

Annotated MMP activity table, highlighting activities to be budgeted for in 2020 financial year.

A full ecological report will be produced before 10 December 2019

Comments by Dr Liz Day – based on latest assessment visit of November 2019

Management Measure	Specifications	Timing/frequency	Skills & Expertise	Compliance & Monitoring
MO1: Establish and maintain a more natural hydrological, hydraulic and geomorphological regime				
1. Replace / repair the flow control / diversion structure and bridge apron downstream of Clarence Drive	- Design a like-for-like replacement (in terms of total footprint) of the original structure. The design should be informed by: - A detailed survey of the area downstream of the bridge to a distance of 100m downstream; - The results, if feasible, of a hydraulic and sediment flood model for the wetland, to indicate the efficacy of the proposed design under flood conditions; - Design details to include allowance for release of a proportion (<20%) of low flow water into the eroded channel to encourage wetland plant growth in this area – multiple low-level pipes should be used; - Design and construction to be under supervision of engineer; - Any areas disturbed during construction to be re-	This intervention must be undertaken as a matter of urgency before the onset of the winter rains. It is a once-off intervention.	Design of replacement structure to be prepared by the project engineer with input from a freshwater ecologist. The construction of the replaced structure must be overseen by an Environmental Control Officer (ECO) to ensure that no unnecessary disturbance or contamination of water or wetlands takes place. In the event of any damage to streambanks	ECO to approve Method Statement which must outline appropriate measures to prevent water pollution and reduce physical disturbance to the wetland bed and banks prior to construction taking place. ECO to oversee the construction project and enforce the MMP.

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	instated to a freshwater ecologist's specifications		and wetland features, the proposed repair measures must be determined in consultation with the freshwater ecologist and engineer.	ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: Activity 1 has been completed. No interventions or repairs / maintenance required in the next year unless there is an unforeseen event.				
2. Remove woody alien vegetation from within the 1:100 year floodline of the Dawidskraal system downstream of Clarence Drive	- Remove all large woody material (e.g. tree root bores, tree trunks and large branches) that have washed into the wetland from upstream or which have been burnt by fire and have collapsed into the wetland where it might cause significant deflections of, or blockages to, flow from the wetland and the 1:100 year floodplain - At the onset of implementation of this MMP remove all woody alien vegetation within the 1:100 year floodline downstream of the Clarence Drive bridge; - Approved alien clearing approaches suitable to the species of concern must be used – where herbicides are required, these must be suitable for use in proximity to watercourses; - Alien clearing activities should be carried out using handheld tools (e.g. chain saws etc) and should not be carried out using excavators which will disturb wetland and channel geomorphology and impact on non-target plants;	Initial clearing activities to be confined to the dry season (when access through the wetland is least likely to result in disturbance) and outside of bird nesting or faunal breeding seasons – clearing should thus take place during late summer / autumn – mid January to end of March only. Ongoing (low intensity) maintenance clearing to take place on the basis of quarterly site inspections, with clearing efforts still concentrated in the dry	Personnel involved in alien plant clearing activities should be familiarized with the appearance of target species prior to the start of any clearing, to prevent accidental removal of non-target or desirable indigenous species.	Municipality / SANBI to keep a record of alien vegetation clearing and make available to ECO upon request. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).

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	- All seedlings and saplings of invasive alien plants must be cleared on an ongoing basis; - Where woody vegetation occurs in in-channel bars, the root stumps themselves should be removed as well as surface material, to facilitate destabilisation of accumulated sediment – removal of root masses should also take place using manual labour rather than in-channel machines; - Provision must be made prior to the start of alien clearing activities for the benign disposal of cleared alien material, outside of any wetland, floodplain or conservation areas.	season (January to March).		
November 2019 Comment: Activity 2 has not been satisfactorily completed or maintained. There is some alien invasion into the wetland and its margins				
3. Define zones in which clearing of vegetation and/or sediment can take place	- Use flow monitoring data to refine ongoing management activities in the area downstream of Clarence Drive; - Definition of each zone prior to each clearing intervention should take place on site and with reference to achieving but not exceeding flow conditions as they were in the 1950s and thereafter until blockages contributed to the flow changes that occurred during the 2005 floods; - The vertical, longitudinal and lateral extent of clearing must be agreed upon before any clearing activity is undertaken, and should be marked on a baseplan of the area, for future reference;	Timing: late summer/ autumn – mid January to end of March only. This activity must take place <u>prior to any implementation of the activities that follow.</u> Prior to the start of any clearing activities, and timed so as to allow adequate time for the sourcing of machinery or labour as required, and	Should be informed initially by input from the project engineer, based on survey information, an understanding of floodwater flows and with due consideration of the management objectives of this MMP and the historical condition of the river in these reaches.	Base Plan of defined zones for clearing to be prepared prior to each clearing event and submitted to the ECO for prior approval. ECO to oversee the clearing construction project

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	- Areas suitable for the disposal of cleared sediment and vegetation must be agreed upon prior to the start of clearing activities – these should be such that they do not result in degradation of any aquatic ecosystem or terrestrial system of conservation importance; <u>This MMP allows for clearing of vegetation and sediment to a maximum distance of 50m downstream of the Clarence Drive bridge</u> and in the eastern section of the channel, on a carefully selected and highly controlled basis only, for a maximum distance of an additional 50m downstream of the bridge.	the identification of sites for dumping of waste.	Definition of zones prior to each clearing intervention should take place on site, with input from a freshwater ecologist. Note that the aim would not be to clear the second (downstream) 50m of the eastern channel, but simply to address discrete areas within this channel, selected at the discretion of the wetland ecologist, where accumulated material might constrict flows or prevent the planned passage of flows into this part of the wetland. Freshwater ecologist / ECO to indicate areas for disposal / temporary stockpiling of removed sediment.	and enforce the MMP. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: Activity 3 was satisfactorily completed in 2017/2018 and there is no need for maintenance over the next half year.				

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4. Remove invasive indigenous vegetation from specified sections of the channel and wetlands downstream of the Clarence Drive road bridge, to allow for the spread of low and high flows into both the eastern and western sections of the wetland, as per the situation prior to the 2005 floods	• Use a small excavator to initially (i.e. <u>in the first year of implementation of the MMP only</u>) remove Palmiet vegetation (and associated sediment), provided that: - the machine can access the wetland from Clarence Drive (possibly down the alien-invaded remnant end of Dawidskraal Road) and would not pass laterally across less disturbed wetlands and channels to access the working area; - all excavated material removed during machine operations is removed from the channel, wetlands and floodplain, via the machine entrance / access point; - clearing operations commence at the downstream extent of the demarcated portion of the area to be excavated, and move upstream, bringing excavated material upstream for suitable disposal; - at all times, operations should aim to minimise the required extent of clearing, and rather allow for repeated (e.g. annual) clearing of smaller volumes. • Ongoing clearing of Palmiet to be undertaken by manual labour using hand-held tools only, to limit disturbance of the rehabilitated channel and bed; • Removal of other invasive indigenous plants may at times be necessary (e.g. <i>Psoralea pinnata</i>; <i>Cliffortia strobilifera</i>) – such plants should only be removed if approved as part of the pre-clearing plan	Timing: late summer/ autumn – mid January to end of March only. Activities to be delayed in the event that it is raining, if rain is forecast for the next week or if it has rained within the past three days.	A freshwater ecologist must provide input at the start of clearing activities to ensure that management objectives are being met. A botanist should be consulted for a list of suitable species if damage occurs during plant clearing.	ECO to approve Method Statement for excavator access to wetland. All work carried out with an excavator must be supervised by the ECO. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).

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	(Management Measure 2 above); In the event that any areas are accidentally disturbed as a result of indigenous plant clearing activities, these must be rehabilitated, with rehabilitation usually involving a combination of ripping, reshaping and/or planting of indigenous plant material. Selection of plants should be based on the indigenous wetland and associated plant species in the affected area.			
November 2019 Comment: Activity 4 was satisfactorily completed in 2017/2018 and there is no need for maintenance over the next half year.				
5. Remove sediment including rocks where these accumulate in the channels and/or wetlands such that they threaten maintenance of the wetland as required	- Initial (Year 1) clearing of identified bars and accumulated sediment should be as outlined for Palmiet clearing in the initial phase (see Management Measure 4 above). - Thereafter, routine sediment clearing (no further than 50m downstream of the foot of the bridge) should take place using manual labour with hand-held tools only, to limit disturbance of the rehabilitated channel and bed; - In the event that any areas are accidentally disturbed as a result of sediment clearing activities, these must be rehabilitated, with rehabilitation usually involving a combination of ripping, reshaping and/or planting of indigenous plant material; - Maintain the pipes under / through the flow control structure (Activity 1) clear of sediment throughout the year by flushing or other means; - Cleared sediment must be disposed of as per pre-	Timing: late summer/ autumn – mid January to end of March only. Activities to be delayed in the event that it is raining, if rain is forecast for the next week or if it has rained within the past three days. The pipes under / through the flow control structure (Activity 1) should be cleared on a regular basis and inspected at least twice annually for this purpose.	Mechanical removal of significant deposits of sediment or debris to take place under the supervision of a wetland ecologist and in accordance with an approved method statement for this activity.	ECO to approve Method Statement for the mechanical removal of significant deposits of sediment or debris (e.g. after floods). ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).

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	agreed disposal sites (Management Measure 2).	The frequency of these activities should be annually to every second year, depending on rate of plant regrowth.		
November 2019 Comment: Activity 5 was satisfactorily completed in 2017/2018 and there is no need for maintenance over the next half year.				
6. Removal of alien and inappropriate senescent or terrestrial vegetation and maintenance thereof from the Dawidskraal system <u>upstream</u> of Clarence Drive	- Vegetation clearing to be informed by detailed survey of this reach – a conservative approach to vegetation clearing is stipulated; - At the onset of the implementation of this MMP remove all alien vegetation as well as dead tree trunks and large loose branches within the lowflow microchannel and on the macro channel banks of the river upstream of the Clarence Drive bridge; - Approved alien clearing approaches suitable to the species of concern must be used – where herbicides are required, these must be suitable for use in proximity to watercourses – ideally, herbicides should not be used; - Alien clearing activities should be carried out using handheld tools (e.g. chain saws etc.) and should not be carried out using excavators which will disturb wetland and channel geomorphology and impact on non-target plants; - Where invasive alien woody vegetation occurs in in-channel bars, the root stumps themselves should be removed as well as surface material, to facilitate destabilisation of accumulated sediment –	Initial clearing activities to be confined to the dry season – clearing should thus take place during late summer/ autumn – mid January to end of March only. Ongoing (low intensity) maintenance clearing to take place on the basis of quarterly site inspections, with clearing efforts still concentrated in the dry season (January to March). All seedlings and saplings of invasive alien plants must be cleared on an ongoing basis.	Personnel involved in alien plant clearing activities should be familiarized with the appearance of target species prior to the start of any clearing, to prevent accidental removal of non-target or desirable indigenous species.	Records of alien clearing operations to be kept by SANBI / Landowners / Municipality and made available to the ECO upon request. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).

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	removal of root masses should also take place using manual labour rather than in-channel machines; - Where terrestrial indigenous species have invaded into the channel and are affecting wetland flows or condition, these should be removed, taking care to minimise disturbance to Palmiet and other wetland vegetation; - Where senescent trees or large shrubs (e.g. <i>Psoralea pinnata</i>) are present in the channel, these may be removed by cutting at the base of the stem and clearing from the channel; - Provision must be made prior to the start of alien clearing activities for the benign disposal of cleared alien material, outside of any wetland, floodplain or conservation areas.			
November 2019 Comment: Activity 6 has not been satisfactorily completed or maintained. There is extensive alien invasion into the wetland as well as along the disturbed edge of the flood protection gabion wall. Invasion by Keurboom is also occurring and must be addressed. This must be initiated as a matter of urgency				
7. Periodic removal of vegetation and /or sediment from the river reaches between the upstream end of the planned berm and the Clarence Drive Bridge	- Determine zone for removal of vegetation and/or sediment based on a detailed survey of this section of the system, showing the location of rocky sills that will act as natural energy beaks and prevent headcut erosion. - Remove all plants and loose sediment from a zone extending to a maximum of 20m upstream from the start of the planned berm to Clarence Drive Bridge;	Timing: late summer/ autumn – mid January to end of March only and at frequencies no shorter than three yearly.	Wetland ecologist and the engineer to determine zone for removal of vegetation and/or sediment. Personnel involved in alien plant clearing activities should be	Records of alien clearing operations to be kept by SANBI / Landowners / Municipality and made available upon request.

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	- The most easily maintainable approach would be to allow for a thorough, low, dry season brushcut of the vegetation in this area, and the maintenance thereof such that plants in this 20m zone do not reach heights >0.5m, but their roots remain in situ. - Where sills are not considered adequate to deal with risk of upstream headcut, a low concrete or gabion sill may be constructed to control bed slope and prevent channel incision and upstream headcuts. The need for this must be decided on during detailed design phase and with engineering and ecological input – it should also be informed by survey data and ideally by the outputs of a sediment and hydraulic model for the system, as suggested for Activity 1 (see M01).		familiarized with the appearance of target species prior to the start of any clearing, to prevent accidental removal of non-target or desirable indigenous species.	All silt removal operations to be overseen by ECO who must enforce compliance with the MMP. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: Activity 7 has not been carried out. Clearing of open channels to spread flow through the wetland must be initiated as a matter of urgency. This will require on-site input from the wetland ecologist to indicate such areas				
8. Maintenance of open pipe culverts along Otter Close	- Remove sediment threatening to block the pipes upstream or downstream of Otter Close; - Remove the sediment to the level of the pipe invert, and no deeper, in a zone no greater than 3m measured from the top of the road; - Palmiet may similarly be kept away from the pipes – Palmiet may not be removed by excavation of its roots, but surface material may be cut from this same zone, at the level of the pipe invert but no deeper - All woody alien vegetation within the wetland	Initial clearing activities to be confined to the dry season (when access through the wetland is least likely to result in disturbance) and outside of bird or faunal nesting periods – clearing should take place during late summer/ autumn – mid	Personnel involved in alien plant clearing activities should be familiarized with the appearance of target species prior to the start of any clearing, to prevent accidental removal of non-target or desirable indigenous species.	Records of alien clearing operations to be kept by SANBI / Landowners / Municipality and made available upon request. All silt removal operations to be

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	downstream of Clarence Drive must be removed on an ongoing basis; - Approved alien clearing approaches suitable to the species of concern must be used – where herbicides are required, these must be suitable for use in proximity to watercourses; - Alien clearing activities should be carried out using handheld tools (e.g. chain saws etc.) and should not be carried out using excavators which will disturb wetland and channel geomorphology and impact on non-target plants; - All seedlings and saplings of invasive alien plants must be cleared on an ongoing basis; - Provision must be made prior to the start of sediment / plant clearing activities for the benign disposal of cleared alien material, outside of any wetland, floodplain or conservation areas	January to end of March only. The pipes should be inspected thereafter on at least an annual basis at the end of the wet season, and provision made for maintenance interventions when required.		overseen by ECO who must enforce compliance with the MMP. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: Activity 8 has not been carried out. The culverts must be unblocked				
9. Use rock fill to address erosion nick-points in the wetlands and channels downstream of the Clarence Drive bridge	- Establish the need for this intervention; - Rock material must be selected in accordance with sizes calculated by the project engineers, taking cognisance of expected flow volumes and velocities; - River rock only should be used; - Sand / gravel associated with excavated rock may be used along with river rock only where downstream impacts of sediment deposition or turbidity are considered of low impact – such areas	Activities to be carried out when required only – the wetlands and channel should be assessed on an annual basis at least and ideally after major flood events, to identify the need for this intervention.	The need for this intervention must be confirmed by both an engineer and a wetland ecologist. Both the project engineer and a wetland ecologist should have input on a case-by-case basis into	All fill operations to be overseen by ECO who must enforce compliance with the MMP. ECO to report on compliance with MMP in ECO Audit

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	include the eroded Dawidskraal Road channel; - River rock should not be sourced from within the Dawidskraal river and wetlands, other than initially, when such rock may be generated through the removal of long-term accumulated rock and sediment in the area downstream of the Clarence Drive bridge; - Place the rock in accordance with the specifications of the project engineer and wetland ecologist; - Any disturbance cause by the placement of rock should be rectified with immediate effect, and allowing for bank reshaping and planting where necessary; - The placement of rock material should be done using manual labour and without permitting construction vehicles access to the affected areas.		the placement of rock material.	Report (see Section 3.2).
November 2019 Comment: There is no current need for Activity 9				
MO2: Prevent and address erosion that threatens river or wetland habitat quality, or other areas of biodiversity importance				
1. Implement proposed gabion armour protection for the eroding dune downstream of Otter Close	- Prepare detailed design for the proposed armour protection, taking into account the mitigation recommendations outlined in the specialist report (see Supplementary Specialist Report - see Section 5.7); - Install gabion protection as per detailed design; - Prepare and submit a Method Statement indicating the method of gabion installation to the ECO for	Ideally, unless active erosion threatens aquatic ecosystem stability and/or infrastructure, these activities should take place in the dry season only, in late summer (i.e.	Engineer required to prepare detailed designs. Gabion protection should be extended under the guidance of an engineer and with approval from a	Method Statements for gabion construction required. All gabion construction operations to be

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	prior approval; - Locally indigenous appropriate plant species should be established on gabion baskets, with priority afforded to the establishment of Palmiet on baskets at or near the base flow level; - Extend gabion protection in the event that ongoing erosion in these reaches occurs; - Where erosion / bank collapse threatens or is taking place downstream of Otter Close in addition to the eroding dune area, alternative approaches such as the use of piled riprap against eroded banks downstream of Otter Close could be implemented in terms of this maintenance activity, coupled with bank shaping and planting as appropriate.	between January and end of April). Post-construction maintenance activities should continue through at least one summer after implementation, and until indigenous plants have achieved at least 60% overall cover of the structures – additional planting may be necessary to achieve this end.	freshwater ecologist in the event that ongoing erosion in these reaches occurs. Engineer to approve the sizing, volume and placement of riprap, with input from an aquatic ecologist regarding its shaping and mechanisms to ensure the planting and long-term establishment of indigenous riverine / wetland vegetation on riprap lined banks. A botanist should be consulted for a list of suitable species in addition to Palmiet.	overseen by ECO who must enforce compliance with the MMP. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: There is no current need for Activity 1 Establishment of Palmiet in the river at the eroded bend is recommended				
2. Implement appropriate erosion protection measures at areas where localized bank erosion is identified,	- The river / wetland channels should be inspected on at least an annual basis at the end of the wet season for signs of fresh or imminent bank collapse or undercutting, or headcut erosion; - Determine in consultation with engineer and aquatic ecologist the most appropriate approach (it needs	Ideally, unless active erosion threatens aquatic ecosystem stability and/ or infrastructure, these activities should take place in the dry season	Inspections can be undertaken by the public, SANBI employee or municipal official.	Method Statements for gabion construction required.

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with a focus on prioritising “softer” erosion protection approaches	to be ensured that proposed approaches will not unnecessarily result in channelization, floodplain shrinkage or loss of lateral or longitudinal ecological or hydrological connectivity within the system); • Priority should be afforded to implementation of “softer” erosion protection approaches where feasible, including bank regrading and planting	only, in late summer (i.e. between January and end of April).	Obtain signoff from an engineer and an aquatic ecologist for the preferred erosion repair approach.	All silt removal operations to be overseen by ECO who must enforce compliance with the MMP ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: Establishment of Palmiet in the river at the eroded bend and vicinity of the Otter Close bridge is recommended				
3. Prevent or address erosion of the eastern (left hand) bank of the eroded Dawidskraal Road channel by bank overtopping from surface flows in the western wetland	• Sections of the bank at risk of such impacts should be identified on the basis of survey information; • These and any other vulnerable areas should (ideally) be proactively addressed by the following activities: ○ Trimming of the top 1m of the bank, using manual labour and not machines, to create a stepped upper bank with side slopes 1:5 or less ○ Planting of these selected areas with appropriate locally indigenous plants, selected from the local template and with botanical input – note that appropriate plants would not necessarily be wetland plants, but are in most cases likely to be terrestrial, given the extent of draw-down of	Bank trimming and planting ideally to be carried out in early spring when availability of moisture coupled with the natural growth period of many indigenous plants may allow a high rate of successful plant establishment.	Survey required to identify the areas at risk.	SANBI / Local Authority and Landowners to maintain records of all bank trimming and revegetation operations. Records to be issued to ECO upon request. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).

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	the water table by the eroded channel; ○ Deposition of trimmed sediment in the eroded channel, where it is likely to be colonised by plant material; ○ Provision for short-term weeding / irrigation of planted areas where necessary			
November 2019 Comment: There is no current need for Activity 3 as the banks are stabilising well.				
4. Prevent erosion as a result of fire damage to bank soil structure along the drained and disturbed banks of the eroded Dawidskraal Road	• Woody and otherwise senescent vegetation should be removed from the upper banks and river margins of the eroded channel on an ongoing basis, to limit fuel loads and thus prevent the likelihood of intense fires resulting in damage to soil structure and resultant increased vulnerability to erosion; • Brush-cutting of the river margins (up to 20m on either side, measured from the top of the river bank), determined on the basis of fuel load and not from the perspective of maintaining visual access, should take place; • Cut plant material must be removed from the river and wetland corridor and disposed of outside of the 1:50 year flood line.	Brush cutting should take place at a frequency that is no more than every two years in late autumn only and well outside of wetland breeding or high flow periods.	To be undertaken by Municipal officials only.	SANBI / Local Authority and Landowners to maintain records of all vegetation removal operations and records to be issued to ECO upon request. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: There is no current need for Activity 4				
MO3: Prevent and address erosion that threatens existing buildings and infrastructure, without impacting negatively on aquatic ecosystem condition, and allow for the replacement of such structures				
1. Address erosion along the Disa Kloof	• Determine the preferred approach in consultation with wetland ecologist, an engineer and a SANBI	Ideally, unless active erosion threatens aquatic	The need for and suitability of approaches	Method Statements for gabion

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Stream as outlined in recommendations for Approach 1c (see MO1)	representative - The preferred approach to rehabilitation would be soft interventions entailing bank reshaping and planting with indigenous riparian species as follows: - Locally indigenous appropriate plant species should be established on gabion baskets and ecologs, with priority afforded to the establishment of Palmiet on at or near the base flow level; - Post-construction maintenance activities should continue through at least one summer after implementation, and until indigenous plants have achieved at least 60% overall cover of the structures – additional planting may be necessary to achieve this end; - If erosion is too severe for the above to be considered effective, then riprap as outlined in Approach 1c (see MO1) may be installed along the bank, provided that it is sized on the basis of recommendations by an experienced engineer, and that its design allows for covering with topsoil and the active establishment by planting and maintenance of appropriate indigenous riparian vegetation; - Any areas of the river bed or bank disturbed during the construction process should be rehabilitated to their pre-disturbance condition or better, with input where necessary from an aquatic ecologist and allowing (where appropriate) for bank shaping	ecosystem stability and/or infrastructure, these activities should take place in the dry season only, in late summer (i.e. between January and end of April).	to addressing active erosion of the riparian area upstream of the weir must be agreed upon upfront by a team including a river / wetland ecologist, an engineer and a SANBI representative	construction required. All gabion construction operations to be overseen by ECO who must enforce compliance with the MMP. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).

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	and/or planting.			
November 2019 Comment: There is no current need for Activity 1				
2. Install and maintain a berm upstream of Clarence Drive. Reduce the frequency of flood damage to built infrastructure in the Harold Porter National Botanical Garden, without compromising wetland integrity both upstream and downstream of Clarence Drive.	- Undertake a detailed topographical survey to inform final berm design; - Design must incorporate the specifications outlined in this MMP or as amended in detailed design stage, assuming no greater level of impact; - Prior to works, identify areas along the channel abutting the berm requiring bank reshaping to address existing erosion; - Ensure that steep-sided river banks are graded and/or shelved / stepped back and planted with deep-rooting indigenous species that will address bank slumping. This must be carried out prior to installation of the proposed berm, and with input from a river ecologist. - Prior to works, mark the berm footprint on site; - Details of design in areas where existing infrastructure limits space to be finalised on site with input from a wetland ecologist; - Layout mitigation measures (as confirmed on-site with wetland ecologist) to be implemented as follows: - The berm must be pulled further away from the top of the channel - a minimum area of 5m between the toe of the berm and the top of the bank must be provided unless existing	Construction must be carried out outside of the wet season, acknowledging that periodic dry season rainfall events do periodically affect this area. Areas where the existing river bank is steep, unvegetated and erosion-prone must be addressed as part of the construction process.	The identification of areas requiring bank reshaping to address existing erosion to be identified by wetland ecologist. Layout mitigation measures to be confirmed on-site with wetland ecologist. Revegetation to be undertaken with input from a river ecologist.	Method Statements for berm construction required. Berm construction to be overseen by ECO who must enforce compliance with the MMP. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).

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	infrastructure or the requirement to tie in to the Clarence Drive bridge preclude this. This means that the berm would be better placed on the garden side of the existing auditorium, than on the river side; - Where existing infrastructure (including the service road through the gardens) precludes the above, the berm must be steepened on its non-riverine side, to reduce its cross-sectional area as much as possible. In such a scenario, stepping or a vertical drop of the non-riverine side should be considered, with exposed gabions potentially used as seating areas or packed with bitem and top soil in the interstitial spaces between rocks, to facilitate the growth of plants in these otherwise ecologically hostile environments; areas where particular. Along the road within the gardens, disguise of an exposed gabion berm would be possible, through directed planting of tall plants along this edge. The implication of the need to expose the gabion in places on its non-riverine side would be a requirement for river rock or other aesthetically acceptable material in the berm; - The side slopes of the berm where the toe lies within 15m of the top of the river bank must be graded to slopes no steeper than 1:3. This will allow the adequate establishment of vegetation on the river side berm. Again, where existing infrastructure or the need to tie the berm into			

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	the Clarence Drive bridge preclude this, the proposed use of geocells is supported, provided that the geocells selected for use on the riverine side of the berm have a minimum open space diameter of 15cm. This will permit indigenous riparian plants to be established along this zone abutting the river; - Locally indigenous vegetation (as per plant species list to be provided by SANBI) must be planted along the river side of the berm, sufficient to ensure 80% cover after one year, and so as to stabilise any areas below the bank that are subject to or vulnerable to erosion. Vegetation within the first 3m from the top of bank must be selected with a view to establishing vegetation with an increased roughness co-efficient that will reduce velocities along the top of the bank during flood conditions and prevent erosion of this sensitive edge; - Areas where the existing river bank is steep, unvegetated and erosion-prone must be addressed as part of the construction process, which must ensure that steep-sided river banks are graded and/or shelved / stepped back and planted with deep-rooting indigenous species that will address bank slumping. This must be carried out prior to installation of the proposed berm, and with input from a river ecologist. - Comply with the following environmental specifications during the construction phase: - Temporary no-go fencing must be erected no			

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	closer than 5m from the top of the river bank, and must be such that windblown fines will be trapped in the meshing - thus plastic danger tape will not suffice as no-go fencing; ○ Stockpiles must be stored no closer than 50m from the top of the river bank, and these areas must be managed such that, although they will generally also lie within the 1:50 year flood line, runoff from these areas would not be into the river unless under extreme events (>1:100-year events) with measures taken to ensure bunding of areas prone to contamination and trapping of runoff likely to contain sediment; ● Long-term (operational phase) maintenance specifications: ○ Annual inspection of the berm and adjacent banks of the river must be undertaken, as well as after major storm events, and erosion addressed as soon as evident, in order to prevent significant degradation of the berm or channel. ○ Intervention measures may include bank reshaping, infilling of the berm with soils; repair and planting of gabions and/or the river bank and margins, to achieve design conditions; ○ Where floods still threaten existing infrastructure by bypassing or overtopping the berm, additional flood control measures must focus on areas outside of the channel and berm corridor, by increasing detention time and	Operational phase maintenance specifications to be implemented following flood or other events that result in erosion or destabilisation of the berm and / or the river bank in the affected area. Inspections for erosion to be undertaken annually as well as after major storm events.		

Management Measure	Specifications	Timing/frequency	Skills & Expertise	Compliance & Monitoring
	surface roughness (e.g. shallow detention areas in car parks and velocity retarding structures along paths). - Removal of in-channel vegetation must be carried out cautiously, and aiming only to remove senescent or alien vegetation, and to maintain a stand of protective indigenous vegetation in the channel. Maintenance measures in the channel upstream of Clarence Drive are thus required to comprise strictly removal of alien vegetation and occasional cutting to above root level of palmiet stands, where senescence occurs. It is recommended that clearing of palmiet vegetation must be minimised in the channel, and roughness maintained as far as practically possible; - Erosion of the berm and top of banks must be addressed as a priority as it occurs, by replanting, berm repair and bank reshaping where necessary; - No further channel lining or encroachment of the berm may take place - alternative approaches to remediating against flood damage to infrastructure must be sought if damage reoccurs.			
November 2019 Comment: Activity 2 was not completed – there has been no effort to plant the wetland side of the berm, which is alien and weed-infested. This MUST be carried out as a matter of urgency				
3. Implement repairs / construction of one of	The Local Authority must decide on the preferred / most feasible structure for implementation as a	Ideally, unless active erosion threatens aquatic	Detailed design for the proposed low level	Detailed design to be signed-off by

Management Measure	Specifications	Timing/frequency	Skills & Expertise	Compliance & Monitoring
the two the proposed low level causeway / drift options	matter of urgency; • Prepare detailed design for the proposed low level structure, taking into account the mitigation recommendations outlined in the specialist report (see Supplementary Specialist Report - see Section 5.9); • Construct the replacement structure in accordance with its final approved design; • Banks that are disturbed during construction should be rehabilitated by shaping and planting with locally indigenous vegetation (palmiet on the lower wetted bank, planted as per specifications in King <i>et al.</i> (2015)); • Ongoing or periodic erosion in the vicinity of this structure should be addressed with engineering input where necessary, and including measures such as: ○ the placement of cobble (not rubble) riprap in the channel downstream of the causeway, if erosion and scour of the river bed or bank occur in this area; ○ bank reshaping and planting if bank collapse occurs as a result of scour; ○ removal of sediment using manual labour or machine activity to remove sediment to an engineer-specified bed height within 20m upstream or downstream of the structure.	ecosystem stability and/or infrastructure, these activities should take place in the dry season only, in late summer (i.e. between January and end of April).	structure to be drawn up by an engineer taking into account the recommendations outlined in the specialist report (see Supplementary Specialist Report). Ongoing or periodic erosion in the vicinity of this structure should be addressed with engineering input where necessary.	freshwater ecologist. The construction of the replacement structure to take place under the supervision of the ECO. ECO to report on compliance with MMP in ECO Audit Report (see Section 3.2).
November 2019 Comment: The crossing has been repaired. However, provision should be made for localised bank shaping (left hand bank too steep) and removal of rubble / waste as well as planting of the disturbed bed,				

