limited to the use of endemic or

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
		indigenous species appropriate to the vegetation of the surrounds

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 watercourses from for example a management category D to a C (Kleynhans, 1996 & Kleynhans, 1999). In order to improve the management category, the current impacts due to urbanisation and other anthropogenic impacts should be address and these fall outside the scope of this document.

This rehabilitation plan recognises two phases of rehabilitation:

- Phase 1: Construction of infrastructure, watercourse crossings and road upgrade; and
- Phase 2: Operation, in particular where release of stormwater causes erosion, pollution or degradation of any sort as identified during the monitoring phase described below

Table 7 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 7: Rehabilitation plan

Impacts	Rehabilitation	Time frame
Destruction of vegetation Areas where vegetation will be impacted include the area directly impacted on by camp, picnic and reception sites, the road reserve for the section of the road to be upgraded and the construction footprint around the proposed bridges.	• Access roads must be restricted in riparian areas and buffers. Only use access as designated during the planning phase • Disturb as little of the vegetation as possible. Where vegetation needs to be removed, remove in such a way so that plants can be replanted as part of the rehabilitation of disturbed areas • Temporary measures should be taken to prevent topsoil from washing away during rainfall • Where structures are installed in areas that slope towards the river or drainage lines, the slopes must be re-vegetated by either using removed vegetation 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 the initial disturbance to reduce the potential of erosion or invasion of the disturbed soils by alien invasive plant species	• Immediately after construction • As and when monitoring indicate degradation of vegetation or failure of the rehabilitation
Removal of vegetation Areas where vegetation will be impacted include the area directly impacted on by the construction of the camp, picnic and reception sites, 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.	• Stripping of vegetation for construction must occur in a phased manner and must be restricted to the building footprint to reduce the risk of erosion during times of precipitation • Where possible, remove vegetation as sods that can be replanted as part of the rehabilitation of vegetation around the construction footprint. Store sods in already cleared areas or degraded 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 around 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 • Ripping shall be done to a depth of 250mm in two directions at right angles.	• Immediately after construction • At any time during the operational phase of the stormwater infrastructure, culverts or bridges, or when maintenance activities might have destroyed natural vegetation • As and when monitoring indicate degradation of vegetation along the servitude

Impacts	Rehabilitation	Time frame
	• 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 • Areas where minimal disturbances took place, can be ripped and allowed to naturally re-vegetate (take note that this excludes sloped areas). Re-vegetation must be monitored to ensure that alien invasive plant species do not colonise the disturbed areas • If natural re-vegetation is unsuccessful, corrective action should be taken and includes seeding and planting by an appropriate specialist as stipulated in the EMP • All rehabilitated areas must be monitored for the presence of exotic and alien plant species. • Should the presence of exotic/alien plant species be observed it should be removed appropriately • 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 • Ideally, the rehabilitated conduit footprints, especially on slopes and along riparian and wetland areas, must be fenced to prevent pedestrian and livestock access. Once rehabilitation was observed to be successful during monitoring, the fenced may be removed (at least two years) • In areas where the topsoil is shallow with underlying bedrock, it is important to ensure that erosion is kept to a minimum by encouraging rapid vegetation growth and/or to use structures approved by an engineer to all the sediment on site	
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	• The contractor shall be responsible for rehabilitating all eroded areas in such a way that the erosion potential is minimised 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	• During and immediately after any construction phase • As and when monitoring indicate erosion is taking place during the operation al phase of the

Impacts	Rehabilitation	Time frame
slopes by the removal of vegetation may result in slope instability and erosion by rain and surface run-off. Erosion is furthermore a risk in the input of high energy stormwater into the river and drainage lines	• Disturbed areas that require rehabilitation should be mulched to encourage vegetation re-growth. • Stockpiled soil should be protected from erosion due to water runoff • 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: o Retaining walls (loffel or otherwise) (DWAF 2005) o Stone pitching. o Gabions. o Shotcrete. • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within work areas • Where access cannot be avoided into sensitive areas, the amount of vehicle and personnel traffic should be kept to a minimum and should make use of only one route • Where crossings of watercourses are unavoidable eco-friendly soft options (such as wooden poles) should be placed over the wet area to be driven over • 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.	infrastructure
Soil Compaction Soil compaction is likely to occur on access roads, and temporary work platforms where heavy vehicles and	• Areas where soil has been compacted should be ripped to encourage vegetation growth • Ripping shall be done to a depth of 250 mm in two directions at right angles. • Do not rip and / or scarify areas under wet conditions, as the soil will not break up and compaction	• Immediately after any construction phase • As and when monitoring indicate severe compaction due to

Impacts	Rehabilitation	Time frame
personnel move around. Soil compaction will decrease permeability of the soil, negatively impact the sub-surface flows and compromise vegetation establishment.	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)	maintenance
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 wetlands and their associated functionality.	• In case of emergencies or unforeseen events, the problem must be remediated immediately and any spillage into any watercourses be reported to the Department of Water Affairs. In addition, the soil must be stabilised (import additional topsoil if necessary) and re-vegetated as soon as possible. Re-vegetation should include seeds from the adjacent grassland and any rescued protected plants and/or plants of conservation concern that might have been impacted upon by the emergency / unforeseen event. • Remove all project-related material / support equipment immediately on completion of any of the construction phases	• Immediately after a construction phase • At any time during operational phase of the infrastructure, when maintenance activities might have resulted in pollution
Spread of Alien Invasive Species	• Appointment of alien plant working group / assign this duty to specific staff • Alien invasive species that were identified within the servitudes 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	• During and after construction phases

Impacts	Rehabilitation	Time frame
	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.	
Sedimentation This is particularly a risk where canalization occurs, or where the vegetation layer is disturbed	• Canalization of rivers and drainage lines should be avoided at all cost • Sedimentation should be prevented though sufficient mitigation at the design phase, throughout construction as well as during the operational phase • 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 specialist should be consulted to find a suitable solution for the specific river and its species composition.	• During and after construction • During the operational phase of the infrastructure as recorded as part of the monitoring phase

7 MONITORING PLAN

The monitoring programme should include:

- Establishing a baseline through the taking of photographs of identified environmental aspects and potential impacts on the road, bridge crossings, prior to construction
- Bi-weekly monitoring during first month where after monthly audits will be conducted by the Environmental Control Officer to ensure compliance to the EMP conditions, and where necessary make recommendations for corrective action. These audits can be conducted randomly and do not require prior arrangement with the Project Manager.
- Compilation of an audit report with a rating of compliance with the EMP. The ECO shall keep a photographic record of any damage to areas outside the demarcated site area. The date, time of damage, type of damage and reason for the damage shall be recorded in full to ensure the responsible party is held liable. All claims for compensation emanating from damage should be directed to the ECO for appraisal.
- The Contractor shall be held liable for all unnecessary damage to the environment. A register shall be kept of all complaints from the Landowner or community. All complaints / claims shall be handled immediately to ensure timeous rectification / payment by the responsible part

The above monitoring should also integrate the river monitoring as set out here. 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 constructed conduits have detrimental impacts on the watercourses after construction (Table 8).

Once-off Monitoring:

1. On completion of construction activities, monitoring should be done in order to record compliance with the targets set out in the EMP and to highlight any areas where further action are required in terms of rehabilitation or routine monitoring

Routine Monitoring:

2. Seasonal monitoring: 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 of the conduits and outlets was completed.

3. 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.

4. Annual monitoring: after three years, provided that all rehabilitation where found to be successful and no additional problems arose, 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. If problems arise due to the constructed stormwater infrastructure that was not pre-empted in this plan, an engineer and wetland specialist should be consulted as soon as possible.

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 8: Monitoring plan

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
Integrity of rehabilitation structures where used	• On-site inspection • Fixed point photography.	• After implementation of the infrastructure • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Arresting of erosion/head cut. • Sedimentation behind structure	• Structures should be fixed where possible or new structures should be implemented
Changes to water energy flow downstream from bridges, stormwater outlets and culverts	• On-site inspection • Fixed point photography.	• After implementation of the infrastructure • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Erosion and canalization becomes visible immediately downstream from bridges, stormwater outlets and culverts • Erosion anywhere in the river after implementation of bridges, stormwater outlets and culverts	• Engineers should be approached to reassess the design of bridges, stormwater outlets and conduits • Erosion should be stabilized and monitored • New or amended structures should be implemented

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
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 construction of infrastructure • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Spreading and distribution of dominant plant species in specified wet zones • Wetland 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 • No bare soils	• If natural re-vegetation does not occur replanting of indigenous plants should be done at sites of concern • Prevent livestock or pedestrian traffic from entering rehabilitated areas • If re-vegetation is not successful at the end of 3 years, develop and implement (in consultation with a professional wetland ecologist) a remedial re-vegetation plan to actively re-vegetate the wetland. Continue re-vegetation efforts until wetland re-vegetation is successful • If vegetation 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
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. • If exotic plants have colonised the area the exotic plants should be removed.
Erosion	• On-site inspection • Fixed point photography • Compare to adjacent land	• After construction of infrastructure • Seasonal for the first three years and rapidly after heavy rainfall	• Areas where vegetation cover is limited or nil and where soil has started to erode • Bare soil patches or ditches	• Should erosion occur, soft options such as hay bales, eco-logs and replanting should be considered, if erosion is too great a rehabilitation method should be discussed with an engineer and wetland specialist

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
		• Thereafter annually.		
Sedimentation	• As determined by ECO • Visual observations and site inspections • Fixed point photography	• After construction of infrastructure • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Excess sediment in drainage lines and rivers • Bare soil upslope from riparian areas	• 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 wetland and its plant species composition.
Alien Invasive Plant Species	• Monitor the emergence of alien invasive plant species in or around rehabilitated areas and the servitude in general • On-site inspection • Fixed point photography	• After construction of infrastructure • 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 servitudes as well as rehabilitated footprint 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 the river or drainage lines

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