REPORT

The Pongola River Bridge off the District Road D1834 at Mboza, Northern KwaZulu-Natal

Construction Method Statement for Watercourse Crossings

Client:	KZN Department of Transport
Reference:	MD1676
Revision:	01/Final
Date:	19 June 2017

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Enhancing Society Together

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Royal HaskoningDHV

Table of Contents

Table of Tables

Table of Figures

1 Description of Activity

Royal HaskoningDHV have been appointed by the KwaZulu-Natal Department of Transport (KZN DoT) to perform feasibility studies and to investigate, design, and manage the construction for the proposed Pongola Bridge (Bridge No. 3513) at the town of Mboza. The proposed bridge is located between Ward 10 of Jozini Local Municipality and Ward 13 of the uMhlabuyalingana Local Municipality. The purpose of the bridge will be to link the two (2) communities within the uMkanyakude District Municipality, KwaZulu-Natal.

The proposed site (GPS co-ordinates: 27°11'17"S 32°14'20"E) is located on the Pongola River about 3.5 km to the west of the Mboza Clinic off District Road D1834. The nearest bridge to the site and the associated local communities is 12 km south of this proposed crossing point.

It is proposed that the bridge comprises a total deck span of approximately 60 metres (m). Further the approaches (50 m on either side of the bridge) are to be upgraded. The total combined length of the proposed works is 160 m. The width of the proposed bridge will be 6 m in order to accommodate a 3 m wide single lane with two (2) 0.5 m shoulders, and a 1.05 m wide pedestrian sidewalk and two (2) 0.475 m parapet hand railings. The height of the carriageway would be approximately 2 m above the water level.

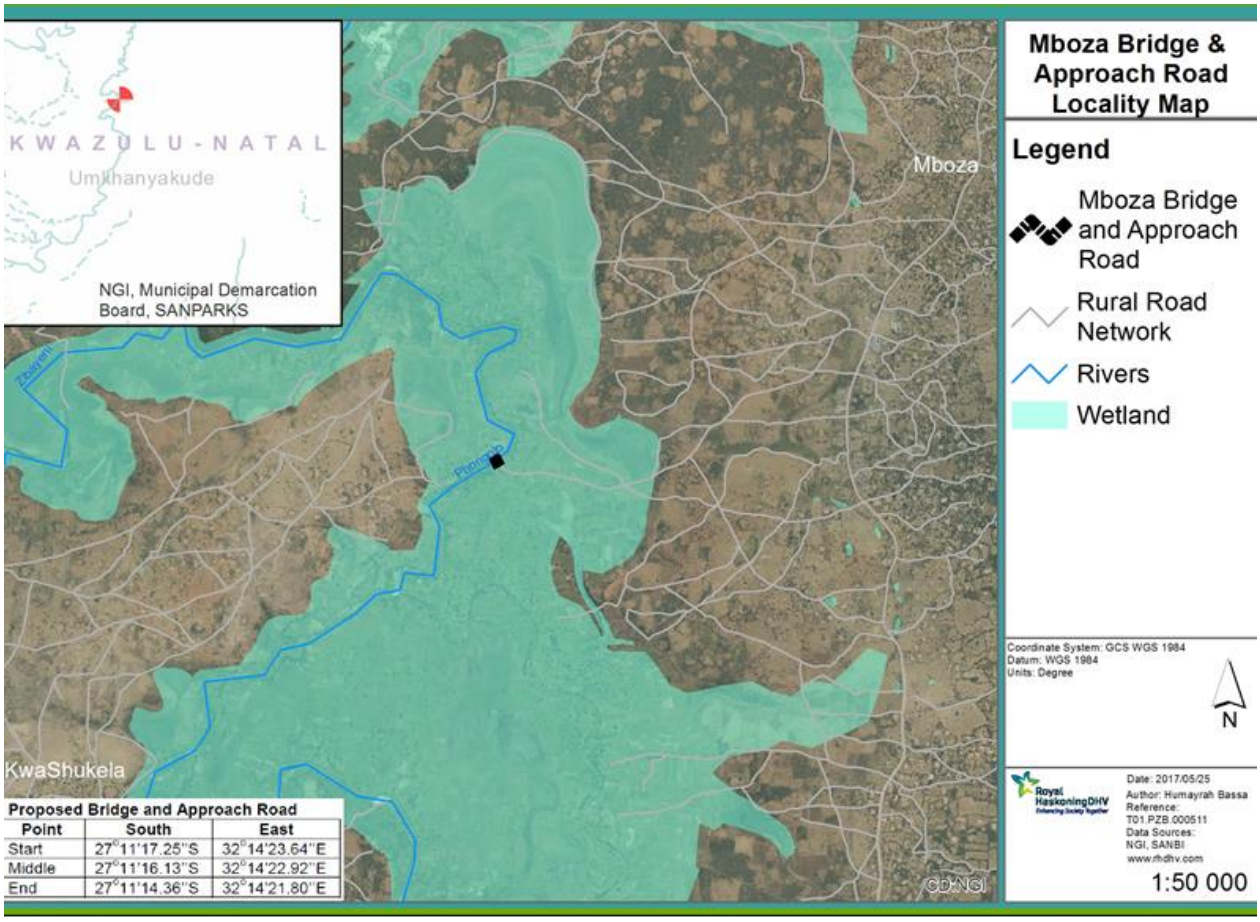


Figure 1-1: Locality of the Proposed Pongola (Mboza) River Bridge

As part of the process to obtain environmental authorisation and a water use licence, *Scientific Aquatic Services CC* were appointed as specialists to undertake an Aquatic and Wetland Ecological Assessment. A single watercourse and wetland crossing was identified and assessed as per the Aquatic and Wetland Ecological Assessment report (S. van Staden and D. Crafford, November 2015).

The purpose of this document is to ensure competent execution of work described herein. This Construction Method Statement (CMS) reflects general requirements according to accepted best practice codes and standards. The Contractor will adhere and observe all the requirements of the Environmental Authorisation and Water Use Licence issued for the proposed project; along with the National Water Act 1998 (Act 36 of 1998) and its regulations as promulgated by the Department of Water and Sanitation (DWS).

This CMS describes the general field work sequence for crossing the Pongola River and floodplain wetland on the proposed project.

Watercourse crossings are typically categorised as follows:

- **Type 1:** Applicable where the road founding layers do not intercept saturated soils, and culverts and or pipes are used to convey surface run-off from the upslope to downslope of the road. Sediment movement along the road verges will be minimised by constructing berms at frequent intervals that distribute water into the adjacent grasslands so as to avoid discharging water onto already saturated wetland soils.
- **Type 2:** Standard culvert designs in channelled valley bottom systems, where if the stream is permanent and contains stretches of open water, the culvert slab will be placed under water.
- **Type 3:** These crossings are those where surface water is managed in the normal way, but the soils are saturated on the surface and the use of sub-surface drains is required to collect water on the upslope and then transfer across the road to discharge on the downslope. Trench breakers will be installed to prevent water in the cut off drains from simply flowing down the drains. Storm-water pipes are installed across the road to ensure the flow of water is uninterrupted. A minimum of 1 m clean dump rock, or greater depending on the ground conditions, is constructed to ensure fill stability and safe movement of water from one side to the other.
- **Type 4**: Where a road crosses wider or larger watercourses, bridge crossings will be constructed to mitigate the effect on the natural drainage system.

This Construction Work Method Statement pertains to a single **Type 4** watercourse crossing and two (2) **Type 3** watercourse crossings (on either side of the river). See Table 1-1 for schedule showing details of these crossings

Table 1-1: Schedule of Crossings

No.	Start Coordinates	End Coordinates	Wetland Type	River Name	Crossing Type
R01	27°11'14.82" S 32°14'22.10" E	27°11'16.52" S 32°14'23.19" E	River	Pongola	Type 4
FW01	27°11'14.82" S 32°14'22.10" E	27°11'14.31" S 32°14'21.78" E	Floodplain Wetland	N/A	Type 3
FW01	27°11'16.52" S 32°14'23.19" E	27°11'17.29" S 32°14'23.68" E	Floodplain Wetland	N/A	Type 3

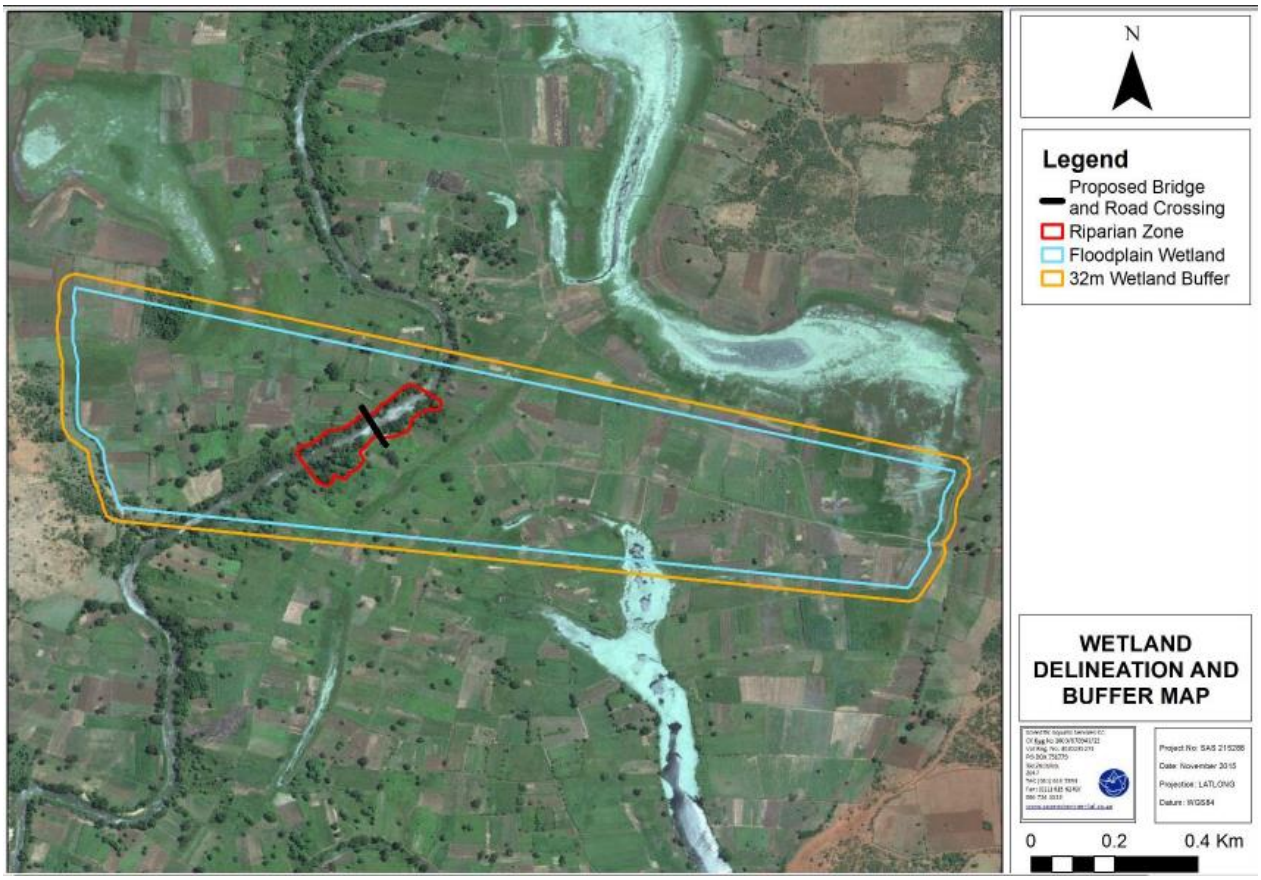


Figure 1-2: Map of Watercourse Crossings

2 Construction Programme

The construction programme is estimated at this stage, depending on the receipt of Environmental Authorisation, a Water Use Licence as well as procurement of a Contractor.

Table 2-1: Estimated Construction Programme

No.	Start Coordinates	End Coordinates	Wetland Type	Start Date	End Date
R01	27°11'14.82" S 32°14'22.10" E	27°11'16.52" S 32°14'23.19" E	River	30/09/2017	31/08/2019
FW01	27°11'14.82" S 32°14'22.10" E	27°11'14.31" S 32°14'21.78" E	Floodplain Wetland	30/09/2017	31/08/2019
FW01	27°11'16.52" S 32°14'23.19" E	27°11'17.29" S 32°14'23.68" E	Floodplain Wetland	30/09/2017	31/08/2019

3 Methodology

The construction methodology adopted for each individual watercourse will be dependent on:

- the season within which construction arrives; and
- the permanent / semi-permanent saturation status of the watercourse.

At this stage, the Contractor proposes that the construction methodologies applied to watercourses will depend on the above factors, and the approaching construction stage. Ultimately, the method to be adopted by the approaching construction stage will be dictated by the saturation status of the wetland (wet or dry), in order to protect and preserve existing hydrological functionality. Some stages of construction e.g. works within the river bed for the purposes of constructing the bridge, will be undertaken according to the season within which construction arrives (at this stage an estimated commencement date of September 2017).

At all times the Contractor will take cognisance of the measures detailed within the Aquatic and Wetland Ecological Assessment report (S. van Staden and D. Crafford, November 2015), the Fauna and Flora Ecological Assessment report (C.L.Cook, December 2015), as well as the Environmental Management Programme (EMPr), and all other relevant documentation.

It has been noted by the Engineer (Royal HaskoningDHV) that some mitigation measures are commonly applied to every wetland, as detailed in the wetland and aquatic assessment study, and as such, become standard to all wetlands regardless of its saturation status.

General guidelines for construction of the water crossings are provided below, following which the sequence to be followed by the Contractor shall be elaborated upon.

3.1 General Guidelines

The Contractor must, where applicable, flume ditches, canals, small streams and drains so as not to interfere with or cause pollution of the water flow and to avoid damage to any banks.

Personnel, equipment and materials must be moved across or around all crossings, which may require the construction of temporary bridges. No ditches, canals, streams or drains may be filled, bridged or otherwise obstructed without written approval of the Project Manager, Environmental Control Officer (ECO) and the relevant Competent Authorities having effective control over such watercourses.

The following principles will be observed:

- The Contractor must ensure that the construction footprint is kept to a minimum in these areas. The construction footprint must be limited to fifty [50] m wide by seventy [70] m in length;
- River/ stream flow will be maintained at all times through fluming or damming/ over-pumping, with sufficient pump capacity available in case of flooding;
- Should water be pumped from the dry working space within any watercourses, this water must be pumped into a retention dam / silt lagoon (or similar structure) to ensure sediment settles and clean water is released back into the watercourse;
- All necessary material for silt and pollution control will be installed at the watercourse crossing, including, but not limited to, silt fences and silt lagoons constructed using suitable geotextile fabric or high density (95%+) shade cloth;
- Should there be any watercourse crossings (as at the Pongola River crossing itself) within the wetland then soil / topsoil stockpiles must be kept away from the banks to avoid silt run-off. Soil / topsoil stockpiles must be appropriately protected using silt fences, sand bag barriers and other methods as required;
- No refuelling or fuel storage will be allowed within fifty (50) m of water bodies or wetland areas;
- Specific oil spill response equipment will be kept on site for intervention. Where required, bunds, grips and other measures will be implemented adjacent to watercourses to prevent silt/ pollutants ingress from the construction spread;
- Wherever possible, and in case work during the dry season cannot be achieved, work in stream channels will be carried out without the use of ‘in-river’ techniques, instead using techniques that divert the flow around the works through flumes or by damming and pumping. This will minimise sediment release;

- If wet cement and / or concrete works are necessary, ready-mix is to be preferred and care will be taken not to spill any product. All priming of hoses for concrete pours must be done away from sensitive areas in a manner that reduces environmental impacts to the bare minimum and can be cleared from site easily, for safe disposal to a recognised local waste landfill site (as provided by the local municipality);
- Full reinstatement of the beds must be undertaken upon completion of the necessary works within any watercourses;
- The pre-construction profile must be restored, and the banks must not be steeper than at pre-construction;
- The pre-construction gradient of the drainage line must be reinstated as exactly as possible, without humping or hollowing over the construction right of way (ROW) so as to limit erosion or replaced material and possible creation of knick-points;
- All surplus, and especially loose, materials must be removed from the watercourse to preserve water quality and avoid sedimentation of downstream riverine habitat;
- Banks must be re-vegetated as soon as construction works are completed. Standard grassing procedures must be used, except in the wetland and except if there is significant risk of fertilizer entering the channel.
- Local indigenous vegetation may be sourced from adjacent areas for the purposes of transplanting onto the construction ROW during the rehabilitation phase, however, the sourcing of transplants must be carefully undertaken under the supervision of a Wetland Specialist.
- Non-project related vehicles or persons will be prohibited from using the Construction ROW.
- Construction personnel must be made aware (through training) and reminded of all project-related environment requirements.

3.2 Preparation Activities (Site Establishment)

The method adopted during the preparation activities, specifically the Construction ROW phase of construction, will depend on the saturation status of the wetland.

Prior to any construction activity, the boundary of each wetland crossed by the proposed bridge and access road/s must be demarcated in the field.

A thirty-two (32) m buffer area must be maintained around each water course that will not be directly impacted on by the development and for which a Water Use Licence (WUL) has not been granted, and will be dependent on site specific conditions, topography and construction requirements.

Within this buffer zone, a setback buffer area must be preserved where vegetation and root systems will remain undisturbed. Topsoil will only be removed from any temporary accesses (where applicable) and within the construction footprint.

The footprint of the construction area will be kept to fifty [50] m wide by seventy [70] m in length. This must be demarcated in the field by a qualified surveyor.

Prior to construction commencing an Ecologist will be appointed and undertake a walk-through of the site in order to identify, relocate or remove protected species under the appropriate permits. This activity will be undertaken in close liaison with the Contractor and the Employers environmental team.

Where the wetland is encountered in a saturated state at the commencement of construction, topsoil stripping width will be minimised. The stripping operation will subsequently allow the installation of a temporary load spreading access, and allow construction operations to proceed with limited damage to the topsoil or underlying soils.

Topsoil stripped from the ROW will be windrowed on the opposite side of the ROW to the storage of subsoil arising from stripping operations (if applicable), and suitably protected from washout and compaction through soil retention curtains and sandbags where necessary; to retain the functionality of the wetlands uppermost stratum.

Planning of crossings will incorporate the location of all environment and pollution prevention devices and equipment. This includes: location of parking and refuelling areas (if any), location of environment equipment storage where appropriate, of spill response equipment, silt control measures, retention dams (silt lagoons), etc.

The establishment of the Contractor's site camp, including offices, services and amenities will be competently supervised by the project team in order to ensure that work is undertaken with respect to managing environmental impacts, as well as health, safety and quality aspects. A detailed environmental risk assessment will be produced and construction monitored accordingly.

The site camp must be securely fenced to prevent unauthorised access and will have:

- Approval from the ECO for the location and layout of the site camp;
- A designated bunded plant refuelling area situated a minimum of fifty (50) m away from any watercourse or wetland; and
- Emergency spill kits will be available and maintained at all times.

In addition to this all plant will be inspected on a daily basis for fluid leaks and will not be allowed to be used if a leak is identified (until it is repaired).

A separate Beam Casting Yard will be established for the construction of precast concrete beams. This facility must be located off-site at the Contractor's site camp.

All other requirements contained in the Environmental Authorisation (EA), EMPr, and all other relevant permits and licenses (where required), related to site establishment, shall be adhered to at all times for the duration of the project.

3.3 Access

Access to the bridge site will be required from both the northern and southern approaches. Access to the bridge is required for the transport of plant, equipment, machinery and materials during construction and will be via existing farm roads (tracks). These tracks may be graded in order to provide safe access to site and better management of storm-water.

Where machinery is to be used, the necessary precautionary mitigation measures need to be implemented to minimise their environmental impact, especially when this involves entering a watercourse. Vehicles with tracks (as opposed to tyres) are preferable – the wider the track the more load spreading and therefore less compaction there is.

Clearing and grubbing works will be undertaken over the full extent of the works area. This will require the removal of vegetation, topsoil and sods, all of which must be used for the sole purpose of rehabilitation.

The method adopted to access the site during this phase of construction will depend on the saturation status of the floodplain wetlands. This may require the construction of a temporary load-spreading access. A temporary load spreading access in a saturated wetland will comprise of geotextile, which will underlie an amount of locally sourced stone-material appropriately wide to allow subsequent construction operations to

proceed in a safe manner, providing a safe stable working platform to support plant during construction. Alternatively the Contractor may consider gaining access to saturated wetland areas *via* suitable bog-mats.

Where a dry wetland is encountered, topsoil stripping will also be minimised and stored in a similar manner to protect it from vehicular compaction and washout. In this situation, no locally sourced stone-material will be laid to complement the temporary access, as a safe working platform can be provided on the dry stable underlying strata.

If precipitation is encountered, however, access through such areas may be restricted, to prevent compaction of soils. Access will be restored once the soil conditions permit. Furthermore, if access is urgently required, or rainfall is encountered during a vital phase of construction, the method employed for a saturated wetland will be implemented to protect the underlying geology and permit construction to proceed in a safe manner.

3.4 Excavations

Where material is excavated from the works area at a saturated wetland, the excavations will be side dug from the temporary access, with careful separation of soil types / strata as identified. Where a previously dry wetland is saturated, a temporary access will be installed to prevent rutting and degradation of the exposed subsoil, to permit construction to proceed.

Where excavating operations occur at a dry seasonal wetland, the excavation will be dug on-line, creating a much narrower excavation, with less subsoil removed as a result, and at a greater rate of construction being attainable. The soils will be removed in such a way that they can be easily reinstated (if required) in the reverse order as detailed below.

A common approach is to be applied to all wetlands, with regard to removal of excavated material, whether side dug or on-line. The soil that is removed from the excavation at its deepest point will be laid closest to the excavation. The first layer of topsoil will be laid furthest away from the excavation. This will ensure that soil layers (strata) are well separated and can be more successfully re-used for rehabilitation elsewhere.

Subsoil will not be stored on geotextile, but instead will be laid directly on the un-stripped topsoil. This will reduce the cost to the project, and avoid creating unnecessary construction-related waste which may become mixed with the subsoil and make backfilling and reinstatement problematic. There is expected to be minimal topsoil loss due to storing subsoil directly on the un-stripped topsoil.

As a result of the standard approach to excavations, whereby separate strata as identified are removed and stored to one side in the order in which they were removed, rehabilitation operations elsewhere are somewhat simplified.

Where special conditions occur, such as the presence of an impermeable clay layer, the foreman will be advised accordingly on site by an Environmental Representative of the Contractor, and may be instructed via signage at the entrance to the wetland area to ensure it is clearly returned to the same depth and compaction as the surrounding layer (if the intention is to return the soil to the area excavated).

Trench breakers are typically only required within trenches on steep slopes where there is a possibility that water may be intercepted and the trench may become a preferential drainage line; this in turn would place the material placed within the trench (i.e. the bedding, padding and backfill material) at risk of “blowing out.” Where trench breakers are required, these will be imported appropriately and installed by a suitably qualified and experienced crew, as instructed by the Engineer, using information provided in the relevant specialist reports.

However, if a saturated wetland is encountered, it will be important to ensure that any backfill (where required) to excavations is not overly compacted, such that it creates a subsurface dam. In these areas, the Engineer proposes that mechanical compaction should be minimised as far as possible. The principal aim will be to restore the backfilled material to a compaction resembling that of the trench walls and existing strata.

Where a dry wetland is encountered, backfill (where required) will be done to the standard specification using mechanical aids, if and when practicable.

Depending on the type of material removed from the excavated area, it will be necessary to import amounts of layering material. This is typically defined by the Engineer according to the Clients specifications.

Any large boulders encountered during excavations will not be returned to the excavation, but removed off site and disposed of according to the requirements outlined in the EA and EMPr.

Excess soil material will be temporarily windrowed and used within the rehabilitation phase elsewhere on site. During excavation, piling or any other relevant works, the watercourse and its banks will be continually monitored.

3.5 River Crossing

The construction works area within the river must be completely isolated (see Table 3-1 for examples).

It is envisaged that temporary restriction of the watercourse will be required during the construction of the bridge sub-structure, which includes the bridge piers and abutments. River / stream flow will be maintained at all times through fluming or damming by constructing a cofferdam and over-pumping, with sufficient pump capacity available in case of flooding. The natural downstream flow of the river is to be maintained during construction by employing flumes and concrete culverts within the cofferdam to direct flows away from the immediate works areas around the base of each of the in-stream piers. The flume pipes must be removed from the channel when the cofferdam is removed and the original flow patterns re-instated on completion of construction and removal of the cofferdam.

Turbidity curtains must be erected to limit downstream impacts of construction activities. These floating barriers are designed to control sediment and run-off at construction sites and usually comprise of vertical liners with floats at the top and a ballast chain at the bottom. These will only be required during the most high risk activities relating to the cofferdam construction, dredging of the river bottom for the foundation and abutment construction and the removal of the cofferdam structure.

During bridge construction, the Contractor will place a debris catch netting / containment system under the bridge structure to ensure that no building materials fall into the river.

The construction servitude (footprint) within the river must be kept to fifty [50] m wide by seventy [70] m in length.

Material used to create the cofferdam, to divert waters away from the works area, must be protected from scouring and erosion through the placement of rock material (i.e. non-erodible material) at the contact point between the cofferdam and the river (i.e. on the face of the cofferdam both up- and downstream of the works area).

Should water be pumped from the dry working space within the river, this water must be pumped into a retention dam / silt lagoon (or similar structure) to ensure sediment settles and clean water is released back into the water course.

No fuel may be stored within the (dry) bund area inside the river, or anywhere else within fifty (50) m of a watercourse.

The onus is on the Contractor to routinely check weather forecasts (on a daily basis) to prepare for inclement weather conditions, including possible flood events. The Contractor must also check for planned releases of water from the Jozini Dam. All tools, equipment and machinery that could potentially have an adverse effect of the environment must be removed from the works area before the arrival of inclement weather with the potential for flooding. Appropriate spill response material must be available on site.

All petrochemical, cement and / or concrete and other hazardous spillages must be reported to the ECO, the Project Manager and any of the relevant authorities. Incidents are to be captured on the environmental incidents register when they occur and must be closed-out by the ECO following corrective action, where applicable, by the Contractor.

Prefabricated elements will be used where practicable in order to minimise construction duration and potentially environmental impacts associated to fabricating elements on site.

If wet cement and / or concrete works are necessary, ready-mix is to be preferred and care must be taken not to spill any product. All priming of hoses for concrete pours must be done away from sensitive areas in a manner that reduces environmental impacts to the bare minimum and can be cleared from site easily, for safe disposal to a recognised local waste landfill site (as provided by the local municipality).

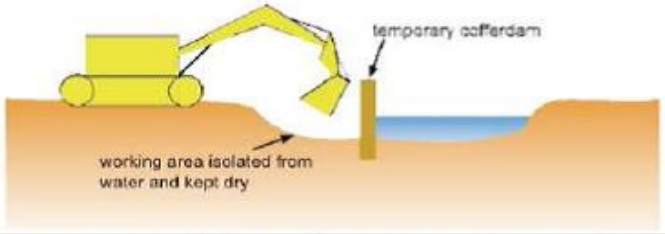
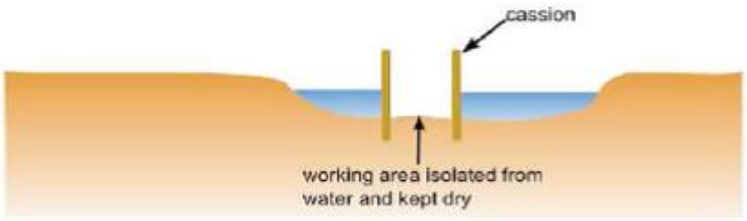
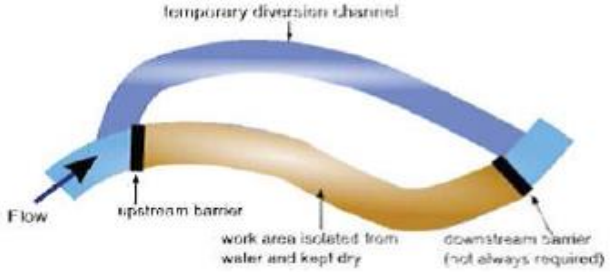
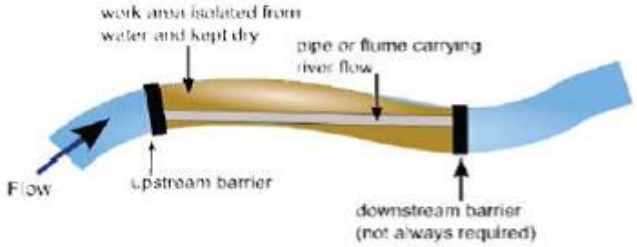
Waste management and house-keeping must be maintained at all times during construction. Sufficient waste receptacles must be available in the laydown area/s for containment of all waste produced on site. As a minimum requirement, general and hazardous waste must be separated and kept within sealed receptacles which do not allow for the ingress of water.

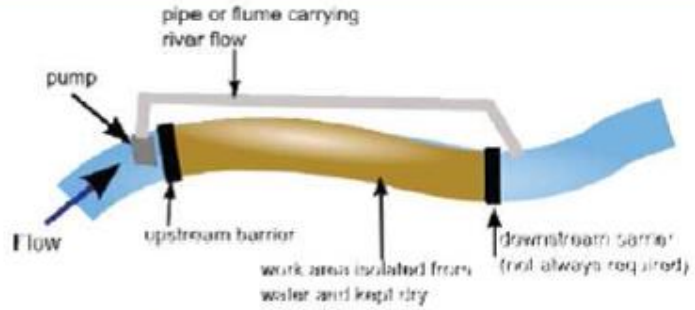
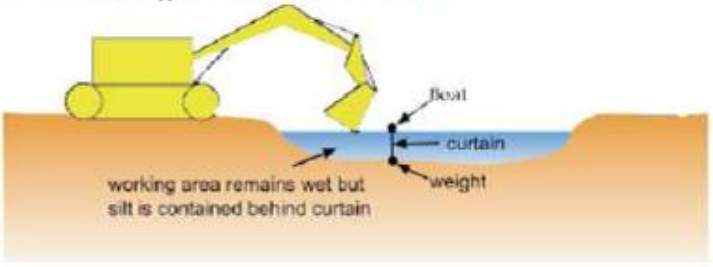
No material may be stored for longer than twenty-four (24) hours within the working area within the river. Material sufficient for the day's work may only be allowed within the working area within the river.

Where the Contractor wishes to deviate from this prescribed CMS, he must draft a site specific method statement for the approval of the Project Manager and ECO, and must ensure the method statement complies in its entirety with the Environmental Authorisation, EMPr and all applicable licenses and permits for the project.

Monitoring will be undertaken as per the requirements stipulated in the Environmental Authorisation, EMPr and all applicable license and permits, including the Water Use Licence.

Table 3-1: Best Practice Methods for Practical and Full Isolation

Method/Approach	Description
Partial isolation	Partial area of the channel is isolated and kept dry with the use of barriers (often referred to as a cofferdam) and flow is allowed to continue in the remainder of the channel. Barriers used to isolate part of the channel can be made of a number of different materials. 
Partial isolation using a Caisson	Provides isolation of the channel similar to cofferdams. They are essentially large boxes or cylinders (usually pre-cast concrete and steel) which are open at the top and bottom and are lowered into the water to isolate an area of bed. 
Full isolation Temporary diversion channel	A whole section of the channel is isolated and kept dry, and the water is transferred downstream of the works area by excavating a temporary open channel. 
Full isolation gravity/flume pipe	A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area through gravity fed flumes/pipes. The flume(s) is normally placed on the bed of the watercourse through the works area and outfalls at the downstream barrier, if present, or far enough downstream to prevent the water backing up into the work area. 
Full isolation over pumping / siphon	A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipe work need not be located in the isolated area.

Method/Approach	Description
	
Isolation with silt curtain	In this case the works area still remains wet and a silt curtain is placed around the works area to minimise sediment being transferred downstream. 

3.6 Piling

Founding conditions at the site are considered to be poor, particularly in view of the likely thick alluvial deposits and boulder bed. All foundations are being designed to carry the load in end-bearing, founded in the underlying competent weathered bedrock. Due to the anticipated significant depth to bedrock, the presence of a shallow water table and prominent boulder beds across the site, piled foundations are the most feasible option for supporting the proposed bridge structure. Pressure Grouted Continuous Flight Auger (CFA) and Driven Cast In-situ (DCI) piles are not considered suitable for the project as they are likely to refuse on the boulders beds and ferricrete layer that was observed on site. The following types of piles are therefore being considered in the pile design:

- Auger piles; or
- Frankie with bulbous base or
- Friction piles or
- Driven precast piles.

In order to create a stable platform for the piling rig it would be necessary to construct a temporary piling mat and cofferdam. The piling mat will be in the form of layers of compacted clean quarry rock to achieve a strong working platform. Flumes utilising suitable pipes will be installed in the piling mat to ensure that that the flow of the river is maintained at all times. Alternatively the contractor could opt for piling off a pontoon/barge but this is unlikely taking into account the remote location of the site and the scale of this project/crossing.

The piling rig will be set up in position on the pile mat and drilling will take place in the soil down to competent weathered bedrock. The ready-mixed concrete will be delivered by truck and will be poured into the newly bored holes from a position that will not allow any concrete to spill near to the watercourse or its banks. Any concrete that does spill will be disposed of in a specially designated skip and this skip will also be used to contain the water used for washing out the mixer. The skip's contents will be disposed of as inert waste when all the cement has cured. Reinforcement will be pushed into the wet concrete and the completed pile left to

cure before the top is cut off to the correct level to suit the design and disposed of as inert waste at a recognised local waste landfill site (as provided by the local municipality).

When the piling is complete, a cofferdam will be constructed to allow the pile cap and pier / abutment to be constructed. This is critical as it will essentially provide a dry construction space within the Pongola River. Should seepage occur and water is required to be pumped from the dry working space within the river, this water must be pumped into a retention dam/silt lagoon (or similar structure) to ensure sediment settles and clean water is released back into the water course; perhaps being allowed to build-up and flow over the top of the retention dam/silt lagoon (or similar structure) and cascade down the clean dump rock of the cofferdam.

On completion of construction the working platform of clean quarry rock and the cofferdam will be removed and the river bed and banks will be restored to the condition they were in prior to construction.

3.7 Abutment and Pier Construction

A layer of blinding concrete will be placed to provide a clean, level working surface on which to construct the reinforced concrete foundations for all piers and abutments. As with the piling operation and all forthcoming concrete placing operations, the same controls will be employed to prevent concrete being deposited in or near the watercourse. If, after thorough risk assessment, the level of risk to the watercourse from contamination from cement remains too high, fast setting concrete mixes may be specified.

Formwork / shutters and steel reinforcement will be erected in-situ to form the pier and abutment base and walls in a number of separate pours.

All backfilling behind the abutment and associated wing-walls will be carried out in a manner to limit the impact on the watercourse. Placement of fill layers will be undertaken in layers not exceeding 200 mm thick when placed loose and compacted using suitable compaction plant to achieve the required Modified AASHTO maximum dry density. Density control of placed fill material will be undertaken at regular intervals during fill construction.

The bridge bearings will be installed and fixed using a cementitious grout ensuring the same levels of environmental protection as for concrete pours.

Backfilling around the abutment and pier walls will be done in layers to ensure adequate compaction and with very great care to ensure that no fill material falls into the watercourse.

3.8 Deck Construction

Each of the spans making up the bridge deck will comprise of cast in situ voided deck. Falsework in the form of staging, shuttering formwork will be placed onto the deck soffit to support the deck during erection. Once this formwork is erected the steel reinforcement for the deck will be placed, deck shutter erected and the concrete deck slab will be poured using ready mix concrete. The concrete will be pumped with the wet concrete spread by hand tools and compacted using electric vibrating pokers.

Parapets will finally be installed together with bridge expansion joints. Once surfaced the bridge deck will be marked accordingly and all relevant signage would be erected.

3.9 Rehabilitation Activities

As soon as backfilling is complete, and the crew has vacated the wetland area, re-instatement of the construction footprint including dewatering areas (if required), can commence subject to appropriate site conditions.

Where a saturated wetland is encountered, all machines will work on the temporary access. The access will be removed in the reverse order in which it was laid.

Machines will remove the stone material which may be transported to another location and re-used if it is required (dependent upon the progress of construction), removed correctly to a recognised municipal landfill, or offered to the landowner. The geotextile base material is also removed during this operation, which ensures that no foreign material is left behind in the wetland area. Following the removal of these materials, the area below can be ripped to an appropriate depth to remove any minor compaction suffered by the preceding construction operations, and topsoil replaced. The pre-construction landscape profile will be restored, matching as closely as possible to the original land form prior to the distribution of the topsoil. This includes the re-distribution of any remaining windrowed material.

Where a dry wetland is encountered, there is no temporary access material to remove. The process of re-instatement will be similar to that described above. Machines will enter the area, and rip the subsoil area to a greater depth to fully reverse compaction from the preceding construction operations. All foreign materials, including boulders which may have arisen from the excavations, will be removed completely. Working out of the wetland, the topsoil will be replaced in the same position as it was originally sited, and de compacted where necessary in preparation for seeding.

For all wetlands, re-instatement will be implemented through continued liaison with a Wetland Specialist and / or the ECO, and both the Employer and the Contractors environmental team. Locally sourced wetland plants may be relocated into the re-instatement area. Relocation of plants from one part of an undisturbed wetland into another (the re-instatement area) can often prove far more successful in terms of survival rates, and this will be the preferred method for re-instatement, bolstered with the original seedbank within the replaced topsoil. Sourcing of wetland plants for transplanting will be scattered so as to limit impact on the source areas. This must be undertaken under the supervision of a Wetland Specialist.

Mineral fertilizers and organic material (manure, compost, chicken litter etc.) will not be used in re-vegetation of wetland areas, and reliance will be chiefly on transplanting (as above).

All effort will be taken to reverse compaction wherever it has occurred by loosening the soil to its original texture and restoring the natural soil profile of the affected area.

Special mitigating measures such as drainage, riprap, sediment and silt traps, diversion berms and gabions will be used throughout (where required) to mitigate soil erosion as per design by the Employer. Information in the wetland database, experience and judgment of the terrain will be used to inform the location of such measures.

Regular inspections of the reinstatement efforts are to be carried out by the Contractor's Environmental Representative(s) and ECO to monitor the progress of the reinstatement and to determine when such efforts are deemed to be successful. Such inspections will be undertaken throughout the duration of the contract period. Should additional measures be required within this period, the Contractor will implement these on instruction. Rehabilitation of disturbed wetland areas will be completed to the satisfaction of the ECO.

The content of this CMS will be brought to the attention of all persons associated with the undertaking of these activities and such measures as necessary will be taken to bind such persons to the requirements herein.

A copy of the CMS and all applicable documents as set out in the EMPr will be on site at all times.

4 Environmental Management Strategy

4.1 Environmental Impact Management

This section must be read in conjunction with the EMPr prepared by Royal HaskoningDHV. The EMPr sets out the specific actions and protocols for environmental management on site.

Changes and impacts to hydrology at landscape level; alteration of stream flow; increased erosion and deterioration of water quality (turbidity) are addressed in the design of the bridge and temporary road and watercourse crossings and the incorporation of sound environmental design principles as set out if the design drawings, the Aquatic and Wetland Ecological Assessment report (S. van Staden and D. Crafford, November 2015), the Fauna and Flora Ecological Assessment report (C.L.Cook, December 2015), and all other referenced documentation.

Nevertheless, certain activities and aspects associated with the actual construction of the bridge, according to these designs, may still cause impacts as a result of how these activities are undertaken, where, when and the duration thereof. These include:

- Clearing of the footprint (including extending activities beyond the maximum impact foot print);
- Establishment and management of the construction camp/s;
- Management of construction materials (movement, storage, preparation/handling);
- Management of machinery (movement, storage, maintenance);
- Management of sanitation and waste (movement, storage);
- Management of storm-water;
- Management of sediment (structures and containment); and
- Rehabilitation.

Possible impacts associated with these activities have been assessed in the Basic Assessment Study along with environmental significance ratings pre- and post-mitigation (i.e. indicating effectiveness of the mitigation measures set out). Mitigation measures are therefore provided according to activities and aspects described in the Environmental Aspects Register contained within the EMPr.

4.2 Monitoring and Review Strategy

Monitoring and reporting will be undertaken as set out in the Environmental Authorisation, EMPr and WUL.

Steps for non-compliance are set out in the EMPr.

5 Responsibilities

Various stakeholders' responsibilities are as follows:

- The Employer, as the holder of the Environmental Authorisation (EA), must be responsible for compliance to the requirements contained within the Final BAR, EA, EMPr, WULA and all relevant legislative requirements.
- The Design Engineer, as the Employer's Representative, manages the project on behalf of the Employer. The Design Engineer must thus employ one (or more) Project Managers.
- The Contractor is responsible for overseeing and ensuring all prescribed activities as detailed by applicable project plans, method statements and statutory documents are executed accordingly on site; and reports to the Design Engineer (Royal HaskoningDHV).
- The Contractor's Safety Manager is responsible for advising on all safety aspects of construction activities. He reports to the relevant Project Manager.
- The Contractor's Environmental Manager is responsible for advising on all environmental aspects of construction, and reports to the relevant Project Manager.
- The Environmental Representative/s of the Contractor, are responsible for ensuring all construction teams adhere to the appropriate environmental project plans, method statements and statutory documents. They report to the Contractor's Environmental Manager.
- The Environmental Control Officer/s (ECO/s) are an independent appointment. ECO/s is responsible for identifying and demarcating wetlands on the ground, following training from an appropriate Specialist, and auditing Contractor construction team performance against stipulations as outlined in the EA and EMPr. They report to the Employer and/or Design Engineer and the relevant Competent Authority according to the conditions of the EA.

6 Declarations

6.1 Declaration of Understanding of EMPr

A Declaration of Understanding of the EMPr as presented below must be signed by a representative of each Developer, Engineer, Contractor and ECO and kept within the Site Environmental File on site.

DECLARATION OF UNDERSTANDING OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME

I, _____

Representing _____

declare that I have read and understood the contents of the Environmental Specifications (which include the Environmental Management Programme, the Record of Decision and the Amended Environmental Authorisation, the Project Specifications and this guideline document) for Contract.

_____

I also declare that I understand my responsibilities in terms of enforcing and implementing the Environmental Specifications for the aforementioned Contract.

Signed: _____

Place: _____

Date: _____

Witness 1: _____

Witness 2: _____

6.2 Declaration of Understanding of Construction Work Method Statement

6.2.1 Design Engineer

The work described in this Work Method Statement, if carried out according to the methodology described, is satisfactorily mitigated to prevent avoidable environmental harm.

_____
Signed

_____
Print Name

_____
Date

6.2.2 Site Manager

I understand the contents of the Work Method Statement and the scope of works required from me.

_____
Signed

_____
Print Name

_____
Date

6.2.3 Environmental Control Officer

The works described in this Work Method Statement are approved.

_____
Signed

_____
Print Name

_____
Date