

***Report to DE Consultants on a Geotechnical Investigation
carried out for the Proposed Lovu Pedestrian Bridge 3383,
KwaZulu-Natal***

Reference : 15-015R01

Dated : November 2015

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Appendix A: Borehole Log and Core Photography

Figure 1

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1. INTRODUCTION

As requested by Mr Imtiaz Asmal of DE Consultants, MSJ Geotechnical Consulting Services (MSJ) met Mr Asmal and Mr H Le Grange on site in August 2015. Based on the results of this site visit, MSJ submitted a proposal to carry out the geotechnical investigation for this bridge on 1 August 2015. Subsequently Mr Asmal instructed MSJ to proceed with the geotechnical investigation for the proposed Lovu Pedestrian Bridge 3383 in KwaZulu-Natal.

This report provides the results of the geotechnical investigation. Recommendations for foundations, excavations and groundwater are provided.

2. INFORMATION SUPPLIED

A site plan showing the bridge alignment was provided by DE Consultants.

3. SITE DESCRIPTION

The site for the pedestrian bridge is located on the Lovu River in the general KwaMakutha area. The site is accessed via the R624 connecting Kingsburgh and Umbumbulu, then taking the turnoff to St Winifred's mission and following the road until the Lovu River is crossed via the steel railway bridge. Turning right (or east) the gravel road extends past the sandwinning works until the site is gained.

The area surrounding the bridge site is fairly densely inhabited with dwellings, with a number of schools.

The location of the bridge is at approximately X-3331346.325 Y-25814.303.

The following plate depicts the site in greater detail.



Plate 1: Approximate location of bridge crossing showing the rocky bank on the southwest and the sandy bank on the northeast

The layout of the site is given in Figure 1.

4. FIELDWORK

The fieldwork for the investigation was conducted in August 2015 and comprised the drilling of 1 rotary cored borehole.

4.1 Rotary Core Drilling

One borehole, designated BH1 was drilled by Geomechanics using rotary core drilling methods to evaluate the ground conditions and possible depth to bedrock. BH1 was located on the northern side of Lovu River as agreed on site in early August 2015. The approximate position of the borehole is shown in Figure 1 attached.

The borehole was advanced by washbore with Standard Penetration Tests (SPT) carried out at 1.5m centres. The borehole was advanced to a final depth of 20.0 metres below existing ground level.

The soil and rock samples recovered from the boreholes were profiled¹. A detailed log for the borehole and core photographs are given in Appendix A.

5. SITE GEOLOGY

The final alignment for the pedestrian bridge was selected on the basis of the characteristics of the local geology; the south-eastern abutment is situated on weathered tillite rock, while the north-western abutment is situated some 10m from an undercut river bank. This location was also considered suitable on the basis of hydrology, the rock bank on the south being on the undercut (or high velocity) side of the river provides a natural hedge against erosion while the northern abutment is on the point bar side of the river with the river in deposition mode in this area and thus lower velocity.



Plate 2: Tillite bedrock beneath the southwest bank



Plate 3: Sandy alluvial soils beneath northeast bank

6. GROUNDWATER

Groundwater can be anticipated at the river level or about 2 meters below the top of the undercut bank.

7. DEVELOPMENT RECOMMENDATIONS

7.1 Proposed Bridge

The Lovu Pedestrian Bridge 3383 over the Lovu River will comprise a main central span supported on abutments with diagonal piers extending from the abutment footings.

¹ Geoterminology Workshop (2002) – Guidelines for Soil and Rock Logging - SAIEG-AEG-SAICE (Geotech Div) pp47

7.2 Foundations

7.3 South-Eastern Abutment

The southern abutment can be founded on the tillite rock which is relatively fresh and sound. It is generally widely to medium jointed, with conjugate jointing sets. The rock is at least hard rock strength.

A maximum allowable bearing of 500 kPa may adopted for the foundations. It will be important to ensure that the footing is not located within 2m of the edge of the rock bank in case there is a long term stability problem with the rock. If it is necessary to have the footing closer than this then rock bolting may be required to secure the long term integrity of the rock founding layer. Once the position of the footing is finalised this aspect can be more carefully evaluated by MSJ.

7.4 North-Western Abutment

The northern abutment of the bridge is located over deep, unconsolidated alluvial soils comprising for the most part gravelly silty fine medium and coarse SAND. The alluvium is generally loose becoming medium dense in consistency with depth, with SPT N values in the range and 13 to 18, with some refusals on occasional small to medium sized cobbles of up to about 50 to 100mm diameter. The amount of gravel and cobbles appear to increase significantly below about 10 metres depth to the end of the borehole which is 20 metres.

Groundwater can be anticipated from river level or about 2 metres below the abutment level as mentioned previously. Collapse of the sandy soils in open excavations must be allowed for. Any major excavations below the ground water table level will also require dewatering and lateral support to protect the workers inside.

With this in mind it is recommended that the north-western abutment be supported on piled foundations. Given the loose consistency in the upper horizons, the following pile types may be considered:

Continuous flight, **grout injected**, augered (CFA) piles. This pile will cope with loose collapsing soils and groundwater inflow, and can be designed to support the majority of the foundation loads mainly in skin friction. Typical pile sizes that could be considered for the founding of the abutment foundations would be the 350 and 450mm diameter piles which would cater for pile loads of 400 and 600kN respectively. The gravel and cobbles observed in BH 1 should not present problems with the installation of the piles, however, it would be prudent to select larger diameter piles (than might be required by the loading conditions) to deal with any small boulders or cobbles in excess of these pile diameters.

Driven-cast insitu or DCI piles (also known as Franki's) should be able to found on the gravel layer of very dense consistency occurring from about 15m depth. This pile consists of a steel casing driven to required founding depth and the base of the piled expanded by continued driving of dry concrete at the base until the required foundation end bearing is obtained. It should be noted that a very dense layer of gravelly sand occurs between 6 and 8m depth which may result in the need for predrilling to ensure that these piles do not found prematurely on this shallower layer. The low order SPT values for medium dense sands underlying this gravelly layer point to the potential for liquefaction of the sands, and therefore the deeper founding horizon from 15m depth is recommended.

Steel and concrete precast driven piles may also be considered but these are generally associated with much heavier loaded structures and not likely to be economical.

A summary of typical pile details is given in Table 1 below:

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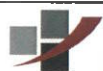
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A summary of typical pile details is given in Table 1 below:

Table 1
Summary of typical pile details

Pile Type	Nom. Shaft Diameter (mm)	Typical Working Load (kN)	Maximum Tension Load (kN)	Maximum Rake	Maximum Depth (metres)	Establishment Costs	Penetration Ability	Ability to Handle Boulders	Noise Pollution Levels	Vibration Levels if not Predrilled
Driven Cast-In-Situ										
Franki (DCI)	250 to 600	250 to 1600	75 to 450	1:4	6 (Franki Mini Only) to 15	Medium	Good	Good	Medium	Medium/High
Steel Tube Pile	150 to 600	Up to 8MPa on shaft	Determined by friction	1:4	15 to 50	Medium	Good	Good	Medium	High
Driven Preformed										
Precast Pile	250 sq to 300sq	1000 to 2000	Determined by friction	1:4	Unlimited	Medium	Good	Poor	High	High
Auger Bored Cast-In-Situ (Grout Injected)										
CFA Pile	300 to 750	Up to 6MPa on shaft	Determined by friction	1:10	22	Medium	Fair	Poor	Low	None

8. CONCLUSIONS AND RECOMMENDATIONS

This report contains the results of a geotechnical investigation carried out for the proposed Lovu Pedestrian Bridge 3383 in KwaZulu-Natal.

It is recommended that the south-eastern abutment be founded on conventional foundations founded on tillite bedrock while the north-western abutment must be founded on piles.

In conclusion, the information and recommendations provided in this report relates to the location of the borehole put down on site. It is quite possible that variations to the ground conditions will be encountered elsewhere on the site during construction. Therefore, it is recommended that MSJ be required to carry out periodic inspections on the earthworks and foundation excavations during construction to confirm the recommendations given in this report and in so doing the construction phase be treated as part of the geotechnical investigation.

APPENDIX A



**MSJ Geotechnical Consulting
Services (Pty) Ltd**

Geotechnical Investigation for Lovu Pedestrian Bridge 3383,
KwaZulu-Natal

Path : S:\16-015 Lovu Pedestrian Bridge 3383\Reports\15-015R01 Final Report.doc



ROCK FABRIC
MF - massive
BF - bedded
FF - foliated
CF - cleaved
SF - schistose
GF - gneissose
LF - laminated

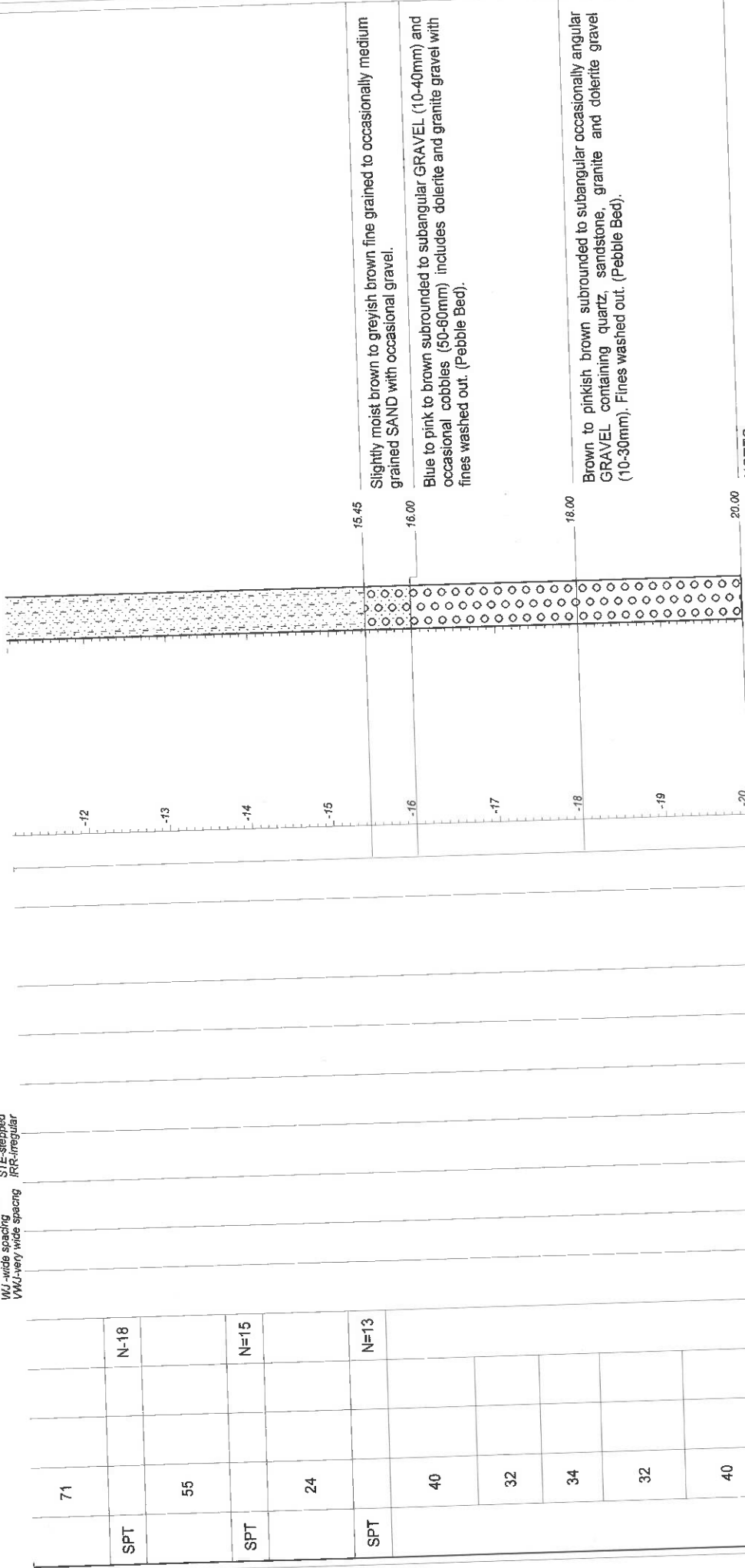
GRAIN SIZE
FG - fine grained
MG - medium grain
CG - coarse grain

JOINT SPACING
VCJ - very close spacing
CJ - close spacing
MJ - medium spacing
WJ - wide spacing
VWJ - very wide spacing

JOINT SHAPE
CJR - curved/linear
PLA - planar
UND - undulating
SITE - stepped
IRR - irregular

JOINT ROUGHNESS
SLJ - slickensided
SJ - smooth
RJ - rough

ROCK HARDNESS
EHR - extremely hard rock
VHR - very hard rock
HR - hard rock
MHR - medium hard rock
SR - soft rock
VSR - very soft rock



Slightly moist brown to greyish brown fine grained to occasionally medium grained SAND with occasional gravel.

Blue to pink to brown subrounded to subangular GRAVEL (10-40mm) and occasional cobbles (50-60mm) includes dolerite and granite gravel with fines washed out. (Pebble Bed).

Brown to pinkish brown subrounded to subangular occasionally angular GRAVEL containing quartz, sandstone, granite and dolerite gravel (10-30mm). Fines washed out. (Pebble Bed).

NOTES
1) End of borehole 20.00m.

ELEVATION :
X-COORD :
Y-COORD :
HOLE No: BH1
llbvu

INCLINATION : Vertical
DIAM :
DATE : 24/08/2015
DATE : 23/11/2015 12:40
TEXT : ...383BoreholeLogsBH1.doc

CONTRACTOR : Geomechanics
MACHINE :
DRILLED BY : ZD
PROFILED BY : ZD
TYPE SET BY : SAS
SETUP FILE : BHRFG-AS.SET

Drilling Method	Material Recovery (%)	Core Recovery (%)	RQD (%)	SPT-N	PL/(IS50)	LCS (MPa)	FRAC. FREQ.	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGHNESS	JOINT FILLING & THICKNESS	WEATH. EROSION LEVEL
SPT	71			N=18										
SPT	55			N=15										
SPT	24			N=13										
	40													
	32													
	34													
	32													
	40													

Lovu Pedestrian Bridge 3383

15-015



Borehole No. BH1

Depth : 0.00 to 9.45m

Box 1 of 2



Borehole No. BH1

Depth : 9.45 to 20.00m

Box 2 of 2

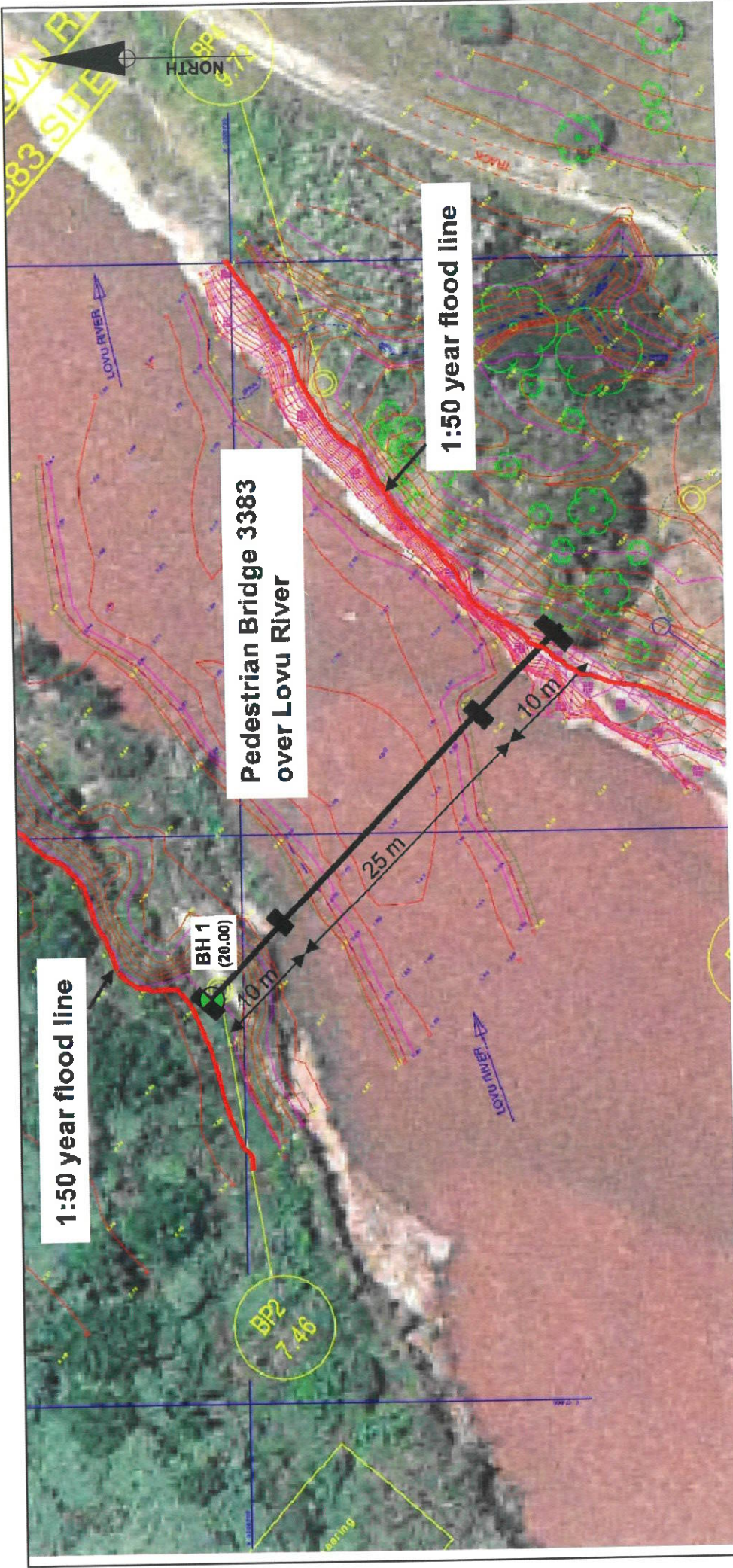
FIGURE



**MSJ Geotechnical Consulting
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Geotechnical Investigation for Lovu Pedestrian Bridge 3383,
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Path : S:\15-015 Lovu Pedestrian Bridge 3383\Reports\15-015R01 Final Report.doc



KEY :

-  **BH 1 (20.00)** Approximate position of Bore Hole showing final depth in metres below existing ground level.

a.) Borehole



NB : Please note that the bar scale supersedes the verbal scale due to print sizes etc.

Site Plan showing approximate positions of :

a.) Borehole

DE CONSULTANTS

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Lovu Pedestrian Bridge 3383



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www.msj.co.za

DATE	17-09-2015
DRAWN	A.S.
CHECK	M.V.R.
REFERENCE No.	15 - 015
FIGURE No.	1
REV.	0

