BUFFALO CITY METROPOLITAN MUNICIPALITY

CONSTRUCTION PEDESTRIAN BRIDGE AND WALKWAY BETWEEN NEW HOPE AND NCERA VILLAGES
WARD 31 & 33

DESIGN REPORT

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1. INTRODUCTION

Sontinga Consulting Services was appointed on September 2018 for provision of consulting civil engineering services for the **DESIGN, SUPERVISION AND PROJECT MANAGEMENT FOR THE CONSTRUCTION OF A PEDESTRIAN BRIDGE BETWEEN NEW HOPE AND NCERA VILLAGES IN WARDS 31 AND 33.**

2. DESCRIPTION OF SITE

2.1 Location and Access

The proposed pedestrian bridge, walkway and culvert is situated between New Hope and Ncera villages. The project falls within two wards in the BCMM namely Wards 31 and 33. The Ncera river is the boundary between the two wards. The site is located approximately 11km North West from Kidd's Beach. Access to the site is from the R346 TO King Williams Town. The coordinates of the site is 33°07'27.78"S and 27°34'48.29"E.

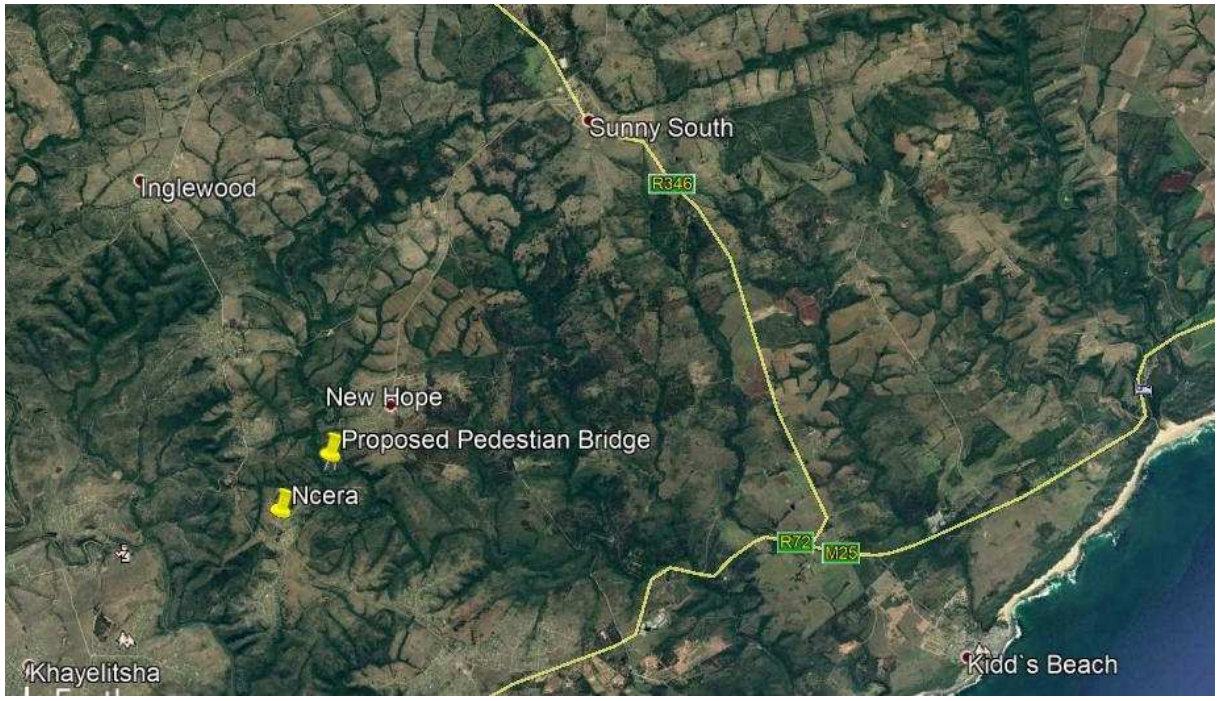

Figure 1: Locality Plan

2.2 Rainfall

The mean annual precipitation for the project area is approximately 800mm/year.

3. EXISTING SERVICES

3.1 Access Road

There is no formal road between the two villages. Only a track exists between New Hope and the river crossing. From the Ncera River to the Ncera village, only a footpath exists.

3.2 Electricity

There are no overhead electrical supply line that will cross the proposed walkway.

3.3 Houses

There are no houses in the area that will be affected by the construction activities.

3.4 Water

There are no existing water supply lines within the project area.

3.5 Sewerage

There is not any waterborne sewerage system in the area.

4. PROPOSED PROJECT

The project will consist of the following components.

- An in-situ concrete bridge over the Ncera River
- A concrete walkway from the bridge to Ncera Village which include a pre-cast concrete culvert.

4.1 Description of Site

The proposed bridge will be constructed over the Ncera. There is an existing pedestrian crossing through the river. Only a track through the river bed exists.

The site of the proposed bridge was surveyed and a visual inspection was conducted. The river bed was found to be solid rock and river stones. The site can be characterized as a narrow river, but will widen in flood conditions.

4.2 Hydraulic and hydrological aspects

4.2.1 Standards

According to the NRA Drainage Manual 5th edition the road under investigation can be classified as a Class 6 Rural Walkway. The design flood frequency for Class 6 walkways is 5 years according to Figure 8.2 in the manual.

4.2.2 Flood line determination

The first step in determining the flood level at the bridge site was by calculating the peak flow in the river.

The catchment area of the Ncera River at the crossing point is 30.16 km^2, therefore the Rational Method could not be used. The following methods were used and results compared:

- Alternative rational method – 65.65 m^3/s
- Standard design flood method – 61.25 m^3/s

According to NRA the recommended method for larger catchments is the Standard design flood method. The two results are very close to each other, therefore it was decided to use the Alternative Rational Method.
Therefore the 1:5 year peak flow was calculated as 65.65 m^3/s. A Detailed Survey showed that the river bed level is 78.20m above sea level. The 1:5 year flood level was calculated at 79.81m above sea level.

4.2.3 Backwater Determination

The following design criteria were implemented:

- The design flow velocity through the structure should be less than 4 m/s.
- The ratio of the design flow velocity through the structure to the natural flow velocity should not exceed 1.67 due to scour considerations.
- Backwater must be 0.6m maximum.

The results of the calculations were as follows:

- Backwater = 0.3m
- The design flow velocity = 4.52 m/s. at bridge upstream point and 4.86 m/s downstream.
- The ratio of the design flow velocity through the structure = 1.02

The flow conditions during floods are super critical with a Froude number of 1.39. The velocity through the structure is high with super critical flow conditions. Additional measures will have to be taken regarding scour and erosion protection.
The backwater is lower than the design criteria of 0.6m.
The backwater of 0.3m was brought into consideration when calculating the freeboard, therefore we do not foresee any problems.

4.2.4 Freeboard

The freeboard was determined with Figure 8.3 in the NRA Drainage Manual. When calculating the freeboard, the 1:20 year flood must be used. The freeboard is 0,5m when using a design flow of 147.93m^3/s. Adding the backwater, a total freeboard of 0.8m is required.

4.3 Geometric Requirements

The bridge level was determined using the calculated flood line levels.

The river bed level at the bridge crossing is 78.20 m above sea level. The 1:5 year flood level at the same point is 79.81m.

The soffit level of the bridge, including freeboard is calculated to be 80.61 m above sea level. A soffit level of 80.65m was used.

The bridge width will therefore be 1.8m.

4.4 Foundation investigation

Controlab has conducted a geotechnical investigation and the geotechnical findings are included as Appendix C.

The results were interpreted as follows:

a) Soil Profile

Three test positions were identified at the proposed crossing. Two profiles in the river embankments in order to determine if there is rock present at abutment foundation level. One position in the the middle of the river. Rock cores were drilled and tested in order to determine the bearing capacity of the rock in the river bed. Rock was encountered at all three positions and the UCS tests showed sufficient bearing.

b) Groundwater

This part of the Ncera river is most of the year perennial. Groundwater is also expected to be present and may occur as an ingress water from the one valley sidewall.

c) Scour

Alluvial materials in the profile are expected to be moderately susceptible to scouring and water erosion.

d) Founding Conditions

The solid rock that was found is sufficient as founding material.

e) Foundation Selection

Block foundations doweled into the rock will be used.

4.5 Availability of construction materials

Most of the construction materials are available from East London. There is more than one a Ready-mix plant in the East London area. Steel reinforcing can be obtained from East London.

4.6 Maintenance of existing services

If during construction, existing services is found, care must be taken to open and protect these services. The authority reliable for the services must be informed.

5. ENVIRONMENTAL ASSESMENT

An Environmental has been appointed and is busy with the EIA. This is a very environmentally sensitive area with a lot of indigenous trees and birdlife. The proposed walkway and precast culvert will be in the same position as the existing path. The existing position of the crossing through the Ncera River is within a very sharp curve in the river. The position of the proposed bridge had to be moved approximately 25m upstream of the existing path where the bridge will cross the river on a straight portion. The area on the curve of the river where the existing path is, is very sandy, showing sand deposits during flood conditions. This area will be totally submerged during floods The water will wash away all material behind the abutments. Therefore is not recommended to position in this area.

Due to the high velocities and critical water levels during flood conditions, a in-situ structure with only one pier and long span slabs have to be used. The backwater calculations on pre-cast culvert were in the extent of 1m. Due to the vegetation at the recommended position, care will have to be taken during construction. An in-situ concrete structure will have much less impact on the vegetation than a pre-cast culvert.

It is important that the Record of Decision for the project will be in place when the bridge is constructed.

An Environmental Management Plan needs to be drafted to guide the Contractor during Construction phase. An Environmental Control Officer will have to be appointed for environmental monitoring during construction phase.

6 STRUCTURAL DESIGN

6.1 Dictates on structure size

The following aspects were taken into consideration for determining the structure size:

- Flood line levels.
- Width of river. Distance between embankments.
- Height of the river embankments.
- Position of the existing path.
- Founding conditions.

6.2 Type of structure

There are a few types of bridge structures and design options namely:

- Pre-cast concrete culvert river crossings.
- Steel structures.
- In-situ abutment walls with pre-cast post stressed beams and in-situ concrete deck combinations.
- In-situ concrete abutment walls with an in-situ concrete simply supported slab.

Due to the height of the bridge deck in comparison with the river bed as well as the complexity of the other structural systems, it is recommended to use an in-situ casted abutment, foundation slab and deck system.

Foundation properties

Due to the presens of a solid rock foundation, a block foundation will be doweled into the rock. The abutment foundations will also be anchored to the rock. This resulted in smaller abutment and wingwall foundations.

Deck properties

Due to the average height difference between the river bed and soffit (2.45 m) as well as the flow conditions in the main stream, an in-situ reinforced concrete structure with two abutments and 1 pier will be constructed. The spacing between the pier and abutments will be 5m. The height of the abutments and piers will be 2.45m.

The total length of the in-situ bridge structure is 10.7m. The width of the bridge will be 1.8m which includes 1.2m pedestrian walkway. The remaining 0.6m is to accommodate for concrete guide blocks and hand railings.

Abutment and pier properties

The geotechnical investigation showed that the river bed consist of solid rock, which will make it possible to place the two abutments and one pier directly onto rock founding material. The abutments and piers will form a solid unit with the top slab.

Railings and guardrail properties

Galvanized steel hand railings will be casted into the concrete guide blocks.

6.3 Construction methods and options

All the components of the structure will be in-situ casted. Due to the height of the abutment walls, the provision of drainage as well as the backfilling method is very important.

The deck needs to be casted and cured properly, before the main backfilling behind the abutments can start.

The following shutter stripping periods will be recommended:

- Vertical faces – 3 days
- Beams and slabs – 7 days
- Props underneath slabs – 21 days

6.4 Design requirements and standards

The design criteria used for the structural design of the bridge elements is according to TMH7 Part 1,2&3.

- Dead Loads = 2400 kg/m³ for Concrete
- Dead Loads = 7850 kg/m³ for Steel
- Superimposed Dead Loads = 2100 kg/m³
- Load Factor for Dead Loads as per Table 17 = 1.2
- Compacted Earth filling behind Abutment Walls = 2000 kg/m³
- Standard Traffic Loading = Pedestrian
- Maximum allowable design surface crack width = 0.2mm

Concrete Strength to be as follows:

- Blinding Class 15/19
- Abutments 30/19
- Deck 30/19
- Guide blocks 30/19

6.5 Drawings

For drawings and details of the proposed bridge structure, see Appendix F.

6.6 Protection works

Due to the flow during normal conditions, provision of coffer dams will not be necessary.

To avoid flooding of the abutment foundation area, sand bags can be provided around the construction area.

After completion of the structure, stone pitching will be provided at all the wing walls to provide protection against erosion of the walkway prism.

6.7 Additional investigations

All the necessary investigations have been conducted in order to do the final design of the bridge.

It is however important to conclude all the necessary environmental investigations before commencement of the project.

6.8 Joints

Construction joints will be provided between the bridge and the walkway slabs.

PORTAL CULVERT DESIGN

Design flood determination

The catchment area of the culver crossing is 1.36 km^2. The Rational Method was used and a 1:5 year flood was calculated as 8.189m^3/s. See Appendix B.

Box Culvert Dimensions

The following culvert size was calculated:

- Rectangular Portal Culvert : 3 x 1200x1200mm 150S SANS 986
- The width of the culvert will be 1.22m.
- Wingwalls, Apron Slabs and Cut-off walls will be provided.
- The geotechnical report indicates that there is no rock present. It is therefore recommended that a conventional portal culvert slab will be used. Unsuitable material will be removed underneath the slab level and selected material will be imported and compacted.
- Gabion mattresses will be provided upstream and downstream of the apron slabs.
- The position of the culvert will be as close as possible to the existing path.
- Handrailings will be provided and casted into the culvert top slab.

8. PROJECT COSTS

The Engineers cost estimate for the project is as follows:

SECTION	DESCRIPTION	AMOUNT	
1	**1200** GENERAL	R	135 500.00
2	**1300** CONTRACTOR'S ESTABLISHMENT	R	1 526 250.00
3	**1500** ACCOMMODATION OF TRAFFIC	R	27 850.00
4	**1600** OVERHAUL / **1700** CLEARING AND GRUBBING	R	21 900.00
5	**1800** DAYWORKS	R	52 283.25
6	**2100** DRAINS	R	10 715.00
7	**2200** PREFABRICATED CULVERTS	R	96 088.00
8	**2300** CONCRETE KERBING, CHANNELLING, CHUTES AND DOWNPIPES, & CONCRETE LININGS FOR OPEN DRAINS	R	-
9	**3300** MASS EARTHWORKS	R	35 270.00
10	**3400** PAVEMENT LAYERS OF GRAVEL MATER	R	28 125.00
11	**4200** ASPHALT BASE AND SURFACING	R	-
12	**5100** PITCHING, STONEWORK AND PROTECTION AGAINST EROSION **5200** GABIONS	R	30 875.00
13	**5400** GUARDRAILS	R	1 290.00
14	**5800** LANDSCAPING & PLANTING PLANTS	R	42 000.00
15	**6100** FOUNDATIONS FOR STRUCTURES	R	49 701.00
16	**6200** FALSEWORK, FORMWORK AND CONCRETE	R	212 325.00
17	**6600** NO-FINES CONCRETE, JOINTS, BEARINGS	R	58 200.00
18	**7100** CONCRETE PAVEMENTS	R	202 550.00
19	**SUB TOTAL (VAT INCL)**	**R**	**2 530 922.25**
20	**10% CONTINGENCIES**	R	253 092.23
21	**TOTAL ENGINEERS ESTIMATE (VAT INCL)**	**R**	**2 784 014.48**

Sontinga Consulting Services was given the Contract 300 Contractor rates to evaluate as per the table below. An allowance for 10% contingencies has been made. No escalation is applicable to this project.

Summary of CE 300

RANKING ON PRICE	TENDERER	TENDERED AMOUNT INCL VAT (R)
1	Imvusa Trading 415 cc	R 2 168 095.60
2	Makali Plant & Construction (Pty) Ltd	R 2 238 957.05
3	Ezulwini Construction	R 2 772 941.24
4	Luqaqambo civil	R 2 784 320.00
5	Mvezo Plant and Civils	R 3 183 490.60
6	Tshiya Infrastrure	R 3 468 825.82
7	Czar JV	R 3 470 809.10
8	Mmakgogo Group & Mpelwani JV	R 3 610 252.80
9	Bontifo JV	R 3 685 951.50

The estimate is R 2 784 014.48. Three contractors are lower than the estimate and 6 are higher.
Based on the amounts in the table, a Tender Analyses will be compiled and submitted to BCMM.
The amounts do not include Professional Fees or Site Supervision. This will only be confirmed after appointment of the contractor. Summary pages of the tenders are attached as Appendix E.

9. NON-TECHNICAL

9.1 Sub-Contractor

The employment of subcontractors will be encouraged in order to give an opportunity the emerging contractors in the area.

9.2 Training

Contractor will be expected to give accredited training to certain individuals from the community.

10. CONCLUSION

It is recommended to construct the proposed river crossing and walkway between New Hope and Ncera. This path is used every day by residence of the two villages. The river becomes very dangerous during heavy rains. The existing path is also very steep and becomes dangerously slippery. Therefore a concrete walkway needs to be built.

APPENDIX A

FLOOD CALCULATIONS AND BRIDGE LEVEL DETERMINATION

APPENDIX B
CULVERT DESIGN

APPENDIX C

GEOTECHNICAL REPORT

APPENDIX D
STRUCTURAL DESIGN

APPENDIX E
COST SUMMARIES

APPENDIX F

DRAWINGS