RECONSTRUCTION AND MODIFICATION OF WEST ST BRIDGE - MALAMALA

FINAL BASIC ASSESSMENT REPORT

August 2012



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Basic assessment report in terms of the Environmental Impact Assessment Regulations, 2010, promulgated in terms of the National Environmental Management Act, 1998(Act No. 107 of 1998), as amended.

Kindly Note:

- Required information must be typed within the spaces provided in the form. The size of the spaces provided is not necessarily indicative of the amount of information to be provided. Tables can be extended as each space is filled with typing.
- 2. Where applicable black out the boxes that are not applicable in the form.
- 3. An incomplete report may be returned to the applicant for revision.

(For applicant / EAP to complete)

		17/2/3/E-136			
		Reconstruction and Modification of West St Bridge on the farm Flockfield 414KU, MalaMala			
		lain Garratt			
		done with circumspection because if it is used in respect of material ority for assessing the application, it may result in the rejection of the			
		(For official use only)			
NEAS Reference Number:					
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- All reports (draft and final) must be submitted to the Department at the address of the relevant DISTRICT OFFICE given below or by delivery thereof to the relevant DISTRICT OFFICE. Should the reports not be submitted at the relevant district office, they will not be considered.
- 6. No faxed or e-mailed reports will be accepted.
- 7. One copy of the draft version of this report must be submitted to the relevant district office. The case officer may request more than one copy in certain circumstances.
- 8. Copies of the draft report must be submitted to the relevant State Departments / Organs of State for comment. In order to give effect to Regulation 56(7), proof of submission/delivery of the draft documents to the State Departments / Organs of State must be attached to the draft version of this report.
- Unless protected by law, all information in the report will become public information on receipt by the competent authority.
 Any interested and affected party should be provided with the information contained in this report on request, during any stage of the application process.
- 10. All specialist reports must be appended to this document, and all specialists must complete a declaration of independence, which is obtainable from the Department.

Project Details

Title : Reconstruction and Modification of the West St

Bridge - MalaMala.

Project Number : 108200

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Aurecon Report Number : 6149

Report Status : Final Basic Assessment Report

Date : 17 August 2012

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This report is to be referred to in bibliographies as: AURECON 2012. MalaMala West Street Bridge: Final Basic Assessment Report. Report No.6429 BAR

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Executive Summary

INTRODUCTION

Aurecon (Pty) Ltd, as Independent Environmental Consultants and Impact Assessors, has been appointed by MalaMala Ranch (Pty) Ltd, to facilitate the Integrated Environmental Management (IEM) procedure, for the proposed Reconstruction and Modification of the West St Bridge on the farm Flockfield 414KU, Mpumalanga.

The project site co-ordinates are S24 49'34.1"E031 33'27.4" situated on the eastern portion of the Sabi-Sands Game Reserve, adjacent to the Kruger National Park.

The development will encompass the following key elements:

- Reconstruction will occur on the same footprint
- > The bridge will be raised by approximately 2m
- The extension of the bridges stays and approaches.

(See Locality Map, attached as **Appendix A, Annexure A** and preferred Layout Plan attached as **Appendix A, Annexure B**).

The development proposal has been informed by intensive planning so as to ensure that the reconstruction and modification of the West St Bridge has a minimal negative impact on the Sand River, its ecology and the surrounding area, while promoting positive impacts, on the receiving environment.

Alternatives were evaluated during the initial planning stage of the project. The inputs received during Public Participation as well as those highlighted through consultation with various authorities, were used to revise and further inform specifics related to the reconstruction and modification of the West St Bridge.

ENVIRONMENTAL IMPACT ASSESSMENT REQUIREMENTS

The proposed development involves listed activities, as defined by the National Environmental Management Act: NEMA, 1998 (Act No. 107 of 1998) as amended and the Environmental Impact Assessment Regulations, 2010. Listed activities are activities, which may have potentially detrimental impacts on the environment and therefore require environmental authorization from the relevant authorizing body. The proposed development occurs in the Mpumalanga Province and thus the Mpumalanga Department of Economic Development, Environment & Tourism (MDEDET) is the responsible regulatory authority.

The proposed reconstruction of the West St Bridge is subject to a Basic Assessment process as prescribed in GN 543.

This document, duly completed, constitutes the Final Basic Assessment Report (BAR). It has been compiled as a result of the findings, from specialist studies, and various inputs from I&AP's and Authorities during the public participation stage of the process. This BAR will be presented to Interested and Affected Parties (IAPs) for comment (a comment period of 21 days) where after any comment received will be included in the final submission to MDEDET for consideration.

The purpose of BAR is to present an objective evaluation of the environmental impact of the proposed reconstruction and modification of the West Street Bridge.

The structure of this BAR has been informed by the Department of Environmental Affairs and Tourism (DEAT) EIR guidelines (DEAT, 2006a), and the need for a clear and succinct document to facilitate informed decision-making by the proponent and environmental authorities. The BAR contains the following information:

- A summary description of the feasible alternatives and potential impacts identified during the planning phase. It should be noted that the alternatives have been refined/ augmented due to requirements and available information:
- Information on the affected environment. Much of this has been drawn from the specialist studies;
- A description and assessment of the potential impacts associated with the various feasible alternatives as well as an indication of potential mitigation measures;
- A conclusion and various recommendations with regard to the way forward; and
- A series of Appendices containing relevant information, including the various specialist studies.

After completion of the Final Basic Assessment (BAR) and incorporation of comment on the DBAR and final BAR as reviewed by the public, the competent Authority (MDEDET) will consider the BAR report for compliance with the provisions of the EIA regulations.

MDEDET will also consider the findings and recommendations compiled by the various specialists and the EIA practitioner, as well as representations made by Interested and Affected Parties and commenting Authorities before making a decision on whether to authorize the activity.

MDEDET will then advise whether it is satisfied with:

- a) The contents of the BA Report
- b) The findings of the BA Report
- c) The recommendations of the BA Report and Environmental Management Programme (EMP)

Should MDEDET be satisfied with the above items it will draft an Environmental Authorization.

PUBLIC PARTICIPATION PROCESS

Public participation forms an integral component of the EIA process. The public participation process for the project initiation and Final Basic Assessment Phase is outlined in detail in **section D - 4.3** of this report.

The approach adopted for the DBAR and BAR phase of the project was to liaise predominantly with registered I&AP's or those directly affected by the proposed activities. Consequently, subsequent correspondence has only been directed to registered I&AP's and commenting Authorities.

The public participation process to date has entailed the following key components:

- Placing an advertisement in the local Lowvelder (English) on Friday 20th April 2012. This
 advertisement served to advertise the proposed development and associated EIA process
 while inviting all potential I&AP's to register as I&AP's
- Distributing a letter and Background Information Document to all identified direct neighbors and other potential I&APs inviting them to raise issues or concerns and to indicate any other potential I&AP's who should be contacted. Distribution was facilitated through the office of the Sabi Sand Wildtuin, who undertook to contact and distribute all relevant documentation to all the landowners that would be affected by the proposed project as well as to all landowners who form part of the Sabi Sands Association.
- Holding the departmental meetings on 17th May 2012 as well as the 1st of June 2012, to give
 the various departments an opportunity to engage with the consultants regarding the
 implications of the proposed development.
- Lodging copies of the Draft Basic Assessment Report, for public review and comment, as well
 as sending a hard copy to all registered I&AP's who requested such. This was done from the
 25th June 2012 and 17 August 2012 respectively. Comments received have been included in
 the Final BAR. Late submissions were accepted. To date, however no comment has been
 received. (See Appendix E; Annexure K for proof of delivery and correspondence).
- Submission of the draft BAR to all departments and registered I&AP's for review and comment.
- Submission of the Final BAR to all departments and registered I&AP's for review and comment.

PROJECT BACKGROUND AND MOTIVATION

Necessity

Due to the torrential rainfall experienced within the eastern areas of Mpumalanga and Limpopo province during January and February 2012, the MalaMala West St Bridge, which was constructed during mid-1997, was recently destroyed.

The bridge was constructed over the Sand River, which is one of the primary watercourses within the Game Reserve, to ensure access into the traversing areas on the western fringes of the Kruger National Park. Being a premier commercial game lodge, access into this game rich area is critical for the economic viability of the business.

Desirability

The bridge crossing the Sand River on MalaMala Game Reserve was constructed as a vital link between the northern and southern portions of the MalaMala property. Due to the bulk of the MalaMala traversing area being situated to the north of the Sand River as well as the relative abundance of game in the north, it is of the utmost importance to have a permanent link (the bridge) between the north and south and thus ultimately ensure the financial viability of MalaMala Game Reserve as a premier wildlife viewing and tourism destination.

In conclusion, the bridge was constructed to ensure access during extreme conditions in order to guarantee traversing for the economic viability of the MalaMala Game Reserve and to ensure a presence in this game rich area on the western fringe of the Kruger Park.

In addition to the above, the bridge may be viewed as having potential disaster management significance, as the current situation and proposed strengthening (by expansion and extension of the eastern stay) would result in a reliable and safe strategic evacuation point to and from the Kruger National Park. This strategic access point into the National Park would be accessible all year round This is an enormous benefit and has been used on occasion in the past.

KEY ENVIRONMENTAL ISSUES

The assessed impacts were identified in the planning phase and have been subjected to detailed investigation and assessment. These impacts include potential biophysical and social impacts that may arise during the operational phase of the proposed activities (i.e. long-term impacts) and construction phase impacts (i.e. short-term impacts).

The methodology was developed by Aurecon and has been continually refined and improved based on our experience in applying it to many EIA processes. The methodology is broadly consistent to that described in the NEMA EIA Regulations and in the DEAT Guideline Document for these regulations (DEAT, 2006b). The methodology was outlined in the Plan of Study for EIA, and in accepting this MDEDET has ratified this approach.

Each issue identified for the proposed study area was taken into consideration in order to ascertain the most suitable layout that has the least possible impacts, or the most manageable impacts, on the environment.

The following table summarizes the significance of the identified potential impacts (i) before and mitigation; and (ii) once recommended mitigation measures are in place.

Table 1: Summary impacts

Ref.	Description of impact	Significance of impact		
TO.	Decemption of impact	Without mitigation	With mitigation	
7 .1	Operational phase: Biophysical and Soc	ial environment		
7.1.1	Erosion and siltaton	Medium (-)	Low (-)	
7.1.1	LIUSION AND SINAION	(Highly Probable)	(Possible)	
7.1.2	Visual – "sense of place"	Medium (-)	Low (-)	
7.1.2	Visual – Selise of place	(Highly Probable)	(Unlikely)	
7.1.3	Land use	Low (+)	Medium (+)	
7.1.5	Land use	(Probable)	(Highly Probable)	
7.1.4	Socio-economic Impact Low (+)		Medium (+)	
7.1.4	Good contonic impact	(Highly Probable)	(Highly Probable)	
7.2	Construction Phase Impacts			
a)	Surface and Ground water contamination	Medium (-)	Low (-)	
u)	Surface and Ground water contamination	(Highly Probable)	(Probable)	
b)	Stormwater and sedimentation	Medium (-)	Low (-)	
<i>5</i>)		(Highly Probable)	(Probable)	

c)	Potential Impact on stream flow and riparian areas	Low (-) (Probable)	Low (-) (Probable)
d)	Ecological Sensitivity	Low (-) (Probable)	Low (-) (Probable)
e)	Founding stability (Geotech conditions)	Medium (-) (Highly Probable)	Low (-) (Probable)
f)	Loss of topsoil and erosion	Medium (-) (Highly Probable)	Low (-) (Probable)
g)	Sanitation and waste management	Medium (-) (Highly Probable)	Low (-) (Probable)
h)	Visual Pollution / "Sense of Place"	Medium (-) (Highly Probable)	Low (-) (Probable)
i)	Dust and noise pollution	Medium (-) (Highly Probable)	Low (-) (Probable)
k)	Traffic	Medium (-) (Highly Probable)	Low (-) (Probable)
l)	Safety	Medium (-) (Highly Probable)	Low (-) (Probable)
m)	Socio-economic & Employment (positive)	Low (+) (Highly Probable)	Medium (+) (Probable)

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-) Probability: (in brackets)

RECOMMENDED MANAGEMENT ACTIONS

A variety of mitigation measures have been identified that could mitigate the scale, intensity, duration or significance of the impacts. These measures, which have been informed by the various specialist studies conducted, are included in this Final Basic Assessment Report (BAR) and in the draft EMP (attached). The BAR and draft EMP also includes guidelines to be applied during the construction and operational phases of the project.

CONCLUSIONS

Development, by its very nature, implies impact. The EIA process identifies and quantifies these impacts. Where possible these impacts are avoided through planning revision. In other cases mitigation is proposed to reduce the severity and significance of the impacts.

The BAR provides a summary description of the feasible alternatives and potential impacts identified during the BAR Phase; additional information on the affected environment, mostly drawn from the specialist studies conducted; a description and assessment of the potential impacts associated with the various feasible alternatives as well as an indication of potential mitigation measures; conclusions and various recommendations with regard to the way forward; and a series of Appendices containing relevant information, including the various specialist studies.

Regional planning frameworks, such as the Municipal Spatial Development Framework and Mpumalanga Biodiversity Conservation Plan are also largely in support of tourism as the preferred landuse within this area, and in principal the MalaMala West Street Bridge adds to the overall value of the MalaMala product which is essentially tourism based. For this reason these planning frameworks can be seen to be largely in support of the proposed bridge reconstruction. The MalaMala West Street Bridge falls within an area that focuses on business and nature conservation. The reconstruction of the bridge is aimed at maintaining and enhancing the sustainability and ongoing operation of MalaMala.

Extensive work has gone into assessing the impact that the proposed activity would have on the daily functionality of the area. The proposed bridge and its associated design has taken cognizance of all of these aspects and has been addressed in detail in the BAR.

The draft EMP provides much more detailed mitigation measures and should all proposed mitigation measures be instituted it is not envisaged that the proposed development poses any negative impacts of high significance which cannot be mitigated.

It is the final considered opinion of the Environmental Assessment Practitioner (Aurecon) that the reconstruction and strengthening of the West Street Bridge adds value to the landuse within this area and as such is thus an acceptable activity that may take place on this property, provided that impacts are avoided where possible and in other instances, mitigated as far as possible.

It is therefore the EAP's recommendation that authorization be granted provided that good environmental practices be implemented; and that this will include environmentally sensitive planning and design of the said bridge.

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Abbreviations

	Terms
ECO	Environmental Control Officer
ECO	Environmental Control Officer –
	A person appointed by the project manager, developer, engineer
	or contractor to oversee compliance to the EMP. This person can
	be an internal appointment or an external consultant/specialist
	depending on the authorities' requirements.
Environment	The external circumstances, conditions and objects that affect the
	existence and development of an individual, organism or group;
	these circumstances include biophysical, social, economic,
	historical, cultural and political aspects.
Environmental Impact	A study of the environmental consequences of a proposed course
Assessment (EIA)	of action.
Environmental impact	an environmental change caused by some human act
Geotechnical	the study of geological conditions
Hydrological	the study of surface water and groundwater flow
Public Participation	a process of involving the public in order to identify needs, address
Process	concerns, choose options, plan and monitor in terms of a proposed
	project, programme or development
Red Data Book (South	an inventory of rare, endangered, threatened or vulnerable species
African)	of South African plants and animals
Scoping	a procedure for determining the extent of and approach to an EIA,
	used to focus the EIA to ensure that only the significant issues and
	reasonable alternatives are examined
Scoping Report	a report describing the issues identified

	Abbreviations
DEA	Department of Environment Affairs
DME	Department of Minerals and Energy
DWAF	Department of Water Affairs and Forestry
ECA	Environment Conservation Act
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
EIR	Environmental Impact Report
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
MDEDET	Mpumalanga Department of Economic Development, Environment and Tourism
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
NWA	National Water Act
SAHRA	South African Heritage Resources Agency
SDF	Spatial Development Framework
ToR	Terms of Reference
WULA	Water Use Licence Application

Section A: Background Information

Project MalaMala Ranch (Pty) Ltd

applicant:

Trading name MalaMala Ranch (Pty) Ltd

(if any):

Contact David Evans

person:

Physical The Farm Flockfield 414 KU, MalaMala Game Reserve, Sabi Sand

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E-mail: iain.garratt@aurecongroup.com

Qualifications: M. Environmental Management; BTech Nature Conservation

Professional EAPSA Certified

affiliations (if

any):

Section B: Detailed description of the proposed activity

Describe the activity, which is being applied for, in detail. The description must include the size of the proposed activity (or in the case of linear activities, the length) and the size of the area that will be transformed by the activity.

MalaMala Ranch (Pty) Ltd plans to reconstruct and modify the West St Bridge on The Farm Flockfield 414 KU, MalaMala Game Reserve.

This project includes the following activities:

- Reconstruction of the bridge on the same footprint;
- The raising of the bridge by approximately 2m
- The extension of the bridges stays and approaches.

The original bridge comprised six spans of 25.5m giving a total length of 153 m between abutments and was designed to support game drive type vehicles only with a maximum mass of 5t.

The deck level was determined from the maximum know flood level with a free board of 1.5m. The deck is level with gaps in the kerbs to allow for drainage of the deck surface.

Section C: Property/Site Description

Provide a full description of the preferred site alternative (farm name and number, portion number, registration division, erf number etc.):

The preferred site is located on Portion 1 of the Farm Flockfield 414 KU.

Indicate the position of the activity using the latitude and longitude of the centre point of the preferred site alternative. The co-ordinates should be in degrees and decimal minutes. The minutes should have at least three decimals to ensure adequate accuracy. The projection that must be used in all cases is the WGS84 spheroid in a national or local projection. The position of alternative sites must be indicated in Section B of this document.

Latituda (C).			Langituda (E	٠.	
Latitude (S):		Longitude (E):			
24	49'	34.1"	031°	33'	27.4"

In the case of linear activities:

		Latitude (S):		Longitude (E):	
•	Starting point of the activity	0	4	0	
•	Middle point of the activity	0	•	0	6
•	End point of the activity	0	4	0	4

Site or Route Plan

A detailed site or route plan(s) must be prepared for each alternative site or alternative activity. It must be attached as an appendix to this document. **See Appendix A, Annexure B for the site layout.**

The site or route plans must be at least A3 and must include the following:

- a reference no / layout plan no., date, and a legend / land use table
- the scale of the plan which must be at least a scale of 1:2000;
- the current land use as well as the land use zoning of each of the properties adjoining the site or sites;
- the exact position of each element of the application as well as any other structures on the site;
- the position of services, including electricity supply cables (indicate above or underground), water supply pipelines, boreholes, street lights, sewage pipelines, storm water infrastructure and telecommunication infrastructure;
- all indigenous trees taller than 1.8 meters and all vegetation of conservation concern (protected, endemic and/or red data species);
- servitudes indicating the purpose of the servitude;
- sensitive environmental elements within 100 meters of the site or sites including (but not limited thereto):
 - watercourses and wetlands;
 - the 1:100 year flood line;
 - ridges;
 - cultural and historical features;
- 10 metre contour intervals

Site Photographs

Color photographs from the centre of the site must be taken in at least the eight major compass directions with a description of each photograph. Photographs must be attached as an appendix to this form. **See Appendix B, Annexure A for the site photos.**

Facility Illustrations

A detailed illustration of the activity must be provided at a scale of 1:200 as an appendix for activities that include structures. The illustrations must be to scale and must represent a realistic image of the planned activity. The illustration must give a representative view of the activity. See Appendix A, Annexure B For the facility illustrations.

Section D: Basic Assessment Report

Prepare a basic assessment report that complies with Regulation 22 of the Environmental Impact Assessment Regulations, 2010. The basic assessment report must be attached to this form and must contain all the information that is necessary for the competent authority to consider the application and to reach a decision contemplated in Regulation 25, and must include:

(Checklist for official use only)

1. A description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity.

Refer to Section 4.1

2. An identification of all legislation and guidelines that have been considered in the preparation of the basic assessment report.

Refer to Section 4.2

- 3. Details of the public participation process conducted in terms of Regulation 21(2)(a) in connection with the application, including –
- (i) the steps that were taken to notify potentially interested and affected parties of the proposed application;
- (ii) proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the proposed application have been displayed, placed or given;
- (iii) a list of all persons, organisations and organs of state that were registered in terms of regulation 55 as interested and affected parties in relation to the application; and
- (iv) a summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues;

Refer to Section 4.3

A description of the need and desirability of the proposed activity;

Refer to Section 4.4

5. A description of any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives will have on the environment and on the community that may be affected by the activity;

Refer to Section 4.5

- 6. A description and assessment of the significance of any environmental impacts, including—
- (i) cumulative impacts, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the activity:
- (ii) the nature of the impact;

the extent and duration of the impact;

the probability of the impact occurring;

the degree to which the impact can be reversed;

the degree to which the impact may cause irreplaceable loss of resources; and

the degree to which the impact can be mitigated;

Refer to Section 4.6

7. Any environmental management and mitigation measures proposed by the EAP:

Refer to Section 4.6

8. Any inputs and recommendations made by specialists to the extent that			
may be necessary;			
Refer to Section 4.6			
9. A draft environmental management programme containing the aspects			
contemplated in regulation 33;			
Appendix F			
10. A description of any assumptions, uncertainties and gaps in			
knowledge;			
Refer to Section 5			
11. A reasoned opinion as to whether the activity should or should not be			
authorised, and if the opinion is that it should be authorised, any conditions that			
should be made in respect of that authorisation			
Refer to Section 4.7			
12. Any representations, and comments received in connection with the			
application or the basic assessment report;			
Refer to Appendix E; Annexures F & J			
13. The minutes of any meetings held by the EAP with interested and			
affected parties and other role players which record the views of the			
participants;			
Refer to Appendix E; Annexure F			
14. Any responses by the EAP to those representations, comments and			
views;			
Refer to Section Appendix E; Annexure J			
15. Any specific information required by the competent authority; and			
N/A			
16. Any other matters required in terms of sections 24(4)(a) and (b) of the			
Act.			
N/A			

The basic assessment report must take into account -

- (a) Any relevant guidelines; and
- (b) Any departmental policies, environmental management instruments and other decision making instruments that have been developed or adopted by the competent authority in respect of the kind of activity which is the subject of the application.
- * In terms of Regulation 22(4), the EAP managing the application must provide the competent authority with detailed, written proof of an investigation as required by section 24(4)(b)(i) of the Act and motivation if no reasonable or feasible alternatives, as contemplated in sub regulation 22(2)(h), exist.

If NO, the motivation and investigation required in terms of Regulation 22(4) must be attached as an Appendix to this document			

4.1 Description of the affected environment

4.1.1 Geographical aspects

The site for the proposed project is located on the property of MalaMala on the western side of the Kruger National Park, Mpumalanga South Africa.

The preferred site (Figure 1) Co-ordinates are S24 49'34.1"E031 33'27.4.

4.1.2 Physical aspects

The site has moderate sloped topography, and has a perennial watercourse (the Sand River) running through it.

The annual summer rainfalls for the area varies from 450 to 600 mm. Temperatures vary between -4°C and 45°C, with an average of 22°C.

Approximately 65 - 70% of the area's rainfall occurs during the summer months between October and March, in the form of conventional thunderstorms and showers, and measure between 450 and 600 mm/year.

4.1.2.1 Geology

The geological description for the general area is described by Venter and Bristow (1986) as consisting of two extremely different types:

- Light-grey colored acid igneous rock, specifically Archaean Basement Granite and Gneiss that underlay large parts of the Lowveld, and
- Dark colored basic or mafic igneous rock, specifically the Sabi-Sands Game Reserve. The
 Granite/Gneiss includes banded metamorphic rocks, medium-grained biotite gneiss with coarsegrained quartz-feldspar leucosomes, recrystallised in places. Conspicuous pegmatite veins are
 visible as outcrops at the soil surface at places. The basic igneous rock type includes medium to
 course-grained Gabbro, olivine and Quartz-gabbro (Frick, 1986).

4.1.3 Biological aspects

The vegetation surrounding the site can be defined as pristine Arid Lowveld, a typical *Acacia nigrescens-Sclerocarya birrea* Savanna with *Digitaria eriantha* as dominant grass.

In general the tree layer is characterised by Red Bushwillow *Combretum apiculatum*, Largefruit Bushwillow *C. zeyheri*, Silver Clusterleaf *Terminalia sericea*, *Strychnos madagascariensis*, *Sclerocarya birrea*, *Lannea stuhlmanni*, and *Peltophorum africanum*. Bottomland situations are dominated by Knob Thorn *Acacia nigrescens*, Scented Thorn *A. nilotica*, Common Falsethorn *Albizia harveyi* and *Euclea divinorum*. The scrub layer is moderately developed and individuals of Hairy Corkwood *Commiphora africana*, Wild Grape *Cissus cornifolia*, Sickle Bush *Dichrostachys cinerea*, *Acacia exuvialis*, *Dalbergia melanoxylon* and *Pterocarpus rotundifloia* are commonly found. The grass layer is poorly to moderately developed, and grasses such as Herringbone Grass *Pogonarthria squarrosa*, Blue Seed Grass *Tricholaena monachne*, Curlyleaf Lovegrass Eragrostis rigidior, *Melinis repens*, *Brachiaria nigropedata*, *Panicum maximum*, *Digitaria eriantha* and *Heteropogon contortus* are the most conspicuous species. Other grasses that can be found are Kalahari Sand Quick *Schmidtia pappophoriodes*, Spreading Bristlegrass *Arastida congesta*, Bushveld Signalgrass *Urochloa mosambicensis* and *Enneapogon cenchroides*.

The riparian zone, within which the bridge is located, is dominated by Jackal-berry *Diospyros mespiliformis* riverine woodland on alluvial soils. Large Jackal-berry trees are present and also other riverine vegetation associated with alluvial soils such as the Weeping Boer-bean *Schotia brachypetala*.

4.1.4 Social aspects

The proposed activity is isolated, from a social perspective. Apart from the management authority of the Sabi Sands Wildtuin and the Kruger National Park as well as adjacent land owners who may traverse the various cutline roads on the boundary of MalaMala, there are no social aspects that may be affected by the proposed activity. The proposed activity is located on privately owned land with restricted access and is intended for the sole benefit of the land owner, his employees and guests.

4.1.5 Economic aspects

The bridge crossing the Sand River on MalaMala Game Reserve was constructed as a vital link between the northern and southern portions of the MalaMala property. Due to the bulk of the MalaMala traversing area being situated to the north side of the Sand River as well as the relative abundance of game in the north, it is of the utmost importance to have a permanent link (the bridge) between the north and south which guarantees access and thus ultimately ensures the financial viability of MalaMala Game Reserve as a premier wildlife viewing and tourism destination.

In conclusion, the bridge was constructed to ensure access during the summer months when the water flow would ordinarily prohibit passage to the game rich area on the western fringe of the Kruger Park.

In addition to the above, the bridge may be viewed as having potential disaster management significance, as the proposed strengthening (by expansion and extension of the eastern stay) would result in a reliable and safe strategic evacuation point during unexpected extreme climatic events. This strategic access point into the National Park would be accessible all year round This is an enormous benefit and has been used on occasion in the past.

4.1.6 Cultural aspects

There was no evidence to show that the existing bridge site is of cultural significance. There are no heritage resources, including known archaeological or paleontological sites over 100 years old, and graves or structures older than 60 years. The affected area is very small, and limited to the bridge crossing point. The site is located between two river terraces, but not within potentially fossiliferous superficial deposits. Furthermore, the public participation process, including site meetings, did not reveal any oral histories and cultural landscapes/viewscapes associated with the site.

4.2 Prescribed Environmental Management Standards, Practices, Policies, Guidelines or Legislation

On 18 June 2010 the Minister responsible for Environmental Affairs promulgated amended EIA Regulations in terms of Chapter 5 of NEMA. from the date of effect of these amended EIA Regulations, 2 August 2010, these amended EIA Regulations replaced the previous EIA Regulations that were promulgated on 21 April 2006

The following legislation, guidelines, departmental policies, environmental management instruments and/or other decision making instruments that have been developed or adopted by a competent authority in respect of activities associated with a development of this nature, were identified and considered in the preparation of this basic assessment report:

- a. Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), as amended.
- b. DEA (2010), Public Participation 2010, Integrated Environmental Management Guideline Series 7, Department of Environmental Affairs, Pretoria, South Africa.

- c. DEA&DP (2010) Guideline on Alternatives, EIA Guideline and Information Document Series. Western Cape Department of Environmental Affairs & Development Planning (DEA&DP).
- d. DEAT (2002) Specialist Studies, Information Series 4, Department of Environmental Affairs and Tourism (DEAT), Pretoria.
- e. DWA (2007), Guideline for Developments within a Flood line (Edition 1), Department of Water Affairs and Forestry, Pretoria, South Africa.
- f. DWAF (2004) General Authorization No. 399 in the Government Gazette No. 26187 dated 26 March 2004.
- g. Ferrar, A.A. & Lotter, M.C. 2007. Mpumalanga Biodiversity Conservation Plan Handbook. Mpumalanga Tourism & Parks Agency, Nelspruit.
- h. Government Notice No. R. 543, R. 544, R. 545, R. 546 and R. 547 in Government Gazette No. 33306 of 18 June 2010.
- i. Haydorn, A.E.F. (2006) Rational Assessment of Development in Sensitive Environments (Ref: ENPLCRIT). Tel/Fax: (021) 887 4382. email: heydaef@adept.co.za
- j. National Environmental Management Act, 1998 (Act No. 107 of 1998) ("NEMA").

4.3 Public Participation Process

The Public Participation Process (PPP) and Departmental Site visit was undertaken according to Regulation 54 of the EIA Regulations, 2010, and took into consideration the Public Participation 2010 Guideline Document (DEA, 2010).

The level of public participation was determined by taking into account the scale of the anticipated impacts of the proposed project, the sensitivity of the affected environment and the degree of controversy of the project, and the characteristics of the potentially affected parties. Based on the findings of the aforementioned consideration, there was no reason to elaborate on the minimum requirements of the public participation process outlined in the EIA Regulations, 2010 or use reasonable alternative methods for people desiring of but unable to participate in the process due to illiteracy, disability or any other disadvantage. Thus the decision was taken to circulate a detailed Background Information Document and that this, with additional input from I&AP's, would be adequate in terms of engaging with the public and affected parties.

Potentially interested and affected parties were notified of the proposed application and site meeting by –

- Fixing two (2) notice boards at a place conspicuous to the public namely, at the Shaw's Gate Entrance to the Sabi Sand Wildtuin and at the junction of the R536 and the dirt road leading to Shaw's Gate. (Appendix E, Annexure A & B). There was no reasonable alternative site (Section D 4.5).
- Giving written notice to owners and occupiers of land adjacent to Farm Flockfield 414 KU and organs of state having jurisdiction in respect of the proposed activity. The applicant, MalaMala Ranch (Pty) Ltd, is the owner of the land and occupies the site where the activity is to be undertaken, namely MalaMala. The site is not designated a ward and there was no reasonable alternative site (Section D 4.5). Consequently, a Background Information Document (BID) was prepared and distributed via email (Appendix E, Annexure C) to

Table 2: Authorities and IAP's

The owner or person in control of that land if the applicant is not the owner or person in control of the land:

N/A - The land is owned by the applicant.

The occupiers of the site where the activity is or is to be undertaken or to any alternative site where the activity is to be undertaken:

The applicant occupies the site where the activity is to be undertaken (MalaMala Camps). There was no reasonable alternative site (Section D 4.5).

The municipal councilor of the ward in which the site or alternative site is situated.

The site is not designated a ward.

The municipality which has jurisdiction in the area:

Bushbuckridge Local Municipality (BBRLM)

Mr Andries Mnisi (mnisiandries@bushbuckridge.gov.za) 013 799 1851/7

Any organ of state having jurisdiction in respect of any aspect of the activity:

Department of Water Affairs

Sampie Shabangu ShabanguS2 @dwa.gov.za 082 857 4275

Mpumalanga Department of Economic Development Environment and Tourism (MDEDET)- Impact Management

Thulisile Nkonyana (SSLanga@mpg.gov.za) 073 173 3894

Mpumalanga Department of Economic Development Environment and Tourism (MDEDET)-Pollution and Waste

Cyprian Theledi (mtheledi@mpg.gov.za) 079 189 5599

South African Heritage Resources Agency (SAHRA)

Philip Hine (philip Hine (phine@sahra.org.za) 021 462 4502

Department of Public Works

Mr. Makgamatho (KGMakgamatho@mpg.gov.za) 072 609 8663

South African National Parks (SANparks)

Stefanie Freitag Donaldson (stefanie@sanparks.org, 013 735 4192)

Richard Sowry (RichardS@sanparks.org)

Tracy-Lee Anne Petersen (TracyP@sanparks.org, 076 896 3399)

Freek Venter (FreekV@sanparks.org)

Leonie du Plessis (leonied@sanparks.org, 013 735 4320)

Placing an advertisement in a local newspaper, the (The Lowvelder) on Friday 20th April 2012.
 (Appendix E, Annexure D & E). No official Gazette existed at the time of the application. The proposed activity shall not have an impact that extends beyond the boundaries of the metropolitan or local municipality in which it will be undertaken.

In terms of regulation 55(1), all organs of state which have jurisdiction in respect of the proposed activity and all persons who submitted written comments, or requested, in writing, to be registered were placed on the register (**Appendix E, Annexure I**).

A summary of the issues raised (**Appendix E, Annexure J**)

4.4 Need and Desirability

4.4.1 Legislative Background and Strategic Context

The National Environmental Management Principles of NEMA, 1998, which guide the interpretation, administration and implementation of NEMA, 1998 (and the EIA Regulations, 2010) specifically *inter alia*, require that environmental management must place people and their needs at the forefront of its concern (Section 2(2)). The latter refers to the broader societal/community needs and interests, and is put into effect through the EIA Regulations, 2010, which require environmental impact assessments to specifically consider 'need and desirability' in order to ensure that the 'best practicable environmental option' is pursued and that development more equitably serves broader societal needs now and in the future. Furthermore, it ensures that the proposed actions of individuals are measured against the long-term public interest.

What is needed and desired for a specific area must be strategically and democratically determined (DEA&DP (2010) Guideline on Need and Desirability). The strategic context for informing need and desirability is best addressed and determined during the formulation of the sustainable development vision, goals and objectives of Integrated Development Plans ('IDPs') and Spatial Development Frameworks ('SDFs') during which collaborative and participative processes play an integral part, and are given effect to, in the democratic processes at local government level (DEA&DP (2010) Guideline on Need and Desirability). The need and desirability must therefore be measured against the contents of the credible IDP, SDF and EMF for the area, and the sustainable development vision, goals and objectives formulated in, and the desired spatial form and pattern of land use reflected in, the area's IDP and SDF (DEA&DP (2010) Guideline on Need and Desirability). Integrated Development Planning (and the SDF process) effectively maps the desired route and destination, whilst the project-level EIA decision-making finds the alternative that will achieve the desired goal (DEA&DP (2010) Guideline on Need and Desirability). However, inadequate planning or the absence of a credible IDP and SDF means that the EIA has to address the broader need and desirability considerations. Consequently, 'need and desirability' is determined by considering the broader community's needs and interests as reflected in a credible IDP, SDF and EMF for the area, and as determined in the EIA decision-making process.

Furthermore, the Constitution calls for *justifiable* economic development. The specific needs of the broader community must therefore be considered together with the opportunity costs and distributional consequences in order to determine whether or not the development is 'justified'.

The general meaning of need and desirability refers to time and place, respectively, i.e. is this the right time and is it the right place for locating the proposed activity. The need and desirability of this application was addressed separately and in detail by answering *inter alia* the following questions:

NEED ('timing')

Question 1:

Is the land use (associated with the activity being applied for) considered within the timeframe intended by the existing approved Spatial Development Framework (SDF) agreed to by the relevant environmental authority? (i.e. is the proposed development in line with the projects and programmes identified as priorities within the credible IDP).

The proposed activity will not occur at the land use scale.

The MEC for the Mpumalanga Department of Economic Development, Environment and Tourism had not adopted a credible IDP, SDF or EMF in terms of the EIA Regulations, 2010, at the time of this application.

Mpumalanga Conservation Plan: Chapter 6 – Land use guidelines Identifies ecotourism as an integral component of the long term sustainability of conservation areas. The bridge and the repair thereof is integral linked to conservation and tourism. Below are extracts from the MCP:

Protected Areas are managed primarily for biodiversity conservation, but also for socioeconomic objectives such as tourism and education.

Land-Use Type 1. Conservation Management

_ Includes: formal and informal Protected Areas managed for biodiversity, wildlife production and recreational and educational tourism, conducted in natural habitats on extensively managed landscapes on public or private land;

Bushbuckridge Local Municipality

The SDF recognises the value eco-tourism brings to the region as a whole and promotes private and rural partnerships which can further enhance the trade. Again the proposed bridge repair falls within this ambit and adds value to the tourism infrastructure already present on this land.

The proposed activity is in line with current activities as carried out within the Sabi Sand Wildtuin.

Question 2:

Should the bridge repair concerned in terms of this land use (associated with the activity being applied for) occur here at this point in time?

The proposed activity is located on privately owned land with restricted access and is intended for the sole benefit of the land owner, his employees and guests and ultimately to support the financial viability of the MalaMala operation. Without the bridge being repaired timeously, access to game rich viewing areas (the bulk of the proponent's property is located on the northern side of the river) and ultimately the ability of MalaMala to function optimally will not be realised. This may lead to a degeneration of the surrounding land and ultimately affect the surrounding landuse.

Explanation: Question 1 and 2 seeks to find clarity as to whether the proposed land use is catered for in the current planning framework of the SDF and is intended for at that specific point in time. In this context the term land use should not only be broadly defined as conservation and tourism, but where relevant, it must be further qualified, for example, stating specifically whether the bridge repair is to benefit the local landuse and environment.

Question 3:

Does the community/area need the activity and the associated land use concerned (is it a societal priority)? This refers to the strategic as well as local level (e.g. development is a national priority, but within a specific local context it could be inappropriate).

As mentioned above, broader societal priorities are irrelevant given the small scale, isolated location and intended beneficiaries of the proposed activity.

However, the statement above must be seen within the context of the potential benefit that the wider community receives through employment and the operation of MalaMala as well.

Explanation: Question 3 relates to the type of development and land use and not just its associated benefits or costs (i.e. the specific needs of the community at that specific time, e.g. the ability of the activity to add value to the local economy and surrounding communities well being, must be considered).

Question 4:

Are the necessary services with adequate capacity currently available (at the time of application), or must additional capacity be created to cater for the re-construction of the bridge?

The bridge is an independent portion of infrastructure within the MalaMala area and does not have any link or reliance on Municipal infrastructure or services.

Question 5:

Is this development provided for in the infrastructure planning of the municipality, and if not what will the implication be on the infrastructure planning of the municipality (priority and placement of services and opportunity costs)?

The proposed activity is independent of the infrastructure planning of the District Municipality.

Explanation: Question 4 and 5: According to the NEMA EIA Regulations an EIA must contain a description and assessment of the significance of any environmental impacts, including cumulative impacts, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the activity. An associated activity/component essential for the undertaking of a proposed development (i.e. any associated component of the development, which cannot be separated from the development itself; e.g. residential development that cannot exist without the essential municipal infrastructure to serve it in terms of water and electricity provision, waste removal, treatment of sewage and management of stormwater) must be considered together with the proposed development, before the environmental authority decides on the development application. The environmental authority must (be able to) apply its mind to all the impacts (of the development and all its associated activities/components) prior to decision-making. Deferring decision-making on associated components to a future date constitutes conditional and piecemeal (incremental) decision-making, which result in the environmental authority not applying its mind to all the impacts and the pre-empting of decisions on the associated components-resulting in unsustainable development and legally impermissible administrative action.

Question 6:

Is this project part of a national programme to address an issue of national concern or importance?

No, the project is not part of a national programme.

Explanation: Question 6: While the legislative frameworks require that national, provincial and municipal plans should be aligned, it is acknowledged that there might be certain strategically important developments (e.g. the construction of a nuclear power station) that are part of strategic programmes that are not always catered for in current planning framework of the SDFs. In these instances the strategic need and desirability considerations must be measured against the needs and desires of the area in question when determining the need and desirability of the development under consideration.

DESIRABILITY ('placing')

Question 7:

Is the utilization of the existing site best practicable environmental option for this land/site?

The anticipated impact posed to the environment by the proposed activity is expected to be negligible because the bulk of the bridge is still standing (impacts on the receiving environment whilst in operation will not increase, in fact negative impacts may decrease). Strengthening and extending the northern stays will only add to the stability of this structure improvement of the design reduces potential impacts. The new stays have specifically been designed as compact, individual footprints that have minimal foundational impact and can easily be placed to accommodate the site sensitivities. The activity will result in some loss/transformation of the river bank; however, no protected species will be removed with the placement of the stays. Moreover the integrity of the existing bank in terms of erosion will be improved. The disturbance of the river bank cannot be altogether avoided but disturbance can be minimized and remedied.

In order to comply with Section 2 (3) of NEMA, 1998, it is important to note that the environment cannot be considered in isolation. Development must also be socially and economically. The government decision-makers and environmental assessment practitioners must serve the public's social, economic and ecological needs equitably. Sustainable development requires the simultaneous achievement of the *triple bottom-line*. Consequently, one has to determine whether the nature and extent of the negative environmental impacts occur at a cost acceptable to society and the economy. This can be determined by considering the opportunity costs. Considering an investigation of potential alternatives revealed no feasible and reasonable alternative (Section D 4.5), the next best alternative for establishing the opportunity cost is the no-go option. Consequently, the opportunity cost is the foregone benefit of losing the no-go option. As mentioned above, a comparative assessment of the proposed activity with the no-go option must consider the social, economical and environmental benefits and/or disadvantages associated with/yielded by each alternative.

There are no economic benefits associated with the preferred (Section D 1) and no-go option. No social benefits are yielded by the no-go option, but there are limited social benefits to the land owner and his employees, specifically the improvement of operational efficiency of MalaMala and thus ultimately an increase in the financial viability of the operation. The loss/transformation of habitat is a minor disadvantage of the preferred alternative when compared with the no-go option. However, the latter negative environmental impact can be minimised (by appropriately positioning and designing the stays to combat further erosion and damage to the river bank) and remedied to the extent that the cost associated with the initial loss/transformation is acceptable relative to the aforementioned limited societal benefits.

Therefore, the proposed/preferred activity is the best practicable environmental option for this site, because it provides the most benefit to the long-term livelihood of the employees and it will not cause any significant damage to the environment, particularly in the long term, and on condition that the environmental impacts (Section D 4.6) are mitigated accordingly (Section D 4.6).

Explanation: Question 7: According to NEMA the "best practicable environmental option" means the option that provides the most benefit and causes the least damage to the environment as a whole, at a cost acceptable to society, in the long term as well as in the short term. In determining the best practicable environmental option, adequate consideration must also be given to opportunity costs.

Question 8:

Would the approval of this application compromise the integrity of the existing approved and credible municipal IDP and SDF as agreed to by the relevant authorities?

The proposed activity is independent of District Municipality's IDP and SDF.

Question 9

Would the approval of this application compromise the integrity of the existing environmental management priorities for the area (e.g. as defined in EMFS), and if so, can it be justified in terms of sustainability considerations?

The approval of this application will not compromise the integrity of the Sabi Sand Wildtuin.

Explanation: Question 8 and 9: If the development is to occur in the proximity of an urban area, clarity must also provided whether or not it will be situated within or outside of the urban area, with the impacts associated with its location in relation to the urban area to be specifically considered and reported on. This is however not the case as the proposed activity will take place on private land outside of the urban edge.

Question 10:

Do location factors favour this land use (associated with the activity applied for) at this place? (this relates to the contextualization of the proposed land use on this site within its broader context).

Yes. Location for development within land owned by MalaMala and within the Sabi Sand is restricted to utilizing the existing footprint or (in terms of the new stays) to a footprint only slightly larger. Consequently, existing structure as remain standing as well as existing components, such as footings; concrete blocks etc...can be utilized.

Question 11:

How will the activity or the land use associated with the activity applied for, impact on sensitive natural and cultural areas (built and rural/natural environment)?

The impact on sensitive natural areas will be limited given the scale and nature of the proposed activity. The physically transformed footprint will be minimal and in fact an extension of the existing footprint. Never the less, some plant species and the river bank will be impacted on There are no perceived impacts of cultural significance (Section D 4.1).

Question 12:

How will the development impact on people's health and wellbeing (e.g. in terms of noise, odours, visual character and sense of place, etc)?

There are no anticipated negative impacts on people's health and wellbeing. The proposed activity is an improvement on the existing damaged bridge. Moreover the bridge has been a part of the landscape for numerous years and as such is not seen as a visual intrusion. In addition to this the bridge is located on a privately owned property with restricted access. With the exception of noise generated during the construction phase, the bridge will have no negative acoustical affect on the environment.

Question 13:

Will the proposed activity or the land use associated with the activity applied for, result in unacceptable opportunity costs?

No. Refer to Question 7 for a review of the consideration of opportunity costs.

Explanation: Question 13: Opportunity costs can be defined as the net benefit that would have been yielded by the next best alternative (for example, if farming is the next best alternative for a piece of land, then the forgone benefit of losing the farming option will be the opportunity cost of any other land use, or if not proceeding with the activity, then the forgone benefits of the proposed activity is the opportunity cost of not proceeding). Opportunity costs also relate to the use of limited resources, for example water. If a limited volume of water is available in an area the most desirable use of the water considering the needs in the area must be determined in order to consider the opportunity costs associated with the different uses of the water. The concept of opportunity costs is applicable to project alternatives as well as policy selection. It is vital information if decision makers are to understand the implications associated with specific development proposals. A key part of considering opportunity costs is commonly to comparatively consider and assess the different alternatives in terms of the benefits and/or disadvantages associated with each alternative. Opportunity cost is a concept that often need not involve monetary values, though where these values can be given, they allow for a more detailed comparison than would otherwise be possible.

Question 14:

Will the proposed land use result in unacceptable cumulative impacts?

No. Refer to Question 4 for a review of the consideration of cumulative impacts resulting from associated activities essential for the proposed development, such as water, energy/electricity provision and sewerage disposal.

Other types of cumulative impacts are addressed in Section D 4.6 and appropriately mitigated in Section D 4.6.

Explanation: Question 14 Cumulative impacts can be defined as:

- Addictive: the simple sum of all the impacts (e.g. the accumulation of ground water pollution from various developments over time leading to a decrease in the economic potential of the resource).
- Synergistic effects occur where impacts interact with each other to produce a total effect greater
 than the sum of individual effects. These effects often happen as habitats or resources approach
 capacity (e.g. the accumulation of water, air and land degradation over time leading to a
 decrease in the economic potential of an area).
- Time crowding effects occur when frequent, repetitive impacts occur on a particular resource at the same time (e.g. boreholes decreasing the value of water resources).
- Neutralizing effects occur where impacts may counteract each other to reduce the overall effect (e.g. infilling of a wetland for road construction, and creation of new wetlands for water treatment).
- Space crowding effects occur where we have a high spatial density of impacts on a particular ecosystem (e.g. rapid informal settlement).
- Externalisation of disadvantages occurs when there is no or insufficient consideration given to the associated social costs that will be borne by the public.

The answers to the questions above will form key informants to the identification and consideration of alternatives, including the option not to proceed with the development.

4.5 Feasible and Reasonable Alternatives

4.5.1 Legislative Background

The very consideration of a development in terms of EIA is about the consideration of alternatives related to the development. The NEMA prescribes that all environmental impact assessments, which are to be utilised in informing an application for environmental authorisation, must identify and investigate the alternatives to the activity on the environment (Sections 24(4)(b)(i) and 24(4A) of NEMA) and include a description and comparative assessment of the advantages and disadvantages that the proposed activity and feasible and reasonable alternatives will have on the environment and on the community that may be affected by the activity (Regulation 22(2)(h) of No. R. 543 of 18 June 2010). If, however, after having identified and investigated alternatives, no feasible and reasonable alternatives exist, no comparative assessment of alternatives, beyond the comparative assessment of the preferred alternative and the option of not implementing the activity (Sections 24(4)(b)(i) and 24(4A) of NEMA), is required during the assessment phase. In this instance, the EAP managing the application must provide the competent authority/MDEDET with detailed, written proof of the investigation(s) undertaken and motivation indicating that no reasonable or feasible alternatives, other than the preferred alternative and the no-go option, exist (Regulation 22(4) of No. R. 543 of 18 June 2010).

4.5.2 Definition of Alternatives

"Alternatives", in relation to a proposed activity, means different means of meeting the general purposes and requirements of the activity, which may include the following types of alternatives:

- The property on which, or location where, it is proposed to undertake the activity;
 - o Refers to both alternative properties as well as alternative sites on the same property.
- The type of activity to be undertaken;
 - o Provision of repair and modification of a bridge crossing the Sand River.
- The design or layout of the activity;
 - o Different engineering designs.
- The technology to be used in the activity;
 - o Option of achieving the same goal by using a different method or process.
- The operational aspects of the activity;
- Demand
 - When a demand for a certain product or service can be met by some alternative means,
 i.e. the demand for access to traversing areas north of the San River could be met by supplying other traversing areas.
- Input
 - Input alternatives for projects that may use different raw materials or energy sources in their processes.
- Routing
 - Alternative routes generally applies to linear developments (pipeline routes).
- Scheduling and Timing
 - Where a number of measures might play a part in an overall programme, but the order in which they are scheduled will contribute to the overall effectiveness of the end result.
- Scale and Magnitude
 - Activities that can be broken down into smaller units and can be undertaken on different scales, i.e. for a housing development there could be the option 10, 15 or 20 housing units.
- The option of not implementing the activity (no-go option).
 - The no-go option is taken to be the existing rights on the property and this includes all the
 duty of care and other legal responsibilities that apply to the owner of the property. All the
 applicable permits must be in place for a land use to be an existing right.

The key criteria when identifying and investigating alternatives are that they should be "feasible" and "reasonable". The "feasibility" and "reasonability" of and the need for alternatives must be determined by considering, *inter alia*, (a) the general purpose and requirements of the activity, (b) need and desirability, (c) opportunity costs, (d) the need to avoid negative impact altogether, (e) the need to minimise unavoidable negative impacts, (f) the need to maximise benefits, and (g) the need for equitable distributional consequences. The (development) alternatives must be socially, environmentally and economically sustainable. They must also aim to address the key significant impacts of the proposed office complex development by maximising benefits and avoiding or minimising the negative impacts.

4.5.3 Identification and Investigation of Alternatives Including Motivations

Given the aforementioned definition and description of alternatives, alternatives for investigation in this assessment were first identified by considering whether the different types of alternatives could meet the general purposes and requirements of gaining annual access to the northern sections of the MalaMala property and ability of MalaMala, and subsequently constitute a comparable activity. Thereafter, the need for an alternative was assessed to determine whether it warranted further investigation. Certain alternatives could not be considered as legitimate alternatives for comparable assessment from the onset of the assessment process because they apply to aspects/parts of the proposed activity. Consequently, they were considered throughout the assessment process to address site-specific impacts when the need for mitigation was identified by the relevant specialist studies.

4.5.3.1 Purpose and Requirements of reconstructing and modifying the West St Bridge

The purpose for reconstructing the MalaMala West Street Bridge is to to gain unrestricted, annual access to the northern sections of their property and maintain valuable traversing for game viewing.

4.5.3.1.1 Alternative No. 1: Property and Location

Purpose and Requirements

The purpose of the proposed activity is to reconstruct and modify the destroyed West St Bridge so as to afford MalaMala unrestricted, annual access to their property north of the Sand River. There is no other means to access the north all year round. The site is ideal in terms of the reasonably shallow rock on site, thus ensuring simple and inexpensive foundations and a less costly construction process.

Methodology

The study is to undertake a robust and defendable EIA process that will serve to inform the MDEDET's decision on the environmental acceptability of the proposed activity. Moreover ,the EIA process should provide MalaMala Ranch (Pty) Ltd with an understanding of the environmental implications and public concerns (if any)associated with the project in question and the range of mitigation measures available, leading to an improved project, while minimising risks and delays associated with the authorisation process.

Criteria used to investigate and assess alternatives

NA

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

It would be *unreasonable* to propose an alternative location because this application if for the repair of an existing bridge and therefore the only alternative would require constructing a new bridge on a new footprint as well as decommissioning the remaining structure with the requisite rehabilitation. This option would significantly compound the negative environmental impacts. It is more environmentally responsible and sustainable to place any activity in an already disturbed footprint, as opposed to an undisturbed and "impact free" area.

4.5.3.1.2 Alternative No. 2: Type of Activity

Purpose and Requirements

The specific nature of this activity, providing MalaMala unrestricted, annual access to their property north of the Sand River, does not afford alternative types of activities that can meet the same purposes or requirements, specifically to gain unrestricted, annual access to the northern sections of their property and maintain valuable traversing for game viewing.

Methodology

NA

Criteria used to investigate and assess alternatives

NA

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

The purpose and requirements of the proposed Bridge reconstruction and modification *cannot* be achieved by using an alternative type of activity. Consequently, this type of alternative is not applicable.

4.5.3.1.3 Alternative No. 3: Design

Purpose and Requirements

The purpose and requirements of the proposed West Street Bridge, including construction and modification so as to ensure resistance to major floods and unrestricted, annual access to the northern sections of their property, *can* be achieved using different architectural and or engineering designs of the bridge and new stays.

Methodology

A Bridge design was prepared so as to accommodate the existing structure and thus require minimal additional construction and footprint modification. This was completed prior to the commencement of this assessment process and thus has been subsequently modified through input from various specialist studies. Specialist studies were undertaken during the assessment process to identify potential impacts and to ascertain what the best design would be in terms of structure safety and robustness. In response to this various appropriate mitigations have been recommended to avoid or minimise negative impacts and enhance beneficial ones. Those mitigations informed the final and preferred structure design (Appendix A, Annexure B).

Criteria used to investigate and assess alternatives

Improvements made to the original design that form aspects of the final and preferred structure design were undertaken to address specific impacts. The assessment of the specific impacts associated with alternative designs included a comparison of the nature of the impact, the extent and duration of the impact, the probability of the impact occurring, the degree to which the impact can be reversed, the degree to which the impact may cause irreplaceable loss of resources, and the degree to which the impact can be mitigated (Section D 4.6).

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

Whilst alternative designs are reasonable, particularly given the need to avoid negative impacts or to minimise unavoidable negative impacts, the extent of those changes is restricted by the topography of the site as well as the morphology of the river. In addition to this the existence and functionality of some sections of the original bridge and the necessity to utilize these remnants, nullifies the suitability of numerous alternative designs. It stands to reason that the existing footprint whereon the bridge stands is totally transformed and thus has little or no sensitivity rating.

Furthermore, the design is informed by the findings contained in the relevant specialist studies. Consequently, this type of alternative had to be considered throughout the assessment process and evolve incrementally as and when the impacts were identified by the relevant specialist studies. The final and preferred design is an outcome of the aforementioned process or the 'end result'. The fact that it could not be predicted from the onset of the assessment process made it impossible to propose as an alternative for assessment.

4.5.3.1.4 Alternative No. 4: Technology

Purpose and Requirements

The purpose and requirements of the proposed bridge being built to afford unrestricted, annual access to the northern sections of the MalaMala property *can* be met by this type of alternative, specifically by using different technologies (methods or processes during the construction)

Methodology

Various technologies and methods available for the construction of a bridge were evaluated by the project team. Specialist studies were undertaken during the assessment process to identify potential, and recommend appropriate mitigations to avoid or minimise negative impacts or enhance beneficial impacts. Those mitigations informed the final and preferred technologies and materials to be used.

Criteria used to investigate and assess alternatives

Recommendations made regarding the utilisation of proper and suitable technologies to construct the bridge were undertaken to address specific impacts. The assessment of the specific impacts associated with the design and types of technologies and materials included a comparison of the nature of the impact, the extent and duration of the impact, the probability of the impact occurring, the degree to which the impact can be reversed, the degree to which the impact may cause irreplaceable loss of resources, and the degree to which the impact can be mitigated

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

The purpose and requirements of the bridge *can* be achieved by using this type of alternative, namely 'technology'. Consequently, this type of alternative is applicable. In addition, alternative technologies were sought throughout the assessment process to address specific impacts identified by the specialist studies, in the manner described in the above mentioned alternative for 'Design No. 3).

4.5.3.1.5 Alternative No. 5: Operational Aspects

Purpose and Requirements

Alternative operational aspects (procedures) *cannot* meet the purpose for providing unrestricted, annual access to the northern sections of their property.

Methodology

NA

Criteria used to investigate and assess alternatives

NA

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

The purpose and requirements of providing unrestricted, annual access to the northern sections of the MalaMala property *cannot* be achieved by using an alternative type of operational activity. Consequently, this type of alternative is not applicable.

4.5.3.1.6 Alternative No. 6: Demand

Purpose and Requirements

The purpose and requirements of the proposed Bridge reconstruction and modification *cannot* be met by this type of alternative, specifically by reducing the demand (or need) for the proposed activity. The services rendered and the need for these to be rendered in the most optimal manner is paramount.

Methodology

NA

Criteria used to investigate and assess alternatives

NA

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

The purpose and requirements of the proposed West Street Bridge reconstruction and modification *cannot* be achieved by using this type of alternative, 'demand'. Consequently, this type of alternative is not applicable. Never the less, alternative means were sought throughout the assessment process to address specific impacts identified by the specialist studies, in the manner described in the above mentioned alternative for 'Design' (Alternative No. 3). For example, ways of reducing the demand for sand were suggested by using in situ river sand¹.

4.5.3.1.7 Alternative No. 7: Input

Purpose and Requirements

The purpose and requirements of the proposed West Street Bridge reconstruction and modification *can* be met using different raw materials or energy sources.

Methodology

NA

Criteria used to investigate and assess alternatives

NA

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

Although the need for alternative inputs (to address site-specific impacts) *cannot* be predicted at the onset of the assessment process and is, therefore, not reasonable, alternative raw materials or energy sources were sought throughout the assessment process to address specific impacts identified by the specialist studies, in the manner described in the above mentioned alternative for 'Design (Alternative No. 3).

¹ River sand used for maintenance purposes may only be sourced by means of "Bar Skimming". Bar skimming or scalping requires scraping off the top layer from a gravel bar without excavating below the summer water level. Preliminary Guidance Document on the Impacts of Sand Mining on In stream and Riparian Habitat. L.Hill & C.j. Kleynhans IWQS March 1999.

4.5.3.1.8 Alternative No. 8: Routing

Purpose and Requirements

The purpose and requirements of the proposed West Street Bridge reconstruction and modification *cannot* be met using an alternative route. This specific type of alternative generally applies to linear developments, such as pipeline routes.

Methodology

NA

Criteria used to investigate and assess alternatives

NA

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

This type of alternative, 'Routing' is not applicable. Never the less, alternative routes for construction access were sought throughout the assessment process to address specific impacts identified by the specialist studies, in the manner described in the above mentioned alternative for 'Design' (Alternative No. 3).

4.5.3.1.9 Alternative No. 9: Scheduling and Timing

Purpose and Requirements

The purpose and requirements of the proposed West Street Bridge reconstruction and modification *can* be met using alternative scheduling and timing, specifically changing the order in which activities are scheduled to contribute to the overall effectiveness of the end result.

Methodology

NA

Criteria used to investigate and assess alternatives

NA

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

Although, the need for alternative scheduling or timing (to address site-specific impacts) **cannot** be predicted at the onset of the assessment process and is, therefore, not reasonable, alternative scheduling or timing was sought throughout the assessment process to address specific impacts identified by the specialist studies, in the manner described in the above mentioned alternative for 'Design' (Alternative No. 3). For example, rehabilitation should not be left until the end of construction, etc.

4.5.3.1.10 Alternative No. 10: Scale and Magnitude

Purpose and Requirements

The purpose and requirements of the proposed West Street Bridge reconstruction and modification *cannot* be met using an alternative scale or magnitude, specifically a smaller physical footprint or smaller structure.

Methodology

NA

Criteria used to investigate and assess alternatives

Reasoned explanation why an alternative was or was not found to be reasonable or feasible

This type of alternative, 'Scale and Magnitude', is not applicable. The size requirements which enable a bridge of this type to operate optimally are limited.

4.5.3.1.11 Alternative No. 11: No-go Option

The option of not implementing the activity (no-go option).was used as the benchmark against which all impacts associated with the proposed development were assessed.

4.5.2 Conclusion

Some types of alternatives were not applicable to the nature of the proposed activity, including its purpose or requirements ('Type of Activity', 'Operational Aspects', 'Demand', 'Routing', Scale and Magnitude"). A range of different types of alternatives did exist, but not all warranted investigation ('Property and Location', 'Design', 'Input', 'Scheduling and Timing'). Based on the findings of the investigation that was undertaken (of 'Operational Aspects') and reasoned motivation there was no verifiable evidence for the existence of any reasonable and feasible alternative(s) other than the preferred option and the no-go option at the time of this environmental impact assessment process. Consequently, no reasonable and feasible alternatives other than the preferred option and the no-go option were identified, described and assessed. Having said that, alternatives, specifically modifications and changes to activities in order to prevent and/or mitigate environmental impacts, were considered throughout the assessment process. The development proposal was amended in an incremental manner throughout the EIA process to address impacts and issues, as and when the need for mitigation was identified.

4.6 Environmental Impacts

The purpose of the assessment is to synthesise and analyse information relevant to the environmental impacts of a proposal. In order to achieve this, two elements, namely the outline of methodology used and the systematic assessment of the impacts are required.

The environmental significance scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can be ecological, economic, social, or all of the aforementioned. The evaluation of the significance of an impact relies heavily on the values of the person making the judgement. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Sections 3 & 5 identifies the issues associated with the proposed development, providing the significance scale and mitigation measures to reduce negative impacts and enhance positive impacts. Section 6 provides an explanatory note on the methodology adopted for assessing the significance of the identified impacts.

To facilitate informed decision-making, EIAs must endeavour to come to terms with the significance of the potential environmental impacts associated with particular development activities. Despite their attempts at providing a completely objective and impartial assessment of the environmental implications of development activities, EIA processes can never completely escape the subjectivity inherent in attempting to define significance. Recognising this, we have attempted to address potential subjectivity in the current process as follows:

- Being explicit about the difficulty of being completely objective in the determination of significance, as outlined above.
- Developing an explicit methodology for assigning significance to impacts and outlining
 this methodology in detail in this BAR. Having an explicit methodology not only forces
 the assessor to come to terms with the various facets contributing toward
 determination of significance, thereby avoiding arbitrary assignment, but also provides
 the reader of the BAR with a clear summary of how the assessor derived the assigned
 significance.
- Wherever possible, differentiating between the likely significance of potential environmental impacts as experienced by the various affected parties.

Although these measures may not totally eliminate subjectivity, they provide an explicit context within which to review the assessment of impacts.

4.6.1 Assessment Methodology

This section outlines the methodology used to assess the significance of the potential environments impacts. For each impact, the EXTENT (spatial scale), MAGNITUDE and DURATION (time scale) are described. These criteria are used to ascertain the significance of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place. The mitigation described represents the full range of plausible and pragmatic measures and does not imply that they would or should be implemented. The tables below show the scale used to assess these variables, and define each of the rating categories.

Table 3: Assessment criteria for the evaluation of impacts

CRITERIA	CATEGORY	DESCRIPTION		
Extent or spatial	Regional	Beyond 5 km of the proposed activity.		
influence of	Local	Within 5 km of the proposed activity.		
impact	Site specific	On site or within 100 m of the site boundary.		
	High	Natural and/ or social functions and/ or processes are severely altered.		
Magnitude of	Medium	Natural and/ or social functions and/ or processes are <i>notably</i> altered.		
impact (at the indicated spatial	Low	Natural and/ or social functions and/ or processes are slightly altered.		
scale)	Very Low	Natural and/ or social functions and/ or processes are <i>negligibly</i> altered.		
	Zero	Natural and/ or social functions and/ or processes remain unaltered.		
	Construction	Up to 2 years.		
Duration of impact	Short Term	0-5 years (after construction).		
Duration of impact	Medium Term	5-15 years (after construction).		
	Long Term	More than 15 years (after construction).		

The SIGNIFICANCE of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained in Table 4.

Table 4: Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED		
	High magnitude with a regional extent and long term duration.		
High	High magnitude with either a regional extent and medium term duration or a local extent and long term duration.		
	Medium magnitude with a regional extent and long term duration.		
	High magnitude with a local extent and medium term duration.		
	High magnitude with a regional extent and short term duration or site specific extent and long term duration.		
Medium	High magnitude with either a local extent and short term duration of a site specific extent and medium term duration.		
	Medium magnitude with any combination of extent and duration except site specific and short term or regional and long term.		
	Low magnitude with a regional extent and long term duration.		
	High magnitude with a site specific extent and short term duration.		
1	Medium magnitude with a site specific extent and short term duration.		
Low	Low magnitude with any combination of extent and duration excepsite specific and short term.		
	Very low magnitude with a regional extent and long term duration.		
	Low magnitude with a site specific extent and short term duration.		
Very low	 Very low magnitude with any combination of extent and duration except regional and long term. 		
Neutral	Zero magnitude with any combination of extent and duration.		

Once the significance of an impact has been determined, the PROBABILITY of this impact occurring as well as the CONFIDENCE in the assessment of the impact, are estimated using the rating systems outlined in

Table 5 and Table 6 respectively. It is important to note that the significance of an impact should always be considered in concert with the probability of that impact occurring. Lastly the REVERSIBILITY is estimated using the rating system outlined in Table 7.

Table 5: Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95 % chance of the impact occurring.
Highly probable	Estimated 80 to 95 % chance of the impact occurring.
Probable	Estimated 20 to 80 % chance of the impact occurring.
Possible	Estimated 5 to 20 % chance of the impact occurring.
Unlikely	Estimated less than 5 % chance of the impact occurring.

Table 6: Definition of confidence ratings

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 7: Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is permanent.
Long Term	The impact is reversible within 2 to 10 years after construction.
Short Term	The impact is reversible within the 2 years of construction.

4.6.2 Subjectivity in Assigning Significance

To facilitate informed decision-making, EIA's must endeavour to come to terms with the significance of the potential environmental impacts associated with particular development activities. Despite their attempts at providing a completely objective and impartial assessment of the environmental implications of development activities, EIA processes can never completely escape the subjectivity inherent in attempting to define significance. Recognising this, we have attempted to address potential subjectivity in the current process as follows:

- Being explicit about the difficulty of being completely objective in the determination of significance, as outlined above.
- Developing an explicit methodology for assigning significance to impacts and outlining
 this methodology in detail in this BAR. Having an explicit methodology not only forces the
 assessor to come to terms with the various facets contributing toward determination of
 significance, thereby avoiding arbitrary assignment, but also provides the reader of the
 BAR with a clear summary of how the assessor derived the assigned significance.
- Wherever possible, differentiating between the likely significance of potential environmental impacts as experienced by the various affected parties.

Although these measures may not totally eliminate subjectivity, they provide an explicit context within which to review the assessment of impacts.

4.6.3 Consideration of Cumulative Impacts

Section 24(4) of the National Environmental Management Act requires the consideration of cumulative impacts as part of any environmental assessment process. EIA's have traditionally, however, failed to come to terms with such impacts, largely as a result of the following considerations:

- Cumulative effects may be local, regional or global in scale and dealing with such impacts requires co-ordinated institutional arrangements; and
- EIA's are typically carried out on specific developments, whereas cumulative impacts
 may result from broader biophysical, social and economic considerations, which typically
 cannot be addressed at the project level.

In terms of the proposed West Street Bridge reconstruction and modification the following cumulative impacts have specifically been identified:

.Impact of additional construction related traffic

4.6.4 Construction Phase Impacts on the Biophysical and Social Environment

The construction phase is likely to result in a number of negative impacts on the biophysical and social environments. The significance of construction phase impacts is likely to be curtailed by their relatively short duration, since the construction phase of the bridge should last approximately 8 months. Moreover, many of the construction phase impacts can be mitigated by the implementation of an approved Environmental Management Programme (EMP), (see draft programme attached as Appendix F).

The potential impacts and an assessment of their significance are discussed below.

The bio-physical issues identified include:

- Fauna and flora (destruction of habitat)
- Loss of topsoil and soil erosion
- Geotechnical conditions
- Ground and surface water impact
- Sanitation and waste management
- Stormwater management

The socio-economic impacts identified include:

- Solid waste removal to a registered site
- "Sense of place" visual impact
- Dust and noise pollution
- Safety
- Employment opportunities (short-term) positive

4.6.4.1 Assessment of construction phase impacts

A summary of the construction phase impacts (assessed within the Final BAR) is provided below.

Table 8: Summary of construction impacts

	Without mitigations		With mitigation			
IMPACT	(positive & negative)		(positive & negative)			
	HIGH	MODERATE	LOW	HIGH	MODERATE	LOW
Surface & Ground-water contamination		*				×
Stormwater		×				×
Potential Impact on stream flow and riparian areas			×			×
Ecological Sensitivity		×				×
Founding Stability (Geotechnical conditions)		*				×
Loss of topsoil and soil erosion		×				×
Sanitation and waste management		*				×
Visual Pollution / "Sense of Place"		*				*
Dust & Noise Pollution		×				×
Traffic		×				×
Safety		*				x
Socio-economic Impact			✓		✓	
Employment Opportunities (short-term)			✓		✓	

A summary of the integrated construction phase impacts for the four proposed layouts are provided in 9 below:

Table 9: Summary of integrated construction impacts for four proposed routes

	Preferred Alternative	Preferred Alternative		
	Without mitigation	With mitigation		
Extent	Site specific/ Local	Site specific/ Local		
Magnitude	High(-)	Low (-)		
Duration	Construction	Construction		
Significance	Medium(-)	Low(-)		
Probability	Highly Probable	Highly Probable		
Confidence	Certain	•		
Reversibility	Short Term			

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

4.6.4.2 Ecological Sensitivity

The following potential impacts have been identified (pre-mitigation significance indicated in parentheses):

- Increased harvesting pressure on vegetation (Low)
- Increased invasion by alien plants (Low)
- Dumping of rubble (Medium)
- Impoverishment of populations of important plants (Low)
- Transformation and fragmentation of habitat for animals (Medium)
- Increased poaching of animals (Low)
- Impoverishment of populations of important animals (Low)
- Increased soil erosion (Medium)

Important mitigation measures would include the appointment of an ECO; prior to construction, the site and the bridge footprint should be demarcated (no barricade tape to be used as this may be harmful to various animal species) in order to prohibit access by the construction team into ecologically sensitive vegetation communities (this barricading must be removed once construction is completed); construction teams must not be allowed to harvest any plant or animal resources from the property; populations of conservation-important plant species found within close proximity to the footprint should be identified and excluded from development site (including laydown yards etc...) or relocated to similar adjacent habitat prior to clearing of vegetation; all listed invasive alien plants, of which there are a reasonable number, must be destroyed throughout the property, no dumping of building rubble must be allowed on the property; topsoil must be protected through stock-piling during the construction phase; this soil can then be used for landscaping at a later stage. If all proposed activities are kept within the developable areas and mitigation measures are implemented then this potentially **medium significance could be reduced to low**.

Table 10: Ecological Sensitivity

	Preferred Alternative	Preferred Alternative		
	Without mitigation	With mitigation		
Extent	Local	Local		
Magnitude	Low (-)	Very Low (-)		
Duration	Short term	Short term		
Significance	Medium (-)	Low(-)		
Probability	Probable	Unlikely		
Confidence	Sure			
Reversibility	Short Term			

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

Mitigation

All works will be conducted in accordance with the National Environmental Management: Protected Areas Act (No 10 of 2004); National Forest Act (No 84 of 1998) and National Water Act (No 36 of 1998); including obtaining the necessary permits to remove, destroy or damage any fauna or flora.

Strategies outlined below will be implemented to minimise potential impacts on flora and fauna:

Planning

- A pre-construction/maintenance vegetation survey will be completed by qualified ecologist in targeted areas of the site to identify for flagging individual significant species and trees that must be avoided during construction.
- Appropriate permits for the clearing of vegetation, including any aquatic vegetation, will be obtained prior to the commencement of construction if relevant.
- The location of vegetation to be retained will be clearly indicated on all construction drawings.
- Flagging of clearing boundaries will be completed prior to any clearing activity.

Construction

- Disturbance will generally be restricted to designated work areas.
- Physical barriers will be installed around significant vegetation areas in order to restrict unauthorised access and avoid disturbance.
- Removal of vegetation is only acceptable if access to infrastructure is impeded.
 Maintenance work must endeavour to not remove vegetation which is obstructive but does not prevent or inhibit access to the existing infrastructure.
- When clearing and excavation works are essential, then this work will occur progressively to minimise the length of time the ground is exposed or excavations left open.
- Clearing and disturbance in riverine and wetland/water body areas will be minimised so as to meet environmental requirements.
- Removed vegetation will be respread/reused on the site.

4.6.4.3 Erosion and Sedimentation

One of the potential impacts of construction is the sedimentation of the river and downstream environments. This is due to the clearing of land, which leads to the runoff from the site having a high sediment load. Potential sedimentation of the Sand River is therefore of particular concern.

Where possible, construction activities should be scheduled to occur outside of the rainy period, thereby reducing the volume of runoff during construction. If this is not possible then extra precaution needs to be taken to reduce this impact. This potential impact is considered to be of **low significance** with mitigation measures implemented.

Table 11: Erosion and Sedimentation

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Low (-)	Very Low (-)	
Duration	Short term	Short term	
Significance	Medium (-)	Low(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

Mitigation

Vehicular activity in the immediate area surrounding the bridge must be kept to a minimum so as to avoid the formation of ruts and possible resultant erosion.

Roads used for access and egress to the bridge should be properly planned and be placed in sympathy to the sites contours. These roads should have the necessary balusters and gabions in place so as to minimise stormwater runoff and the resultant erosion.

Erosion protection measures should include, but not be limited to:

- The use of groundcover or grass
- Hard landscaping e.g. gabions.

Excavated spoil (sub soils) will be stockpiled separately to topsoil and vegetation.

Excavated material will be stockpiled outside watercourses, and/or behind containment structures so as to prevent siltation of any land or surface water or blockage of any existing drainage channels.

Regular gaps and spaces in the topsoil, subsoil and vegetation stockpile will be provided for fauna movement.

The distances between gaps in stockpiles will be reduced at approaches to stream crossing.

Any excavations will be left open for the minimum time practicable.

Ramps will be installed in the terrestrial excavations to allow the easy egress of fauna.

River sand used for maintenance purposes may only be sourced by means of "Bar Skimming"2

Sand/gravel should be removed only during low flows and from above the low-flow water level

The final grading of the gravel bar should not significantly alter the flow characteristics of the river during periods of high flow.

Bar skimming operations need to be monitored to ensure that they are not adversely affecting gravel recruitment downstream or stream morphology either upstream or downstream of the site.

If the stream or river has recent history of rapidly eroding bars or streambed lowering, bar skimming should not be allowed.

Sand used for construction and maintenance may only be removed from the river where there is an excess of surface sedimentation deposit.

These excess sand deposits should only be removed where access in and out of the river is suitable (river banks should facilitate easy egress/ingress).

A maximum of 150 cubic meters of sand may be removed and utilised for reparation purposes.

Pooled water in excavations will be monitored and managed to reduce the potential for wall instability, biting insect breeding areas and contamination.

Quantities should be strictly limited so that gravel recruitment and accumulation rates are sufficient to avoid extended impacts on channel morphology and instream habitat.

In areas of high fauna density, additional ramps, branches, hessian sacks or similar devices to enable small fauna to exit the trench may be used.

Temporary sediment, siltation and erosion control devices will be reinstated when no longer required.

Excavations will be constructed to an approved standard to minimise the potential for wall collapse or subsidence.

Catchment areas to excavations will be managed to minimise the pooling of water.

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² Bar skimming or scalping requires scraping off the top layer from a gravel bar without excavating below the summer water level. Preliminary Guidence Document on the Impacts of Sand Mining on Instream and Riparian Habitat. L.Hill & C.j. Kleynhans IWQS March 1999.

4.6.4.4 Deterioration of Water Quality

During construction, pollutants may find their way into drainage channels and watercourses. Typical sources of pollution include oils and fuels from construction vehicles and construction materials such as cement, detergents, paints and other chemicals. Careful management and education of all construction staff, together with the implementation of an appropriate EMP at this site, would curtail the risk of pollution spills. This potential impact is considered to be of **low significance** with mitigation measures implemented.

Table 12: Deterioration of Water Quality

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Medium (-)	Low (-)	
Duration	Short term	Short term	
Significance	Medium (-)	Low(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

Mitigation

The following strategies will be implemented to minimise potential impacts on receiving surface waters:

- To minimise potential impacts on receiving surface waters, preparation and implementation
 of a site-specific construction erosion and sediment control plan in accordance with
 engineering best practice guidelines. These may include the following:
 - Stabilising cleared areas not used for construction activities with vegetation or appropriate surface treatments as soon as practicable following earthworks, to minimise erosion.
 - Provision of appropriate bunded storage areas for fuels and dangerous goods in accordance with SABS standards.
 - Ensuring that relevant construction personnel are trained in appropriate handling of fuels and dangerous goods and spill prevention.
 - o Refuelling will occur only within bunded areas or off site.
 - All transfers of fuels and chemicals will be controlled and managed to prevent spillage outside bunded areas.
 - Restricting vegetation clearance to the smallest area necessary.

- Stripping and stockpiling of topsoil from disturbed areas. Diversion channels will be constructed around the topsoil stockpiles to prevent erosion and loss of topsoil. The topsoil will be re-spread prior to re-vegetation of areas to be rehabilitated at completion of construction.
- Topsoil stockpiles will be located in areas outside drainage lines and will be protected from erosion. Prior to the re-spreading of topsoil, the ground surface will be ripped to assist with binding of the soil layers, water penetration, and re-vegetation.

4.6.4.6 Noise disturbance to surrounding land users

Construction activities, construction vehicles and construction personnel on site would cause an increase in noise in the area, which may impact negatively on adjoining landowners and users. Since neighbours are particularly sensitive, given the general natural ambiance and utilisation of the Sabi Sand Wildtuin for high-end tourism, this impact is considered of **medium** significance prior to mitigation.

Impacts of noise generation during construction in general could be mitigated by ensuring that all regulations relating to noise generation are observed and by restricting work to hours outside of game viewing activities. This potential impact could be readily managed by effective implementation of an EMP. The significance of this impact would be **reduced from medium to low** by the implementation of these mitigation measures.

Table 13: Noise disturbance to surrounding land users

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Medium (-)	Low (-)	
Duration	Short term	Short term	
Significance	Medium (-)	Low(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

Mitigation

- Construction work during evening and night-time periods (6.30 pm to 6.30 am) and on Sundays/Public Holidays will be undertaken in accordance with "best practice" noise management.
- Construction work may not take place during game drive times.
- Use of the quietest plant and equipment that can practically and reasonably undertake the work wherever possible.
- Maintain equipment in order to keep it in good working order.

- Adjacent landholders will be notified prior to any atypical noise events outside of daylight hours.
- Operators of construction equipment will be made aware of the potential noise problems and of techniques to minimise noise emission through a continuous process of operator education.
- Best available work practices will be employed on-site to minimise occupational noise levels.
- High efficiency mufflers will be fitted to appropriate construction equipment.
- Reversing alarms within construction areas cannot be avoided for safety reasons.
- Large rocks and concrete blocks will be placed in dump trucks not dropped.
- To prevent a startle response from fauna at the start of impact piling (if required), observations will be made of an area (350 m radius initially and 150 m after first day) around the pile before commencement of impact piling on any day or after an extended time when piling has stopped.
- If large fauna is observed within the area then commencement of impact piling will be delayed until they clear the area. Alternatively, a soft start to piling will be considered.

4.6.4.7 Windblown dust

Construction activities are likely to result in the increased production of windblown dust. However, provided that normal dust control measures (e.g. watering, suspending dust generating activities during high wind conditions, re-vegetating/ stabilising disturbed surfaces as soon as possible) are implemented, the significance of this potential impact is considered to be **medium to low**.

Table 14: Windblown dust

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Medium (-)	Low (-)	
Duration	Short term	Short term	
Significance	Medium (-)	Low(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

Mitigation

Air pollution caused during construction can be limited by using dust suppression methods such as water spraying.

The use of delivery trucks during construction should be limited to travelling during the times as stipulated by the Sabi Sand Wildtuin. Moreover delivery times should take place out side of game drive times.

Trucks that comply with the relevant legislation should be used and these delivery vehicles should be restricted in terms of the speed that they travel.

Building material and sand should be covered during transport to and from the site.

4.6.4.8 Litter/waste pollution

The effects of litter/waste pollution on the biophysical environment would be small, but could be more significant for the aesthetics of the area if not properly controlled. This potential impact could be readily managed by the provision of suitable animal proof refuse disposal facilities and the effective implementation of an EMP. The significance of this potential impact is considered to be **low** if the proposed mitigation measures are implemented.

Table 15: Litter/Waste pollution

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Medium (-)	Low (-)	
Duration	Short term	Short term	
Significance	Medium (-)	Low(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

Mitigation

Waste management plan for specific waste streams will be developed by the construction contractor prior to construction commencing.

General waste will be collected and transported generally to local council approved disposal sites.

Food wastes will be collected, where practicable, considering health and hygiene issues, for disposal off-site.

Refuse containers will be located at each worksite.

Where practical, wastes will be segregated and reused / recycled (e.g. scrap metal).

All personnel will be instructed in project waste management practices and procedures as a component of the environmental induction process.

Suppliers will be requested to minimise packaging where practicable.

A high emphasis will be placed on housekeeping and all work areas will be maintained in a neat and orderly manner.

All equipment and facilities will be maintained in a clean and safe condition.

4.6.4.9 Safety

Construction activities could lead to injuries to staff or the public. These activities include:

- The construction of the proposed bridge
 - o Movement of construction vehicles to and from the site
 - Handling of equipment and material

The significance of this potential impact is considered to be **low** if the proposed mitigation measures are implemented.

Table 16: Safety

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Medium (-)	Low (-)	
Duration	Short term	Short term	
Significance	Medium (-)	Low(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

Mitigation

Emergency Response.

The contractor will prepare a detailed emergency response plan prior to work commencing. The plan will include consideration of the following:

- Information identifying the obligations under the relevant legislation.
- Development of a response, investigation, command, control and recovery for both natural disasters and other disasters/emergencies and incidents.

- Response procedures in the event of a fire, chemical release, spill, accident, explosion, equipment failure, bomb threat, natural disaster (including severe storm, bushfire and flood events) or any other likely emergency.
- Communication arrangements and contact details.
- Roles and responsibilities of responsible personnel.
- Emergency controls and alarms.
- Evacuation procedures.
- Emergency response equipment.
- Training requirements.
- Site access and security.

Fire Management

Minimise fire risk through evaluation processes and management of those risks.

- Restrict high-risk activities in accordance with local fire bans or in times of high fire danger.
- Maintain a plan for rapid and co-ordinated response to the outbreak of fire through an established fire response plan in conjunction with the local reserve and rural fire brigades.
- Develop evacuation procedures and hazard reduction.
- Undertake fire safety awareness training as part of site inductions.
- Conduct fire safety awareness training as part of site inductions.
- Conduct regular fire drills and record exercises as actions generated.
- Conduct periodic fire equipment audits.
- Consult with all relevant fire management authorities.

Incidents and Complaints

All incidents and complaints will be managed through the auditing process and reported to the appropriate authority as required.

All incidents and complaints will be documented in an incidents/complaints register. The complaints form will document at least the following information:

Time, date and nature of complaint.

Type of communication (telephone, letter, email, visit).

- Name, contact address and contact number (if provided).
- Response and investigation undertaken as a result of the complaint.
- Action taken and signature of person investigating complaint.

Each complaint will be investigated as soon as practicable and, where appropriate, corrective action taken to remedy the cause of the complaint.

4.6.4.10 Socio-Economic Impact

There will definitely be a positive economic impact during the construction phase as temporary employment will be provided through building activities that may utilise non-skilled labour (cement mixing, clearing and grubbing etc....) as well as the construction of the proposed bridge itself and there is the potential for local suppliers to also benefit from the proposed bridge reconstruction and modification. This positive impact will, however, be negated if out-of-town contractors are employed who utilise non-local construction workers and make use of supplies brought in from other provinces (i.e. Gauteng). If local labour and suppliers are utilised during the construction phase this potential positive socio-economic impact will go from a low to medium-high significance.

Table 17: Socio-economic Impact

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Medium (-)	Low (-)	
Duration	Short term	Short term	
Significance	Low (+)	Medium(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

There is also the potential for negative social impacts if there is an influx of construction workers from outside the area. This issue needs to be carefully managed which will then reduce the significance from **medium-high to low**.

Mitigation

Continued promotion of Department of Trade and Industry's guidelines to redress past racial and gender inequalities.

Promotion of local business ventures.

Employment of local labour for permanent positions.

Provision made for improvement of local skills

a. Environmental Management Plan and Environmental Control Officer

As alluded to under Chapter 4, all of the aforementioned construction phase impacts could be addressed and minimised by the development and effective implementation of an Environmental Management Plan/Programme (EMP). Accordingly, a draft EMP for both construction and operational phases will be prepared (see draft report attached as **Appendix F**). Prior to construction, an appropriately qualified environmental consultant should ensure that the draft EMP be amended to take cognisance of any further requirements included in the Rod. This EMP should be incorporated into the Civil Tender Document, since this would ensure that:

- The Contractor is made aware of the EMP "up front";
- The EMP is presented in a form and language familiar to the Contractor;
- The Contractor is able to cost for compliance with the EMP; and
- The EMP is binding within a well developed legal framework.

To give appropriate effect to the environmental controls, it is essential that this EMP be enforced by an appropriately qualified, independent Environmental Control Officer (ECO). The roles and responsibilities of the ECO should include:

- Ensuring that the necessary environmental authorisations and permits have been obtained;
- Monitoring and verifying that the EMP is adhered to at all times and taking action if the specifications are not followed;
- Monitoring and verifying that environmental impacts are kept to a minimum;
- Reviewing and approving construction method statements with input from the Engineers;
- Assisting the Contractor in finding environmentally responsible solutions to problems;

- Giving a report back on the environmental issues at the monthly site meetings and other meetings that may be called regarding environmental matters;
- Keeping records of all activities/ incidents on Site in the Site Diary concerning the environment;
- Inspecting the site and surrounding areas regularly with regard to compliance with the EMP;
- Keeping a register of complaints in the Site Office and recording and dealing with any community comments or issues;
- Monitoring the undertaking by the Contractor of environmental awareness training for all new personnel coming onto site;
- Ensuring that activities on site comply with other relevant environmental legislation;
- Ordering, via the Engineer's Representative, the removal of person(s) and/or equipment not complying with the specifications;
- Issuing of fines for contraventions of the EMP;
- Completing monitoring checklists; and
- Keeping a photographic record of progress on Site from an environmental perspective.

4.6.5 Operational Phase Impacts on the Biophysical and Social Environment

A limited number of potential long-term (operational) impacts were identified during the investigative phases.

Potential bio-physical impacts:

Erosion

The socio-economic impacts identified include:

- Safety
- Visual impact
- Economic
- Land use

4.6.5.1 Assessment of operation phase impacts

A summary of the operation phase impacts (assessed within the Final BAR) is provided below.

Table 18: Summary of operation impacts

	Without mitigations		With mitigation			
	HIGH	MODERATE	LOW	HIGH	MODERATE	LOW
Erosion and siltation			×			×
Visual – "sense of place"		×				×
Land use			✓		✓	
Socio economic (job creation and capital investment)			✓		✓	

4.6.5.1.1 Erosion and Siltation

Impact

Erosion and siltation can be caused by various activities during the operational phase of the proposed MalaMala West Street Bridge if not properly managed. These activities include:

- The operation of the bridge
 - Increased run-off on the exposed areas of the rehabilitated bank prior to vegetation recolonizing the worked areas.

Discussion

During the Operational phase the significance of this impact is viewed as **LOW** but may be mitigated to **VERY LOW** as vegetation cleared during construction will re-establish in a relatively short period providing natural stabilisation of the terrain against erosion.

Mitigation

Vehicular activity in the immediate area surrounding the bridge must be kept to a minimum so as to avoid the formation of ruts and possible resultant erosion.

Roads used for access and egress to the bridge should be properly planned and be placed in sympathy to the sites contours. These roads should have the necessary balusters and gabions in place so as to minimise stormwater runoff and the resultant erosion.

Erosion protection measures should include, but not be limited to:

- The use of groundcover or grass
- Hard landscaping e.g. gabions.

Excavated spoil (sub soils) will be stockpiled separately to topsoil and vegetation.

Excavated material will be stockpiled outside watercourses, and/or behind containment structures so as to prevent siltation of any land or surface water or blockage of any existing drainage channels.

Regular gaps and spaces in the topsoil, subsoil and vegetation stockpile will be provided for fauna movement.

The distances between gaps in stockpiles will be reduced at approaches to stream crossing.

Any excavations will be left open for the minimum time practicable.

Ramps will be installed in the terrestrial excavations to allow the easy egress of fauna.

River sand used for maintenance purposes may only be sourced by means of "Bar Skimming"3

Sand/gravel should be removed only during low flows and from above the low-flow water level

The final grading of the gravel bar should not significantly alter the flow characteristics of the river during periods of high flow.

Bar skimming operations need to be monitored to ensure that they are not adversely affecting gravel recruitment downstream or stream morphology either upstream or downstream of the site.

If the stream or river has recent history of rapidly eroding bars or streambed lowering, bar skimming should not be allowed.

Sand used for construction and maintenance may only be removed from the river where there is an excess of surface sedimentation deposit.

These excess sand deposits should only be removed where access in and out of the river is suitable (river banks should facilitate easy egress/ingress).

A maximum of 150 cubic meters of sand may be removed and utilised for reparation purposes.

Pooled water in excavations will be monitored and managed to reduce the potential for wall instability, biting insect breeding areas and contamination.

Quantities should be strictly limited so that gravel recruitment and accumulation rates are sufficient to avoid extended impacts on channel morphology and instream habitat.

In areas of high fauna density, additional ramps, branches, hessian sacks or similar devices to enable small fauna to exit the trench may be used.

Temporary sediment, siltation and erosion control devices will be reinstated when no longer required.

Excavations will be constructed to an approved standard to minimise the potential for wall collapse or subsidence.

Catchment areas to excavations will be managed to minimise the pooling of water.

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³ Bar skimming or scalping requires scraping off the top layer from a gravel bar without excavating below the summer water level. Preliminary Guidence Document on the Impacts of Sand Mining on Instream and Riparian Habitat. L.Hill & C.j. Kleynhans IWQS March 1999.

<u>Assessment</u>

Table 19: Erosion and Siltation

	Preferred Alternative.		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Low (-)	Very Low (-)	
Duration	Short term	Short term	
Significance	Low (-)	Very Low(-)	
Probability	Probable	Unlikely	
Confidence	Sure		
Reversibility	Short Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

4.6.5.1.2 Visual – "Sense of Place"

Impact

Operation of the proposed development may impact negatively on the visual character of the area.

Discussion

The relative industrial look of the bridge within a rural and natural setting utilised for high-end tourism may impact on the local sense of place. Various mitigatory measures will have to be implemented so as to ensure that visual impact significance be minimised. However, it is important to highlight that the only receptors (people who will be able to view the bridge) will be patrons of the lodge and will also receive the functional benefit of the infrastructure. It is important to contextualise this because there will not be any unwilling receptors (the bridge will not be imposed on anyone).

Mitigation

The appearance of the infrastructure (within reason) is possible to mitigate.

- In terms of infrastructure, it is recommended that the access road be planned so that the unnecessary clearing of vegetation is avoided. This implies making use of already disturbed sites rather than pristine areas wherever possible, and avoiding large specimens and dense established areas.
- The bridge must be maintained in a neat and visually acceptable state throughout the operational life of the structure.
- Good practice requires that the mitigation of visual impacts as listed above be implemented and maintained on an ongoing basis.

<u>Assessment</u>

Table 20: Visual Sense of Place

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Low -medium (-)	Very low (-)	
Duration	Long term	Long term	
Significance	Medium (-)	Low(-)	
Probability	Highly Probable	Probable	
Confidence	Sure		
Reversibility	Long Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

4.6.5.1.3 Land Use

Impact

The proposed land use is compatible with the current land use, namely the use of the land for conservation and tourism. The bridge is directly linked to the successful operation of MalaMala as a tourism based entity.

Discussion

The proposed activity is in line with current activities as carried out within the Sabi Sand Wildtuin.

Mpumalanga Conservation Plan: Chapter 6 – Land use guidelines Identifies ecotourism as an integral component of the long term sustainability of conservation areas. The bridge and the repair thereof is integral linked to conservation and tourism. Below are extracts from the MCP:

Protected Areas are managed primarily for biodiversity conservation, but also for socioeconomic objectives such as tourism and education.

Land-Use Type 1. Conservation Management

_ Includes: formal and informal Protected Areas managed for biodiversity, wildlife production and recreational and educational tourism, conducted in natural habitats on extensively managed landscapes on public or private land;

Bushbuckridge Local Municipality

The SDF recognises the value eco-tourism brings to the region as a whole and promotes private and rural partnerships which can further enhance the trade. Again the proposed bridge repair falls within this ambit and adds value to the tourism infrastructure already present on this land.

Mitigation

No mitigation is required as the development falls within the prescribed land use for the area.

Table 21: Land Use

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Local	Local	
Magnitude	Low (+)	Medium (+)	
Duration	Long term	Long term	
Significance	Low (+)	Medium(+)	
Probability	Highly Probable	Probable	
Confidence	Sure		
Reversibility	Long Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

4.6.5.1.4 Socio-Economic (Job Creation & Capital Investment)

Impact

The reconstruction and modification of the West Street Bridge will add further positive socio-economic opportunities to the MalaMala operation (direct benefit) as well as to the local community (both direct and indirect benefit).

Discussion

The anticipated impact posed to the environment by the proposed activity is expected to be negligible because the bridge has been in existence since mid-2007 and the majority of the structure is still intact (impacts on the receiving environment whilst in operation will not increase, in fact negative impacts may decrease). Strengthening and extending the northern stays will only add to the stability of this structure improvement of the design reduces potential impacts. The new stays have specifically been designed as compact, individual footprints that have minimal foundational impact and can easily be placed to accommodate the site sensitivities. The activity will result in some loss/transformation of the river bank; however, no protected species will be removed with the placement of the stays. Moreover the integrity of the existing bank in terms of erosion will be improved. The disturbance of the river bank cannot be altogether avoided but disturbance can be minimized and remedied.

In order to comply with Section 2 (3) of NEMA, 1998, it is important to note that the environment cannot be considered in isolation. Development must also be socially and economically. The government decision-makers and environmental assessment practitioners must serve the public's

social, economic and ecological needs equitably. Sustainable development requires the simultaneous achievement of the *triple bottom-line*. Consequently, one has to determine whether the nature and extent of the negative environmental impacts occur at a cost acceptable to society and the economy. This can be determined by considering the opportunity costs. Considering an investigation of potential alternatives revealed no feasible and reasonable alternative the next best alternative for establishing the opportunity cost is the no-go option. Consequently, the opportunity cost is the foregone benefit of losing the no-go option. As mentioned above, a comparative assessment of the proposed activity with the no-go option must consider the social, economical and environmental benefits and/or disadvantages associated with/yielded by each alternative.

There are no economic benefits associated with the preferred (Section D 1) and no-go option. No social benefits are yielded by the no-go option, but there are limited social benefits to the land owner and his employees, specifically the improvement of operational efficiency of MalaMala and thus ultimately an increase in the financial viability of the operation. The loss/transformation of habitat is a small disadvantage of the preferred alternative when compared with the no-go option. However, the latter negative environmental impact can be minimised (by appropriately positioning and designing the stays to combat further erosion and damage to the river bank) and remedied to the extent that the cost associated with the initial loss/transformation is acceptable relative to the aforementioned limited societal benefits.

Therefore, the proposed/preferred activity is the best practicable environmental option for this site, all things considered, because it provides the most benefit to the people and it will cause acceptable damage to the environment particularly in the long term and on condition that the environmental impacts are mitigated accordingly.

Mitigation

- Continued promotion of Department of Trade and Industry's guidelines to redress past racial and gender inequalities.
- · Promotion of local business ventures.
- Employment of local labour for permanent positions.
- Provision made for improvement of local skills

<u>Assessment</u>

Table 22: Socio-economic (Job creation)

	Preferred Alternative		
	Without mitigation	With mitigation	
Extent	Regional	Regional	
Magnitude	Low (+)	High (+)	
Duration	Long term	Long term	
Significance	Low (+)	Medium (+)	
Probability	Highly Probable	Highly Probable	
Confidence	Sure		
Reversibility	Long Term		

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-)

4.7 Final Conclusions and Recommendations

The essence of all EIA processes is aimed at ensuring informed decision-making and environmental accountability. Furthermore, it assists in achieving environmentally sound and sustainable development. In terms of NEMA (No 107 of 1998), the commitment to sustainable development is evident in the provision that "development must be socially, environmentally and economically sustainable and requires the consideration of all relevant factors. In addition, the preventative principle is required to be applied, i.e. that the disturbance of ecosystems and loss of biological diversity are to be "...avoided, or ... minimised and remedied" and "disturbance of the landscape and the nation's cultural heritage is avoided and where it cannot be altogether avoided is minimised and remedied". Therefore negative impacts on the environment and on people's environmental rights in terms of the Constitution (Act 108 of 1996)) should be anticipated and prevented, and where they cannot be altogether prevented, they must be minimised and remedied in terms of "reasonable measures". "Reasonable measures" implies that "every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law and cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment".

4.7.1 Conclusions

The preceding chapters and the specialist reports provide a detailed assessment of the anticipated environmental impacts on specific components of the biophysical and social environments associated with the proposed MalaMala West Street Bridge. This BAR has provided a comprehensive assessment of the potential environmental impacts, identified by the EIA team and I&APs, associated with the proposed project. This investigation has not identified any potential impacts on the biophysical or social environments that are so severe as to suggest that the proposed extension should not proceed. The conceptual design has taken cognisance of the various environmental considerations and accordingly, incorporates remedial measures aimed at curtailing the significance of the potential negative environmental impacts associated with the proposed development, as well as enhancing the potential positive environmental (including Socio-economic and land use) impacts.

The significance of the potential environmental (biophysical and social) impacts associated with the proposed bridge are summarised in

Table 23.

It should be noted that the impacts have been assessed with a reasonable amount of confidence, i.e. in terms of the defined confidence ratings presented in **Table 6**.

From

Table 23 it is apparent that there is no long term or operational phase impacts of significant concern. The negative impacts associated with the operational phase are likely to be of **low** to **very low** significance, particularly if the proposed mitigation measures are implemented. Moreover, there are a number of potential positive impacts associated with the proposed development, viz., compliance with landuse for the area, the creation of positive construction and operational phase impacts on employment opportunities and increased economic activity.

With regards to the short term or construction phase impacts, the significance of the construction phase impacts are likely to be curtailed by the relatively short duration of the construction phase. Moreover, many of the construction phase impacts could be mitigated by the effective implementation of the mitigation measures outlined above. If these measures were put into practice the significance of all construction phase impacts would be reduced to **low**. While the probability of the construction phase impacts occurring is relatively high without mitigation, the effective implementation of the mitigation measures will reduce the probability of the impacts occurring.

Table 23: Summary of the significance and probability of the potential positive and negative impacts associated with the proposed Bridge.

Ref.	Description of impact	Significance of impact			
ivei.	Description of impact	Without mitigation	With mitigation		
7 .1	Operational phase: Biophysical and Soc	ocial environment			
7.1.1	Erosion and siltaton	Low (-) (Possible)	Low (-) (Possible)		
7.1.2	Visual – "sense of place"	Medium (-) (Highly Probable)	Low (-) (Unlikely)		
7.1.3	Land use	Low (+) (Unlikely)	Medium (+) (Highly Probable)		
7.1.4	Socio-economic Impact	Low (+) (Highly Probable)	Medium (+) (Highly Probable)		
7.2	Construction Phase Impacts		_		
a)	Surface and Ground water contamination	Medium (-) (Highly Probable)	Low (-) (Probable)		
b)	Stormwater and sedimentation	Medium (-) (Highly Probable)	Low (-) (Probable)		
c)	Potential Impact on stream flow and riparian areas	Low (-) (Probable)	Low (-) (Probable)		
d)	Ecological Sensitivity	Medium (-) (Highly Probable)	Low (-) (Probable)		
e)	Founding stability (Geotech conditions)	Medium (-) (Highly Probable)	Low (-) (Probable)		
f)	Loss of topsoil and erosion	Medium (-) (Highly Probable)	Low (-) (Probable)		
g)	Sanitation and waste management	Medium (-) (Highly Probable)	Low (-) (Probable)		

h)	Visual Pollution / "Sense of Place"	Medium (-)	Low (-)
11)	Visual Foliation / Gense of Flace	(Highly Probable)	(Probable)
i)	Dust and noise pollution	Medium (-)	Low (-)
,,	Duct and noise political	(Highly Probable)	(Probable)
k)	Traffic	Medium (-)	Low (-)
K)	Trainc	(Highly Probable)	(Probable)
1)	Safety	Medium (-)	Low (-)
1)	Salety	(Highly Probable)	(Probable)
m)	Socio-economic & Employment (positive)	Low (+)	Medium (+)
111)	Socio-economic & Employment (positive)	(Highly Probable)	(Probable)

Significance: positive impacts indicated by no shading & (+), negative impacts indicated by shading & (-) Probability: (in brackets)

It is felt that the proposed MalaMala West Street Bridge reconstruction and modification will have an overall positive impact on the natural and socio-economic environment, and should the necessary mitigation measures be implemented there are no impacts envisaged of high significance or any fatal flaws.

4.7.2 Recommendations

Should the proposed activity be authorised, the most important mitigation measures, which should be stipulated as requirements in any authorisation include the following:

- The Construction Phase EMP that addresses, inter alia, the issues discussed under Construction Phase impacts, viz. sedimentation, deterioration of water quality, traffic, windblown dust, noise disturbance and socio-economic impacts, should be effectively implemented for the duration of the project.
- A suitably qualified professional should be appointed to act as the ECO and oversee the implementation of the EMP during construction.

4.7.3 The way forward

The competent environmental authority (i.e. MDEDET) will review the final BAR and decide whether or not to grant authorisation.

Once MDEDET has reviewed the Final BAR they will either issue a Record of Decision based on the information contained in the Final BAR or indicate that further information is required in order to make an informed decision with regard to the proposed activities. If a Record of Decision is issued, this would be communicated by means of letters to all identified I&APs. Following the issuing of the Record of Decision, there will be a 10-day notice of intent to appeal period, followed by a 30-day appeal period within which I&APs will have an opportunity to appeal against MDEDET's decision to the Provincial MEC for Environmental Affairs and Development Planning in terms of the National Environmental Management Act.

4.8 References

DEAT (2006a) Guideline 3: General Guide to the Environmental Impact Assessment Regulations, 2006, Integrated Environmental Management Guideline Series. National Department of Environmental Affairs and Tourism (DEAT), Pretoria.

DEAT (2006b) Guideline 5: Assessment of Alternatives and Impacts in Support of the Environmental Impact Assessment Regulations, 2006, Integrated Environmental Management Guideline Series. National Department of Environmental Affairs and Tourism (DEAT), Pretoria.

KEATIMILWE, K. & ASHTON, P.J. (2005) *Guideline for the review of specialist input in the EIA process*. Provincial Government of the Western Cape, Department of Environmental Affairs and Development Planning (DEA&DP), Cape Town.

LOCHNER, P. (2005) *Guideline for Environmental Management Plans*. Provincial Government of the Western Cape, Department of Environmental Affairs and Development Planning (DEA&DP), Cape Town.

MÜNSTER, F. 2005. (2005) Guideline for determining the scope of specialist involvement in the EIA process. Provincial Government of the Western Cape, Department of Environmental Affairs and Development Planning (DEA&DP), Cape Town.

Section E: Consultation with other state departments

Provide a list of all State Departments / Organs of State that have been consulted and registered as interested and affected parties, and to whom draft and final reports have been submitted for comment. Proof of submission / delivery of the draft and final report to all State Department / Organs of State must be attached to this document.

The municipal councilor of the ward in which the site or alternative site is situated.

The site is not designated a ward.

The municipality which has jurisdiction in the area:

Bushbuckridge Local Municipality (BBRLM)

Mr Andries Mnisi (mnisiandries@bushbuckridge.gov.za) 013 799 1851/7

Any organ of state having jurisdiction in respect of any aspect of the activity:

Department of Water Affairs

Sampie Shabangu ShabanguS2 @dwa.gov.za 082 857 4275

Mpumalanga Department of Economic Development Environment and Tourism (MDEDET)-Impact Management

Thulisile Nkonyana (SSLanga@mpg.gov.za) 073 173 3894

Mpumalanga Department of Economic Development Environment and Tourism (MDEDET)- Pollution and Waste

Cyprian Theledi (mtheledi@mpg.gov.za) 079 189 5599

South African Heritage Resources Agency (SAHRA)

Philip Hine (phine@sahra.org.za) 021 462 4502

Department of Public Works

Mr. Makgamatho (KGMakgamatho@mpg.gov.za) 072 609 8663

South African National Parks (SANparks)

Stefanie Freitag Donaldson (stefanie@sanparks.org, 013 735 4192)

Richard Sowry (RichardS@sanparks.org)

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Leonie du Plessis (leonied@sanparks.org, 013 735 4320)

5	Assumptions, Uncertainties and Gaps in Knowledge
	A description of any assumptions, uncertainties and gaps in knowledge;

SECTION F: APPENDICES

Appendix A: Site plan(s)

Annexure A: Locality Map

Annexure B: Layout

Appendix B: SITE Photographs

Annexure A: Site photos

Appendix C: FACILITY ILLUSTRATION(S)

See Appendix A Viz. Layout

Appendix D: Specialist REPORTs & Internal

Studies

Annexure A: Flood Line Report

APPENDIX E: PUBLIC PARTICIPATION

PROCESS

Annexure A: Site notice text

Annexure B: Proof of displayed notice

boards

Annexure C: Background Information Document (BID)

Annexure D: Advertisement text

Annexure E: Proof of placed advertisement

Annexure F: Public and departmental

meeting minutes

Annexure G: Public meeting register

Annexure H: Departmental meeting register

Annexure I: List of registered Interested

and Affected Parties (I&AP's)

Annexure J: Comments and responses

Annexure K: Proof of submission and distribution of Draft and Final Basic

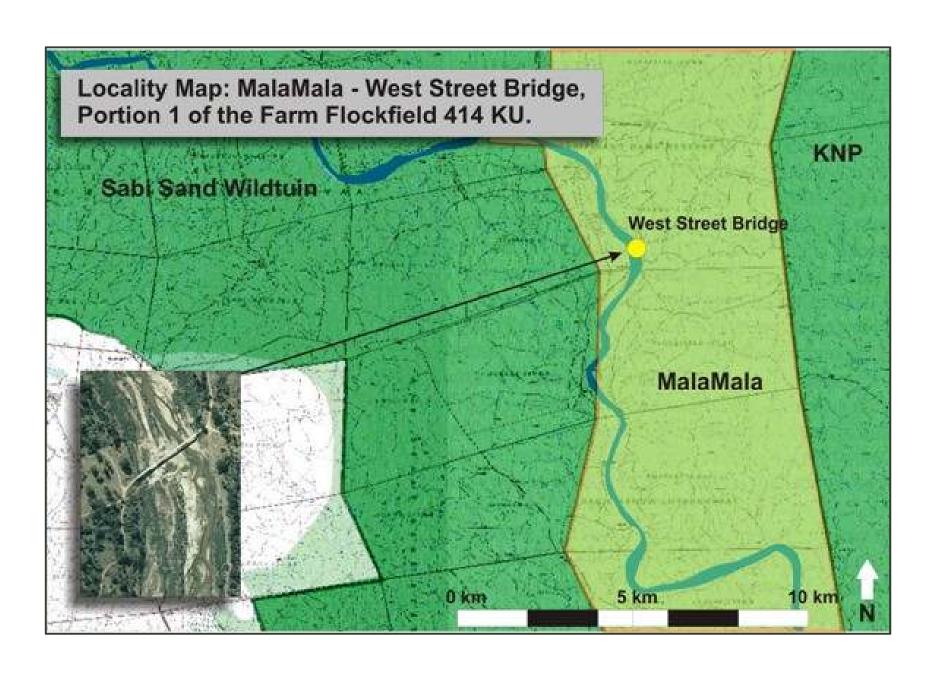
Assessment

APPENDIX F: OTHER

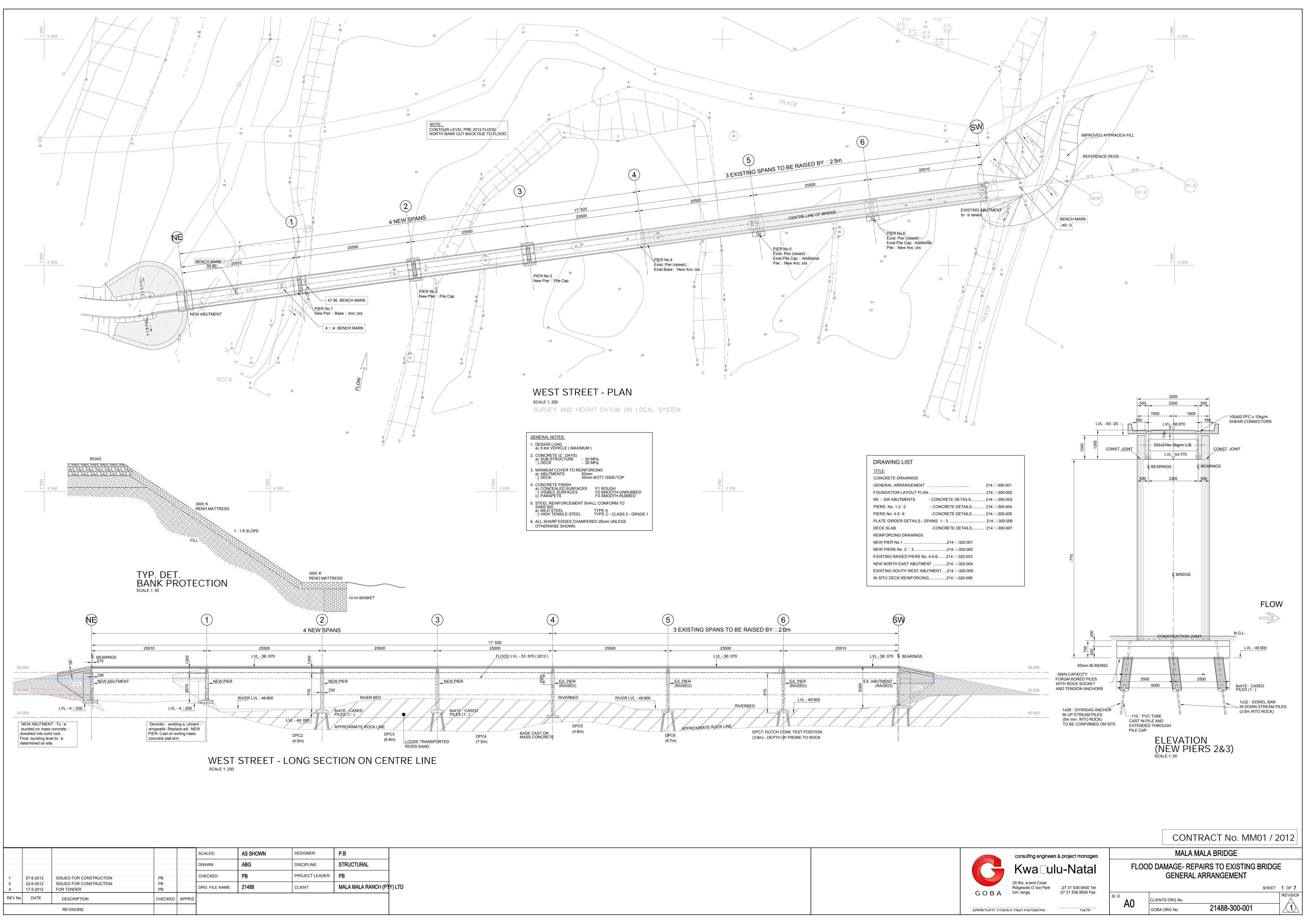
Annexure A: Draft Environmental

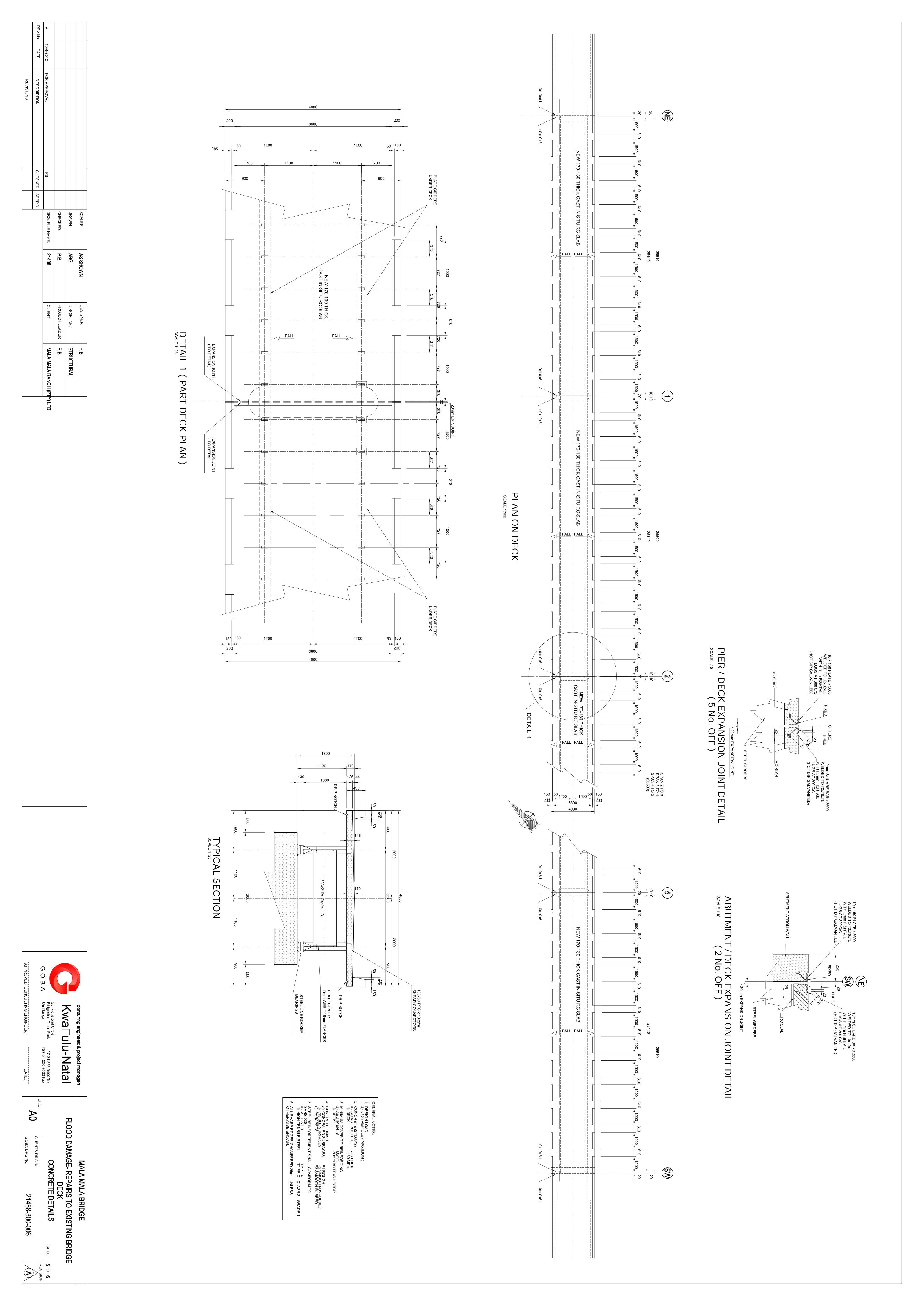
Management Programme

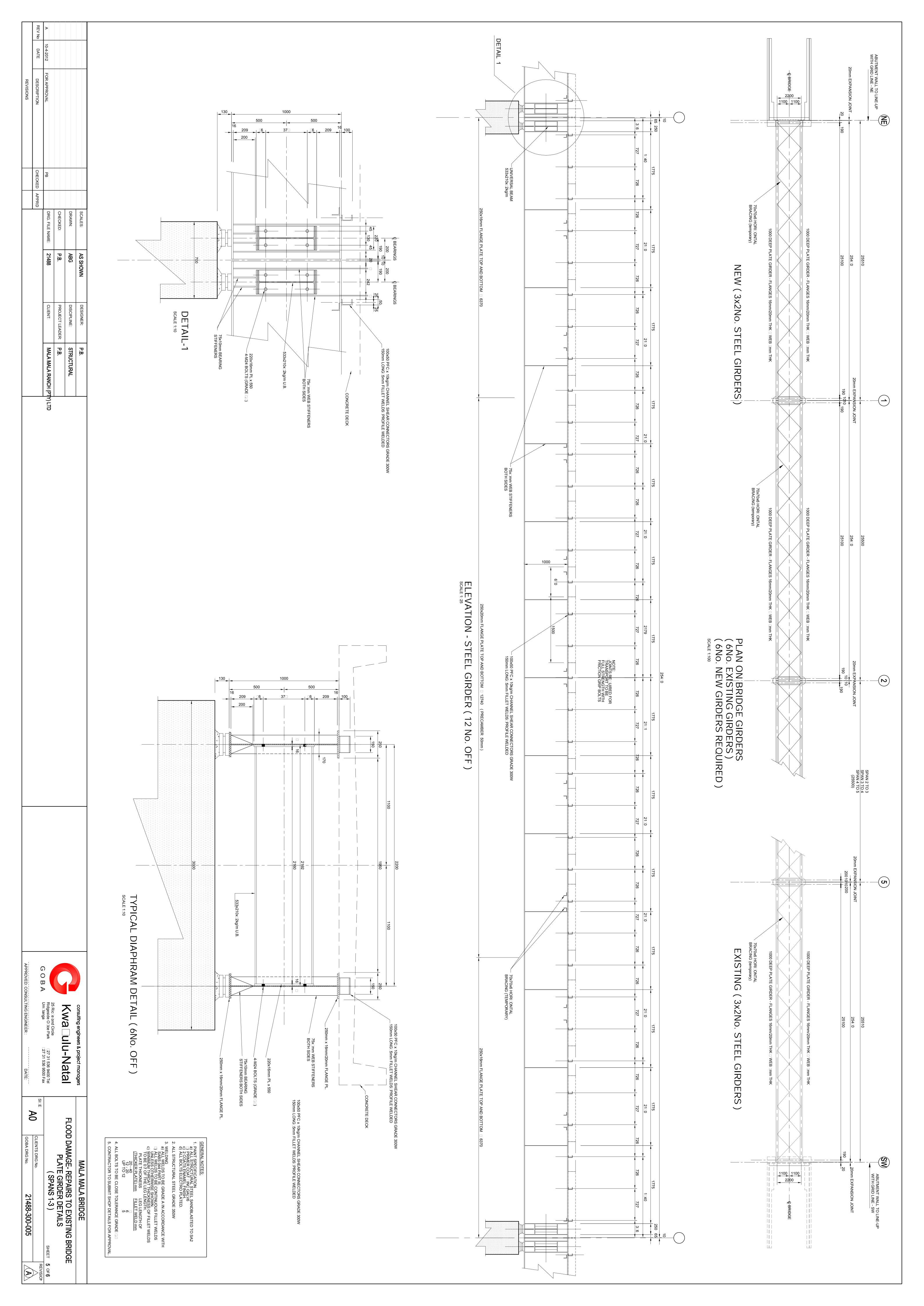
Appendix A Annexure A Locality Map

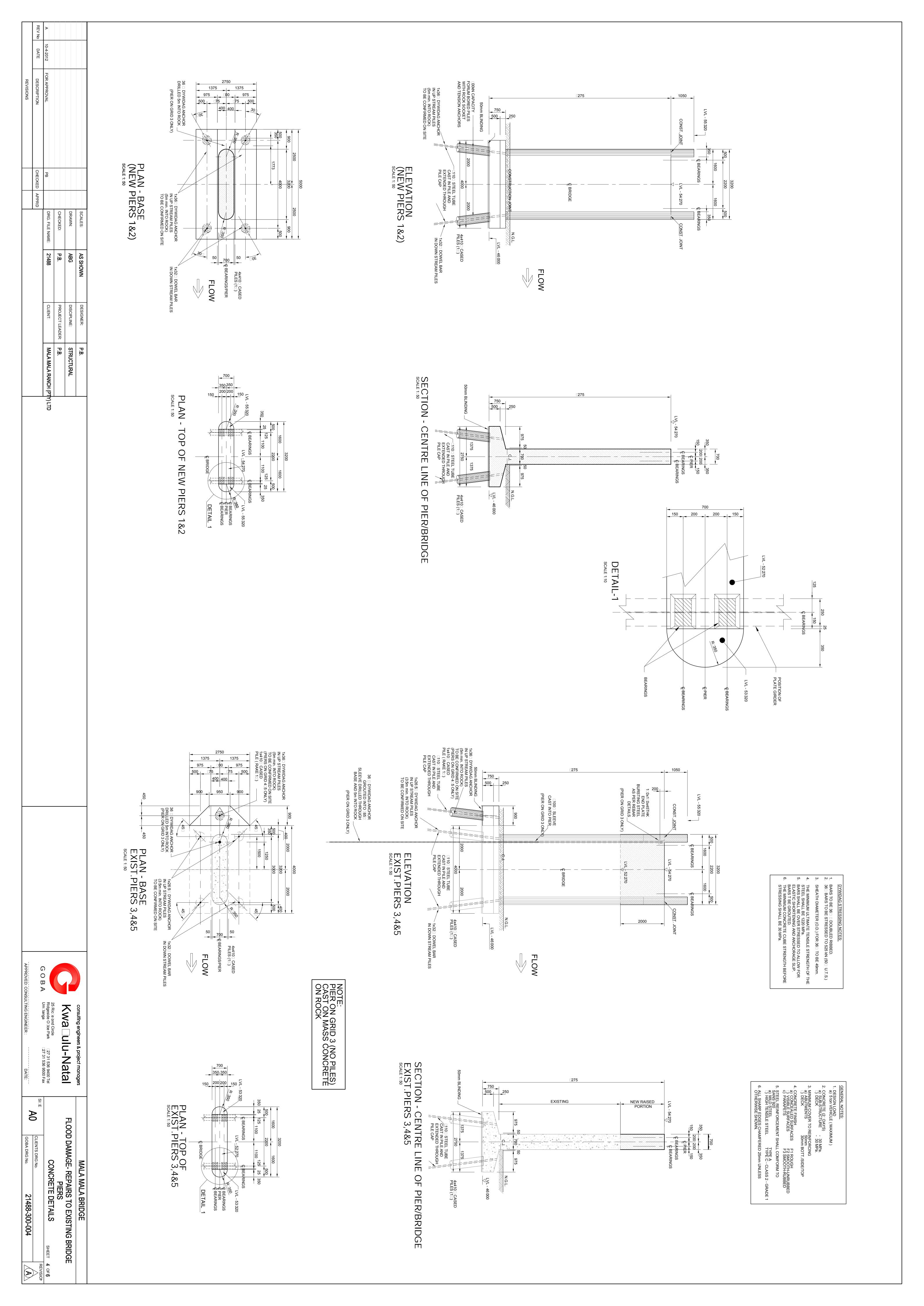


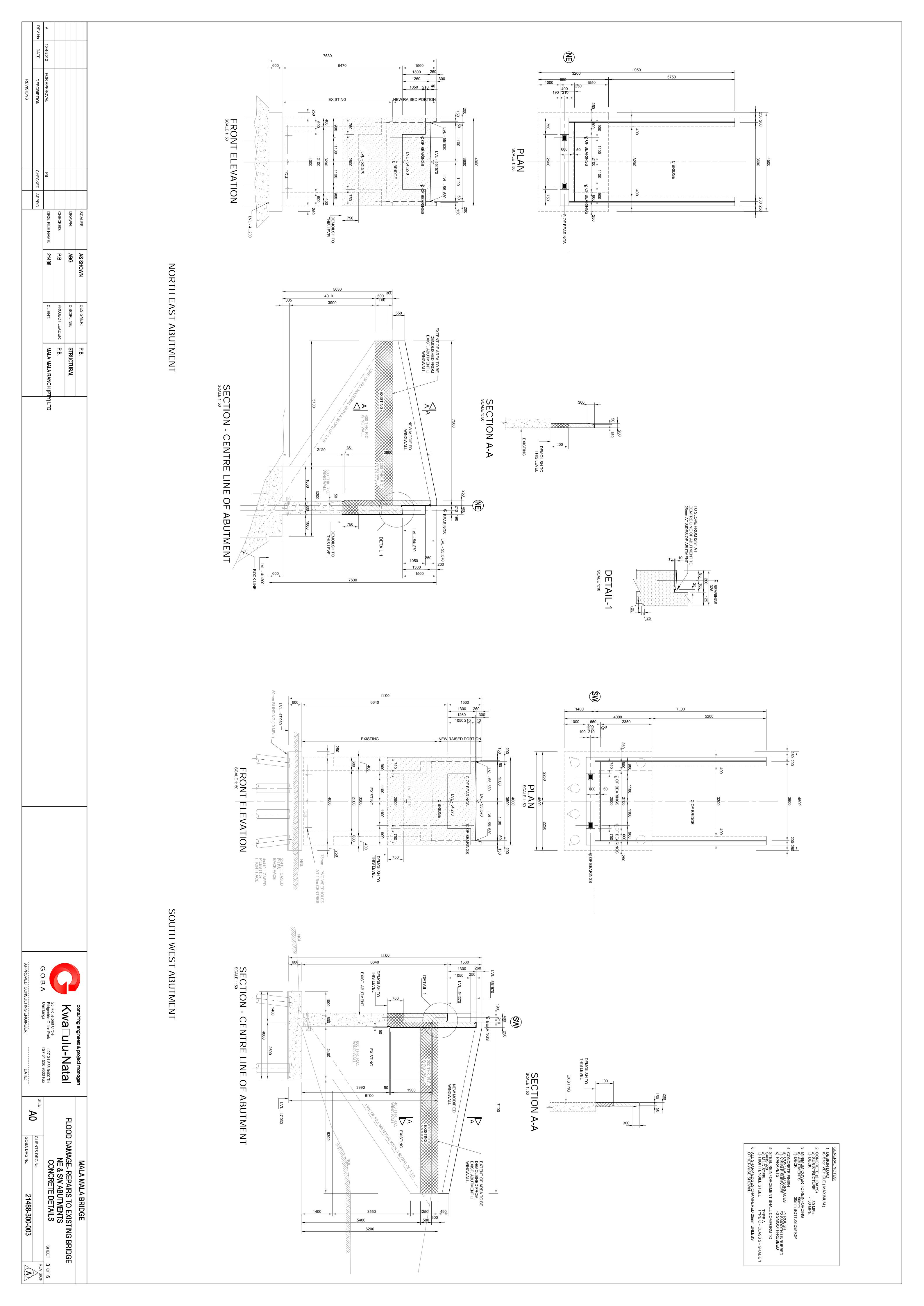
Annexure B Layout

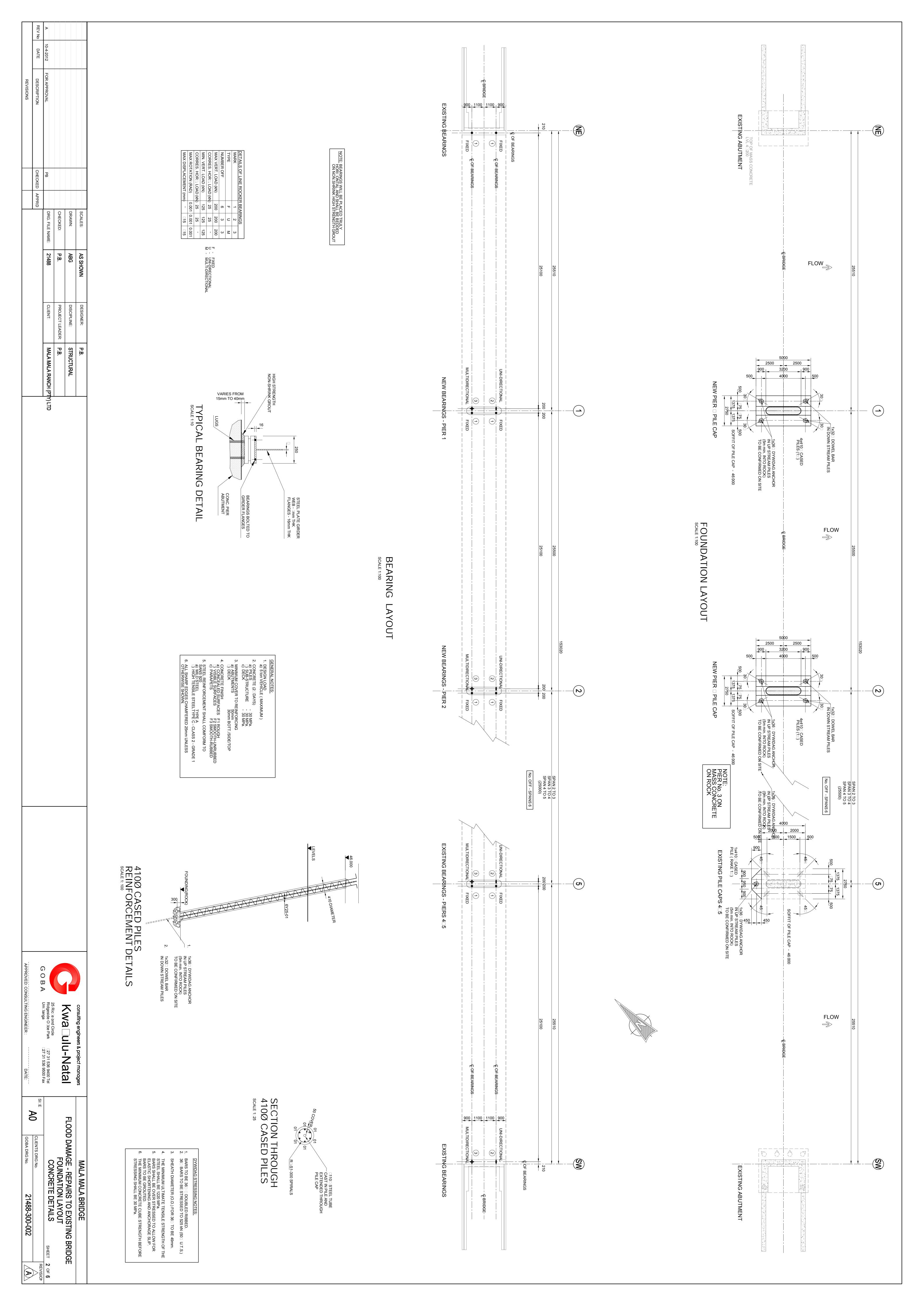












Appendix B Photographs



Figure 1 | Aerial view of the MalaMala West Street Bridge – post flood 2012



Figure 2 | Flood damage to existing bridge



Figure 3 | Stay on eastern bank (abutment(to be rebuilt)



Figure 4 | Flood damage to river bank.

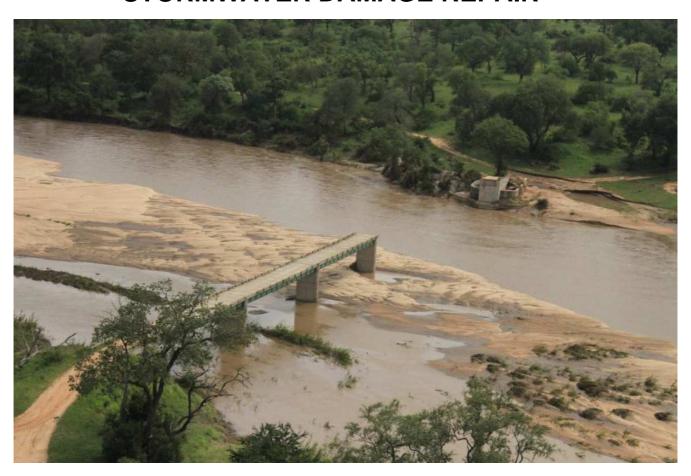
Appendix C Facility Illustrations

See Appendix A; Annexure B

Appendix D Specialist Reports

Annexure A Flood line Report

MALA MALA STORMWATER DAMAGE REPAIR



MALA-MALA SABI SAND GAME RESERVE

FLOODLINE REPORT

24 MAY 2012





ENDECON UBUNTU (PTY) LTD ENGINEERING CONSULTANTS	TITLE OF REPORT: FLOOD LINE REPORT FOR THE STORMWATER DAMAGE OF THE MALA MALA BRIDGE IN THE SABI SAND GAME RESERVE			
Report File Name:	Mala Mala Floodline report.doc			
Client:	Mr. Iain Garratt			
Prepared by:	N.C.J van der Merwe	Signed		
Reviewed by:	H. J. M. H. Venter	Signed		
Approved by:	H.J.M.H Venter	Signed		
DESCRIPTION OF REVISIONS		REVISION	DATE	



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1 FLOOD LINE DELINEATION

1.1 Introduction

Endecon Ubuntu (Pty) Ltd was appointed by Mr Iain Garratt on behalf of Mala Mala Private Game Reserve for the calculation of a 1 in 100 year flood line for the rebuilding of a bridge located on the Mala Mala game reserve property. See figure 1 below:



Figure 1: Existing damaged bridge

The designated flood line is widely used throughout the world to control development in flood prone areas. Limitations are placed on any development below this flood line, while no restrictions are placed on development above this flood line. The designated flood line is defined as that level that is reached by a constant discharge equal to the estimated peak flow in a water course having a specified annual exceedance probability of usually either 1 in 20 years (5%), 1 in 50 years (2%) or 1 in 100 years (1%).

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FLOODLINE REPORT:

MALA MALA, SABI SAND GAME RESERVE, MPUMALANGA

In South Africa the 1 in 50 year flood line was specified when Section 169A of the Water Act was introduced in 1975. The Act was amended in 1978 and the designated flood line was reduced to 1 in 20 years. This was again amended in the National Water Act (Act No. 36 of 1998), Chapter 14, Part 3 which states:

144. For the purposes of ensuring that all persons who might be affected have access to information regarding potential flood hazards, no person may establish a township unless the layout plan shows, in a form acceptable to the local authority concerned, lines indicating the maximum level likely to be reached by floodwaters on average once in every 100 years

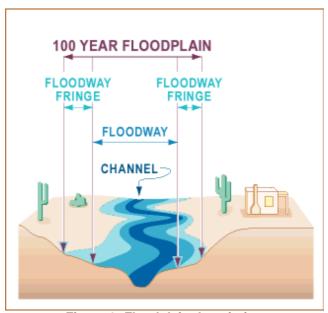


Figure 2: Floodplain description

1.2 Location and description of the site

a) Location

The site is located in the Sabi Sand Game Reserve and entails an existing concrete bridge spanning the Sand river. The bridge is located approximately 3km south east of the main camp.

Coordinates of the bridge are: S2449'32.9" E3133' 29.1" See Figure 3 below:



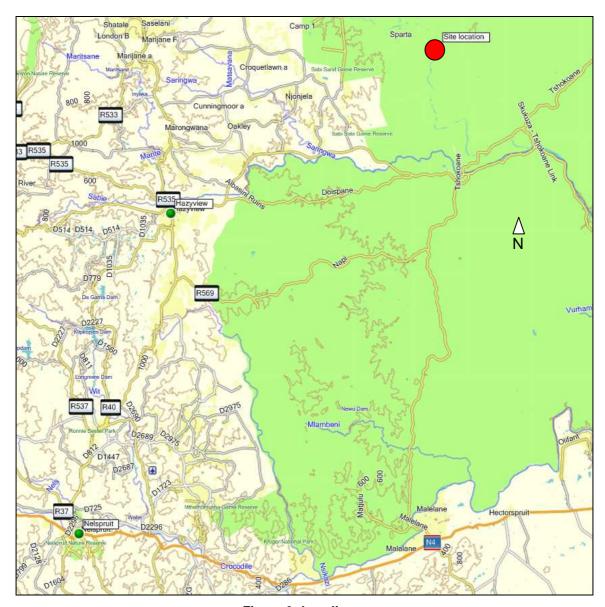


Figure 3: Locality

b) Site details and topography

The Sand river flows from north to south underneath the existing concrete bridge, the river flows south until it reaches the Sabie river that flows towards the east. The existing bridge has been extensively damaged and a new bridge is being designed by others to replace the damaged existing bridge. The floodplain area outside the riverbank is relatively steep and slopes towards the stream at approximately 10-16%, see figure 4 below. The stream itself has a very flat

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longitudinal slope of approximately 0.2%.



Figure 4: Steep slopes

A very large area drains into the Sand river via perennial streams, see Figure 5 below (Perennial streams are indicated with dashed blue lines).



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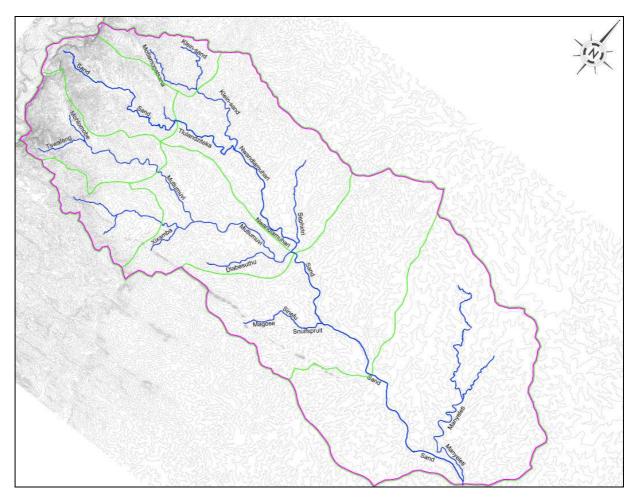


Figure 5: Catchment area

1.3 <u>Hydraulic factors</u>

a) Vegetation:

The site is located mainly in riparian woodlands and large trees and sparse shrubs dominate the vegetation. The type of vegetation is bushveld type savannah. The storm water course river bed is sandy and none to minimal vegetation occurs which will influence the velocity of the water course flow during flood events as minimal hydraulic flow resistance is generated. A higher velocity will cause the water course level to lower in order for the volume of water to pass. See Figure 6 below:

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Figure 6: Vegetation

b) Shape of water course:

The shape of the particular section of the water course where the floods line is generated allows for constant laminar flow conditions as there are few bends in the water course. The constant laminar flow condition causes the flood volume to pass in parallel lines. The straight line of flow is an advantage. The water course has minimal bends and widenings and narrows where the flood conditions may alter in the form of back water curves being formed (damming) and can therefore be considered inconsequential. The river is very wide (±150m) at the site location and therefore has a high storage capacity before the water rises significantly and overtops the banks.

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Figure 7: Shape of the watercourse

c) Slope of water course:

The slope of the water course has in general a very constant flat slope of approximately 0.2% and a varying flood level is not expected. The flow regime is also expected to be sub-critical laminar flows. Refer to **Annexure A** for Calculation results.

d) Normal water course flow (Base flow)

The normal water course flow is known as base-flow and in this case the base-flow is regarded as dead space occupied by the constant flow in the river. The flood is therefore modelled above the water surface level as surveying the river bed is impractical and this will be the case in an actual flood event.

e) Flood lines

The area is affected by a perennial storm watercourse and indication of the 1 in 100 year flood line is therefore required on the site. The general topography and size of the catchment are

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such that a very high volume flush flood can be expected during high intensity rainstorm events.

1.4 Hydrological calculations

a) Calculation method

The run-off was calculated using a combination of methods described in the "Road Drainage Manual" South African Roads National Roads Agency Limited", 5th edition page 3-10 to 3-46. The "Utility Programs for Drainage" program developed by Sinotech CC compliments the mentioned Road Drainage Manual and was used to calculate the run-off. For the results of the above mentioned, see attached calculations (Annexure A).

b) Run-off calculations

i. Unit Hydrograph Method

The unit hydrograph method is suitable for the determination of flood peaks as well as hydrographs for medium-sized rural catchments (15 to 5 000km²). The method is based mainly on regional analyses of historical data, and is independent of personal judgement. The results are reliable, although some natural variability in the hydrological occurrences is lost through the broad regional divisions and the averaged form of the hydrographs.

ii. Standard Design Flood method

This method is based on a calibrated discharge coefficient for a recurrence period of 2 and 100 years. Calibrated discharge parameters are based on historical data and were determined for 29 homogeneous basins in South Africa. There is no limitation to the size of the catchment area that may be analysed with this method.

iii. Empirical method

This method requires a combination of experience, historical data and/or the results of



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FLOODLINE REPORT:

MALA MALA, SABI SAND GAME RESERVE, MPUMALANGA

other methods. Empirical methods are more suited to check the order of magnitude of results obtained by means of the other methods. There is no limitation to the size of the catchment area that may be analysed with this method.

iv. RMF method

Most of the existing methods fail to predict flood peaks for return periods in excess of 100 years. It is however sometimes desirable or necessary to obtain realistic values for extreme peak floods and the accompanying water levels; particularly where human lives may be endangered and/or valuable property may be damaged.

In an investigation for the Directorate of Water Affairs, Kovacs studied the approximately 300 highest flood peaks observed in South Africa between 1894 and 1979. The information was processed using the Francou-Rodier relationship and five regional curves with confidence bands were compiled (k-values).

According to Kovacs a simple unorthodox analysis of the k-value and the representative return period of entirely independent flood peaks have provided coefficients which represent the 50 to 200 year peaks as fractions of RMF. There is no limitation to the size of the catchment area that may be analysed with this method.

The flood discharges calculated with the various methods are indicated in the following summary:



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Table 1: Runoff calculations summary

	DRAINAGE LINE	Details
1	Catchment area	1560 km ²
2	River	Sand
3	Mean Annual Precipitation	700mm/annum
4	Length of longest water path	87 km
5	Average slope of water path	0.002 m/m
6	Return period	1 in 100 years
7	Unit hydrograph method 1 in 100 year run-off	1066.08 m³/s
8	Standard design flood method 1 in 100 year run-off	2570.47 m³/s
9	Empirical method 1 in 100 year run-off	1210.64 m³/s
10	RMF _{1:100} run-off (To check order of magnitude)	2583.09 m³/s
11	Average 1 in 100 year run-off (7+8+9) ÷ 3	1615 m³/s
12	RMF (Regional Maximum Flood)	3949.68 m³/s

The design flow used in the HEC-RAS model has been determined by using the average runoff result. The value used in the HEC-RAS model is 1615 m³/s.

1.5 Flood line calculations

The flood line areas of encroachment for the storm water course were calculated using the HEC-RAS River Analysis System programme Version 3.0.1 of the U.S. Army Corps of Engineers, Hydrologic Engineering Centre. The results of these calculations are attached in Annexure A to this report.

A Manning roughness value of 0.07 has been chosen for the overbanks and 0.04 for the channel. Refer to the vegetation paragraph. For a list of manning friction factors, see the table below.



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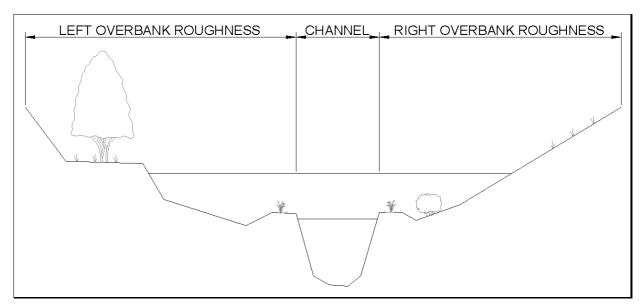
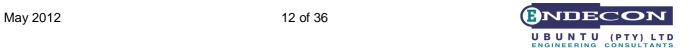


Figure 8: Floodplain roughness

Table 2: Manning friction factors

Type of Channel and Description	Minimum	Normal	Maximum
A. Natural Streams			
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective	0.040	0.048	0.055
slopes and sections			
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or flood ways with	0.070	0.100	0.150
heavy stands of timber and brush			
2. Flood Plains			
a. Pasture no brush			
Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
Mature row crops	0.025	0.035	0.045
Mature field crops	0.030	0.040	0.050
c. Brush			
 Scattered brush, heavy weeds 	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110



5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
 Cleared land with tree stumps, no sprouts 	0.030	0.040	0.050
Same as above, but heavy sprouts	0.050	0.060	0.080
Heavy stand of timber, few down trees, little	0.080	0.100	0.120
undergrowth, flow below branches			
4. Same as above, but with flow branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. Mountain Streams, no vegetation in channel, banks			
usually steep, with trees and brush on banks submerged.			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070

Expansion and contraction factors for gradual transitions were chosen as 0.3 and 0.1 respectively. For bridges and culverts the expansion factor will be 0.3 and 0.6 respectively. For bridges and culverts the contraction factor will be 0.5 and 0.8 respectively. In this case only gradual transitions were present.

The flow in the channel is a sub-critical flow regime.

The flood line was also elevated slightly to the elevation of the energy line to account for obstructions that might elevate the flood level in storm events.

The 1 in 100 year flood line is indicated on the attached layout plan. (Annexure B).



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FLOODLINE REPORT: MALA MALA, SABI SAND GAME RESERVE, MPUMALANGA

ANNEXURE A: RESULTS OF CALCULATIONS



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Project name: N2402 Mala Mala Floodline

Analysed by: NC vd Merwe Name of river: Sand river

Description of site: Sabi Sands Game Reserve

Filename: X:\02 Projects\2000\2400 - 2499\N2402 - Mala mala floodline\e Design\1 Basi

c\f Floodline\a Runoff calculations\Runoff calculations.fld

Date: 8 May 2012

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Summary of peak flows (m³/s)

Method	1:2	1:5	1:10	1:20	1:50	1:100	1:200	Design year
Rational	438.92	637.52	857.29	1120.65	1537.77	1992.26		100
Alternative rational								
Unit hydrograph	149.24	246.26	359.43	503.36	765.15	1066.08		100
Standard design flood	196.07	609.00	987.25	1412.47	2043.17	2570.47	3128.69	100
Empirical			508.47	690.06	956.40	1210.64		100

Statistical: LN Statistical: LEV1 Statistical: LP3 Statistical: EV1

Class of road = Class 1 Primary Distributors



Project name: N2402 Mala Mala Floodline

Analysed by: NC vd Merwe Name of river: Sand river

Description of site: Sabi Sands Game Reserve

X:\02 Projects\2000\2400 - 2499\N2402 - Mala mala floodline\e Design\1 Basi **Filename:**

c\f Floodline\a Runoff calculations\Runoff calculations.fld

Date: 8 May 2012

Printed: 16 May 2012 Page 3

Flood Frequency Analysis: Empirical methods

Project = N2402 Mala Mala Floodline

Analysed by = NC vd Merwe Name of river = Sand river

Description of site = Sabi Sands Game Reserve

= 2012/05/08

Area of catchment $= 1560.0 \text{ km}^2$ Length of longest watercourse = 87.0 kmHeight difference along equal-area slope = 1240.0 m Distance to catchment centroid = 40.0 kmDolomitic area = 0.0 % = 700.0 mmMean annual rainfall Veld type = 8 = K1(K = 2.8)

Kovács region Catchment parameter with regard to

reaction time = 0.054

Peak discharges by means of an empirical method developed by Midgley and Pitman

Return period (years)	KT constant	Peak flow (m³/s)
1:10	0.42	508.47
1:20	0.57	690.06
1:50	0.79	956.40
1:100	1.00	1210.64

This RMF calculation includes a transition zone adjustment in the case of small catchments.

 $346.4 \text{ m}^3/\text{s}$ Regional maximum flood:

Q50(RMF): 113.31 m³/s (based on QT/QRMF relationship for Kovács regions) Q100(RMF): 151.66 m³/s (based on QT/QRMF relationship for Kovács regions) Q200(RMF): 200.37 m³/s (based on QT/QRMF relationship for Kovács regions)

The following equivalent maxima make no transition zone adjustments for small catchments.

Equivalent southern African maximum

K-factor 5.6: $7673 \text{ m}^3/\text{s}$

Equivalent world maxima

11947 m³/s K-factor 6.0: K-factor 6.3: 16652 m³/s

Calculated using Utility Programs for Drainage 1.1.0

The software programs were developed for the convenience of its users. Although every reasonable effort has been made to ensure that the programs are accurate and reliable the program developers, Sinotech CC, accept no liability of any kind for any results, interpretation thereof or any use made of the results obtained with these programs. All users of these programs do so entirely at their own risk. Copyright (C) 2009 SINOTECH CC, www.sinotechcc.co.za, software@sinotechcc.co.za



Project name: N2402 Mala Mala Floodline

Analysed by: NC vd Merwe Name of river: Sand river

Description of site: Sabi Sands Game Reserve

Filename: X:\02 Projects\2000\2400 - 2499\N2402 - Mala mala floodline\e Design\1 Basi

c\f Floodline\a Runoff calculations\Runoff calculations.fld

Date: 8 May 2012

Printed: 16 May 2012 Page 2

Flood frequency analysis: Standard Design Flood method

Project name = N2402 Mala Mala Floodline

Analysed by = NC vd Merwe
Name of river = Sand river

Description of site = Sabi Sands Game Reserve

Date = 2012/05/08

Catchment characteristics:

Area of catchment = 1560 km^2 Length of longest watercourse = 87 km 1085 height difference = 1240 mAverage slope = 0.0190 m/m

Drainage basin characteristics:

Drainage basin number = 29 Mean annual daily max rain = 66 mmDays on which thunder was heard = 11 days Runoff coefficient C2 = 15 % Runoff coefficient C100 = 50 % Basin mean annual precipitation = 740 mmBasin mean annual evaporation = 1600 mmBasin evaporation index MAE/MAP = 2.16

RAINFALL DATA

The rainfall data in the table below are derived from two sources. The daily rainfall is from the Department of Water Affair's publication TR102 for the representative site. The modified Hershfield equation is used for durations up to four hours. Linear interpolation is used for values between 4 hours and one day.

Weather Services station ex TR102 = 556088 @ MAYFERN Point mean annual precipitation = 740 mm

Dur:	RP =2	5	10	20	50	100	200
.25 h	14	23	30	38	47	54	61
.50 h	18	30	40	49	61	70	80
1 h	22	37	49	60	75	87	98
2 h	26	44	58	71	89	103	117
4 h	30	51	67	83	104	119	135
1 day	66	93	113	135	168	196	227
2 days	78	108	130	154	189	218	250
3 days	89	125	153	183	227	265	306
7 days	113	159	194	232	286	331	380

Runoff coefficients C2 = 15 % C100 = 50 %

Return period	Time of concentration	Point precipitation	ARF	Catchment precipitation	Runoff coefficient	Peak flow
(years)	(hours)	(mm)	(%)	(mm)	(%)	(m³/s)
1:2	9.50	35 . 5	80.6	28.6	15.0	196.07
1:5	9.50	60.0	80.6	48.3	27.6	609.00
1:10	9.50	78.4	80.6	63.2	34.2	987.25
1:20	9.50	96.9	80.6	78.1	39.6	1412.47
1:50	9.50	121.3	80.6	97.8	45.8	2043.17
1:100	9.50	139.8	80.6	112.6	50.0	2570.47
1:200	9.50	158.3	80.6	127.5	53.8	3128.69

Calculated using Utility Programs for Drainage 1.1.0

The software programs were developed for the convenience of its users. Although every reasonable effort has been made to ensure that the programs are accurate and reliable the program developers, Sinotech CC, accept no liability of any kind for any results, interpretation thereof or any use made of the results obtained with these programs. All users of these programs do so entirely at their own risk. Copyright (C) 2009 SINOTECH CC, www.sinotechcc.co.za, software@sinotechcc.co.za

Sinotech

Project name: N2402 Mala Mala Floodline

Analysed by: NC vd Merwe Name of river: Sand river

Description of site: Sabi Sands Game Reserve

Filename: X:\02 Projects\2000\2400 - 2499\N2402 - Mala mala floodline\e Design\1 Basi

c\f Floodline\a Runoff calculations\Runoff calculations.fld

Date: 8 May 2012

Printed: 16 May 2012 Page 1

Flood Frequency Analysis: Unit Hydrograph Method

Project = N2402 Mala Mala Floodline

Analysed by = NC vd Merwe
Name of river = Sand river

Description of site = Sabi Sands Game Reserve

Date = 2012/05/08Area of catchment = 1560.0 km^2 Length of longest watercourse = 87.0 km

Height difference along equal area slope
Distance to catchment centroid

Veld type

Duration interval

1240.0 m

40.0 km

Region 8

30 minutes

 Slope of longest stream
 = 0.0143 m/m

 Catchment index
 = 29149.3

 Catchment lag
 = 7.880

Coefficient (Ku) = 0.367 m³/s - hours/km²

Peak discharge of unit hydrograph (Qp) = $72.652 \text{ m}^3/\text{s}$

Return period = 1:2 year

Storm	Point	Point	ARF	Average		Effective
duration	rainfall	intensity	(0)	rainfall	factor	rain
(minutes)	(mm)	(mm/h)	(%)	(mm)	(%)	(mm)
30	26.1	52.2	47.4	12.4	5.8	0.71
60	33.1	33.1	47.4	15.7	6.9	1.08
90	36.8	24.5	50.2	18.5	7.7	1.43
120	39.3	19.6	52.1	20.4	8.3	1.69
150	41.1	16.4	53.5	22.0	8.7	1.91
180	42.5	14.2	54.7	23.2	9.0	2.10
210	43.7	12.5	55.7	24.3	9.3	2.26
240	44.7	11.2	56.6	25.3	9.5	2.41
270	45.6	10.1	57.4	26.2	9.7	2.55
300	46.3	9.3	58.1	26.9	9.9	2.67
330	47.0	8.5	58.8	27.7	10.1	2.79
360	47.6	7.9	59.5	28.3	10.2	2.90
390	48.2	7.4	60.0	29.0	10.4	3.01
420	48.8	7.0	60.6	29.5	10.5	3.11
450	49.2	6.6	61.1	30.1	10.6	3.20
480	49.7	6.2	61.6	30.6	10.8	3.29
510	50.1	5.9	62.1	31.1	10.9	3.38
540	50.5	5.6	62.6	31.6	11.0	3.47
570	50.9	5.4	63.0	32.1	11.1	3.55
600	51.3	5.1	63.4	32.5	11.2	3.63
630	51.6	4.9	63.8	32.9	11.2	3.70
660	51.9	4.7	64.2	33.4	11.3	3.78
690	52.3	4.5	64.6	33.8	11.4	3.85
720	52.6	4.4	64.9	34.1	11.5	3.92
750	52.8	4.2	65.3	34.5	11.6	3.99
780	53.1	4.1	65.6	34.9	11.6	4.06
810	53.4	4.0	66.0	35.2	11.7	4.13
840	53.6	3.8	66.3	35.6	11.8	4.19
870	53.9	3.7	66.6	35.9	11.8	4.25
900	54.1	3.6	66.9	36.2	11.9	4.31
930	54.4	3.5	67.2	36.5	12.0	4.37
960	54.6	3.4	67.4	36.8	12.0	4.43
990	54.8	3.3	67.7	37.1	12.1	4.49
1020	55.0	3.2	68.0	37.4	12.2	4.55
1050	55.2	3.2	68.2	37.7	12.2	4.60
1080	55.4	3.1	68.5	38.0	12.3	4.66
1110	55.6	3.0	68.8	38.2	12.3	4.71
1140	55.8	2.9	69.0	38.5	12.4	4.76
1170	56.0	2.9	69.2	38.8	12.4	4.82
1200	56.2	2.8	69.5	39.0	12.5	4.87
1230	56.4	2.7	69.7	39.3	12.5	4.92

1260	56.5	2.7	69.9	39.5	12.6	4.97
1290	56.7	2.6	70.1	39.8	12.6	5.02
1320	56.9	2.6	70.3	40.0	12.7	5.06
1350	57.0	2.5	70.5	40.2	12.7	5.11
1380	57.2	2.5	70.8	40.5	12.7	5.16
1410	57.3	2.4	71.0	40.7	12.8	5.20
1440	57.5	2.4	71.1	40.9	12.8	5.25
1470	57.6	2.4	71.3	41.1	12.9	5.29
1500	57.8	2.3	71.5	41.3	12.9	5.34
1530	57.9	2.3	71.7	41.5	13.0	5.38
1560	58.1	2.2	71.9	41.8	13.0	5.42
1590	58.2	2.2	72.1	42.0	13.0	5.47
1620	58.3	2.2	72.2	42.2	13.1	5.51
1650	58.5	2.1	72.4	42.4	13.1	5.55
1680	58.6	2.1	72.6	42.5	13.1	5.59
1710	58.7	2.1	72.8	42.7	13.2	5.63
1740	58.9	2.0	72.9	42.9	13.2	5.67
1770	59.0	2.0	73.1	43.1	13.2	5.71
1800	59.1	2.0	73.2	43.3	13.3	5.75
1830	59.2	1.9	73.4	43.5	13.3	5.79
1860	59.4	1.9	73.5	43.7	13.3	5.82
1890	59.5	1.9	73.7	43.8	13.4	5.86
1920	59.6	1.9	73.8	44.0	13.4	5.90
1950	59.7	1.8	74.0	44.2	13.4	5.94
1980	59.8	1.8	74.1	44.3	13.5	5.97
2010	59.9	1.8	74.3	44.5	13.5	6.01
2040	60.0	1.8	74.4	44.7	13.5	6.04
2070	60.1	1.7	74.6	44.8	13.6	6.08
2100	60.2	1.7	74.7	45.0	13.6	6.11
2130	60.4	1.7	74.8	45.2	13.6	6.15
2160	60.5	1.7	75.0	45.3	13.6	6.18
2190	60.6	1.7	75.1	45.5	13.7	6.22
2220	60.7	1.6	75.2	45.6	13.7	6.25
2250	60.8	1.6	75.3	45.8	13.7	6.28
2280	60.9	1.6	75.5	45.9	13.8	6.32
2310	61.0	1.6	75.6	46.1	13.8	6.35
2340	61.1	1.6	75.7	46.2	13.8	6.38
2370	61.1	1.5	75.8	46.4	13.8	6.41
2400	61.2	1.5	75.9	46.5	13.9	6.45
2430	61.3	1.5	76.1	46.6	13.9	6.48
2460	61.4	1.5	76.2	46.8	13.9	6.51
2490	61.5	1.5	76.3	46.9	13.9	6.54
2520	61.6	1.5	76.4	47.1	14.0	6.57
2550	61.7	1.5	76.5	47.2	14.0	6.60
2580	61.8	1.4	76.6	47.3	14.0	6.63
2610	61.9	1.4	76.7	47.5	14.0	6.66
2640	62.0	1.4	76.8	47.6	14.1	6.69
2670	62.0	1.4	76.9	47.7	14.1	6.72
2700	62.1	1.4	77.0	47.9	14.1	6.75
2730	62.2	1.4	77.1	48.0	14.1	6.78
2760	62.3	1.4	77.2	48.1	14.1	6.81
2790	62.4	1.3	77.3	48.2	14.2	6.83
2820	62.5	1.3	77.4	48.4	14.2	6.86
2850	62.5	1.3	77.5	48.5	14.2	6.89
2880	62.6	1.3	77.6	48.6	14.2	6.92

Return period = 1:5 year

Storm duration (minutes)	Point rainfall (mm)	Point intensity (mm/h)	ARF (%)	Average rainfall (mm)	Runoff factor (%)	Effective rain (mm)
30	35.5	71.1	47.4	16.8	7.3	1.22
60	45.1	45.1	47.4	21.3	8.5	1.82
90	50.1	33.4	50.2	25.1	9.5	2.39
120	53.5	26.7	52.1	27.8	10.1	2.82
150	55.9	22.4	53.5	29.9	10.6	3.17
180	57.9	19.3	54.7	31.6	11.0	3.47
210	59.5	17.0	55.7	33.1	11.3	3.74
240	60.8	15.2	56.6	34.4	11.6	3.98
270	62.0	13.8	57.4	35.6	11.8	4.20
300	63.1	12.6	58.1	36.7	12.0	4.40
330	64.0	11.6	58.8	37.7	12.2	4.60
360	64.9	10.8	59.5	38.6	12.4	4.78
390	65.7	10.1	60.0	39.4	12.5	4.95
420	66.4	9.5	60.6	40.2	12.7	5.11
450	67.1	8.9	61.1	41.0	12.8	5.27
480	67.7	8.5	61.6	41.7	13.0	5.42
510	68.3	8.0	62.1	42.4	13.1	5.56
540	68.8	7.6	62.6	43.1	13.2	5.70
570	69.3	7.3	63.0	43.7	13.3	5.83
600	69.8	7.0	63.4	44.3	13.5	5.96
630	70.3	6.7	63.8	44.9	13.6	6.09
660	70.7	6.4	64.2	45.4	13.7	6.21
690	71.2	6.2	64.6	46.0	13.8	6.33
720	71.6	6.0	64.9	46.5	13.9	6.44
750	72.0	5.8	65.3	47.0	13.9	6.55
780	72.3	5.6	65.6	47.5	14.0	6.66
810	72.7	5.4	66.0	48.0	14.1	6.77
840	73.1	5.2	66.3	48.4	14.2	6.87
870	73.4	5.1	66.6	48.9	14.3	6.98
900	73.7	4.9	66.9	49.3	14.4	7.08

930	74.0	4.8	67.2	40.7	14.4	7 17
960	74.0 74.3	4.6	67.2 67.4	49.7 50.1	14.4	7.17 7.27
990	74.6	4.5	67.7	50.5	14.6	7.27
1020	74.9	4.4	68.0	50.9	14.6	7.36
1050	75.2	4.3	68.2	51.3	14.7	7.55
1080	75.5	4.2	68.5	51.7	14.8	7.64
1110	75.7	4.1	68.8	52.1	14.8	7.72
1140	76.0	4.0	69.0	52.4	14.9	7.72
1170	76.3	3.9	69.2	52.8	15.0	7.81
1200	76.5	3.8	69.5	53.1	15.0	7.89
1230	76.7	3.7	69.7	53.5	15.1	8.06
1260	77.0	3.7	69.9	53.8	15.1	8.14
1290	77.2	3.6	70.1	54.1	15.2	8.22
1320	77.4	3.5	70.3	54.5	15.2	8.30
1350	77.7	3.5	70.5	54.8	15.3	8.37
1380	77.9	3.4	70.8	55.1	15.3	8.45
1410	78.1	3.3	71.0	55.4	15.4	8.53
1440	78.3	3.3	71.1	55.7	15.4	8.60
1470	78.5	3.2	71.3	56.0	15.5	8.67
1500	78.7	3.1	71.5	56.3	15.5	8.74
1530	78.9	3.1	71.7	56.6	15.6	8.81
1560	79.1	3.0	71.9	56.9	15.6	8.88
1590	79.3	3.0	72.1	57.1	15.7	8.95
1620	79.4	2.9	72.2	57.4	15.7	9.02
1650	79.6	2.9	72.4	57.7	15.8	9.09
1680	79.8	2.9	72.6	57.9	15.8	9.16
1710	80.0	2.8	72.8	58.2	15.8	9.22
1740	80.2	2.8	72.9	58.5	15.9	9.29
1770	80.3	2.7	73.1	58.7	15.9	9.35
1800	80.5	2.7	73.2	59.0	16.0	9.42
1830	80.7	2.6	73.4	59.2	16.0	9.48
1860	80.8	2.6	73.5	59.4	16.0	9.54
1890	81.0	2.6	73.7	59.7	16.1	9.60
1920	81.1	2.5	73.8	59.9	16.1	9.66
1950	81.3	2.5	74.0	60.2	16.2	9.72
1980	81.4	2.5	74.1	60.4	16.2	9.78
2010	81.6	2.4	74.3	60.6	16.2	9.84
2040	81.7	2.4	74.4	60.8	16.3	9.90
2070	81.9	2.4	74.6	61.1	16.3	9.96
2100	82.0	2.3	74.7	61.3	16.3	10.01
2130	82.2	2.3	74.8	61.5	16.4	10.07
2160	82.3	2.3	75.0	61.7	16.4	10.13
2190	82.5	2.3	75.1	61.9	16.4	10.18
2220	82.6	2.2	75.2	62.1	16.5	10.24
2250	82.7	2.2	75.3	62.3	16.5	10.29
2280	82.9	2.2	75.5	62.5	16.5	10.34
2310	83.0	2.2	75.6	62.7	16.6	10.40
2340	83.1	2.1	75.7	62.9	16.6	10.45
2370	83.3	2.1	75.8	63.1	16.6	10.50
2400	83.4	2.1	75.9	63.3	16.7	10.55
2430	83.5	2.1	76.1	63.5	16.7	10.61
2460	83.6	2.0	76.2	63.7	16.7	10.66
2490	83.8	2.0	76.3	63.9	16.8	10.71
2520	83.9	2.0	76.4	64.1	16.8	10.76
2550	84.0	2.0	76.5	64.3	16.8	10.81
2580 2610	84.1	2.0	76.6	64.5	16.8	10.86
2610 2640	84.2	1.9	76.7	64.6	16.9 16.9	10.91
2640 2670	84.4 84.5	1.9	76.8	64.8 65.0		10.95
2670 2700	84.5 84.6	1.9	76.9	65.0 65.2	16.9	11.00
2700 2730	84.6 84.7	1.9 1.9	77.0 77.1	65.2 65.3	17.0 17.0	11.05
2760	84.8	1.8	77.1 77.2	65.5	17.0	11.10 11.14
2790	84.9	1.8	77.3	65.7	17.0	11.14
2820	85.0	1.8	77.4	65.9	17.1	11.24
2850	85.2	1.8	77.5	66.0	17.1	11.24
2880	85.3	1.8	77.6	66.2	17.1	11.23
2000	03.3	1.0	, , . 0	00.2	11.T	11.00

Return period = 1:10 year

Storm duration (minutes)	Point rainfall (mm)	Point intensity (mm/h)	ARF	Average rainfall (mm)	Runoff factor (%)	Effective rain (mm)
30	45.0	90.0	47.4	21.3	8.5	1.82
60	57.0	57.0	47.4	27.0	9.9	2.68
90	63.4	42.3	50.2	31.8	11.0	3.50
120	67.7	33.8	52.1	35.2	11.7	4.13
150	70.8	28.3	53.5	37.9	12.2	4.64
180	73.2	24.4	54.7	40.0	12.7	5.07
210	75.3	21.5	55.7	41.9	13.0	5.46
240	77.0	19.3	56.6	43.6	13.3	5.81
270	78.5	17.4	57.4	45.1	13.6	6.13
300	79.8	16.0	58.1	46.4	13.8	6.43
330	81.0	14.7	58.8	47.7	14.1	6.70
360	82.1	13.7	59.5	48.8	14.3	6.97
390	83.1	12.8	60.0	49.9	14.5	7.21
420	84.0	12.0	60.6	50.9	14.6	7.45
450	84.9	11.3	61.1	51.9	14.8	7.68
480	85.7	10.7	61.6	52.8	15.0	7.89
510	86.4	10.2	62.1	53.7	15.1	8.10
540	87.1	9.7	62.6	54.5	15.2	8.30
570	87.7	9.2	63.0	55.3	15.4	8.50

600	00.4		62.4	56.0	15 5	0.60
600	88.4	8.8	63.4	56.0	15.5	8.68
630	89.0	8.5	63.8	56.8	15.6	8.87
660	89.5	8.1 7.8	64.2	57.5	15.7	9.04
690 720	90.1 90.6	7.8 7.5	64.6 64.9	58.2 58.8	15.8 15.9	9.22 9.38
750 750	91.1	7.3	65.3	59.5	16.1	9.55
780	91.6	7.0	65.6	60.1	16.2	9.71
810	92.0	6.8	66.0	60.7	16.2	9.86
840	92.5	6.6	66.3	61.3	16.3	10.01
870	92.9	6.4	66.6	61.8	16.4	10.16
900	93.3	6.2	66.9	62.4	16.5	10.31
930	93.7	6.0	67.2	62.9	16.6	10.45
960	94.1	5.9	67.4	63.5	16.7	10.59
990	94.5	5.7	67.7	64.0	16.8	10.73
1020	94.8	5.6	68.0	64.5	16.8	10.86
1050	95.2	5.4	68.2	65.0	16.9	10.99
1080	95.5	5.3	68.5	65.4	17.0	11.12
1110	95.9	5.2	68.8	65.9	17.1	11.25
1140	96.2	5.1	69.0	66.4	17.1	11.37
1170	96.5	4.9	69.2	66.8	17.2	11.50
1200	96.8	4.8	69.5	67.3	17.3	11.62
1230	97.1	4.7	69.7	67.7	17.3	11.74
1260	97.4	4.6	69.9	68.1	17.4	11.86
1290	97.7	4.5	70.1	68.5	17.5	11.97
1320	98.0	4.5	70.3	68.9	17.5	12.08
1350	98.3	4.4	70.5	69.3	17.6	12.20
1380	98.6	4.3	70.8	69.7	17.7	12.31
1410	98.8	4.2	71.0	70.1	17.7	12.42
1440	99.1	4.1	71.1	70.5	17.8	12.52
1470	99.3	4.1	71.3	70.9	17.8	12.63
1500	99.6	4.0	71.5	71.2	17.9	12.74
1530	99.8	3.9	71.7	71.6	17.9	12.84
1560	100.1	3.8	71.9	72.0	18.0	12.94
1590	100.3	3.8	72.1	72.3	18.0	13.04
1620	100.6	3.7	72.2	72.6	18.1	13.14
1650	100.8	3.7	72.4	73.0	18.1	13.24
1680	101.0	3.6	72.6	73.3	18.2	13.34
1710	101.2	3.6	72.8	73.7	18.2	13.43
1740	101.5	3.5	72.9	74.0	18.3	13.53
1770	101.7	3.4	73.1	74.3	18.3	13.62
1800	101.9	3.4	73.2	74.6	18.4	13.71
1830	102.1	3.3	73.4	74.9	18.4	13.80
1860	102.3	3.3 3.3	73.5	75.2	18.5	13.89
1890 1920	102.5 102.7	3.2	73.7 73.8	75.5 75.8	18.5 18.6	13.98 14.07
1950	102.7	3.2	74.0	76.1	18.6	14.16
1980	103.1	3.1	74.1	76.4	18.6	14.25
2010	103.3	3.1	74.3	76.7	18.7	14.33
2040	103.5	3.0	74.4	77.0	18.7	14.42
2070	103.6	3.0	74.6	77.3	18.8	14.50
2100	103.8	3.0	74.7	77.6	18.8	14.58
2130	104.0	2.9	74.8	77.8	18.8	14.67
2160	104.2	2.9	75.0	78.1	18.9	14.75
2190	104.4	2.9	75.1	78.4	18.9	14.83
2220	104.5	2.8	75.2	78.6	19.0	14.91
2250	104.7	2.8	75.3	78.9	19.0	14.99
2280	104.9	2.8	75.5	79.1	19.0	15.07
2310	105.1	2.7	75.6	79.4	19.1	15.14
2340	105.2	2.7	75.7	79.7	19.1	15.22
2370	105.4	2.7	75.8	79.9	19.1	15.30
2400	105.5	2.6	75.9	80.2	19.2	15.37
2430	105.7	2.6	76.1	80.4	19.2	15.45
2460	105.9	2.6	76.2	80.6	19.2	15.52
2490	106.0	2.6	76.3	80.9	19.3	15.60
2520	106.2	2.5	76.4	81.1	19.3	15.67
2550	106.3	2.5	76.5	81.3	19.4	15.74
2580	106.5	2.5	76.6	81.6	19.4	15.81
2610	106.6	2.5	76.7	81.8	19.4	15.88
2640	106.8	2.4	76.8	82.0	19.4	15.95
2670	106.9	2.4	76.9	82.3	19.5	16.02
2700	107.1	2.4	77.0	82.5	19.5	16.09
2730	107.2	2.4	77.1	82.7	19.5	16.16
2760	107.4	2.3	77.2	82.9	19.6	16.23
2790	107.5	2.3	77.3	83.1	19.6	16.30
2820	107.6	2.3	77.4	83.4	19.6	16.37
2850 2880	107.8 107.9	2.3 2.2	77.5 77.6	83.6 83.8	19.7 19.7	16.43 16.50
2000	10/.3	4.4	//•0	03.0	13.1	10.30

Return period = 1:20 year

Storm duration (minutes)	Point rainfall (mm)	Point intensity (mm/h)	ARF	Average rainfall (mm)	Runoff factor (%)	Effective rain (mm)
30	55.5	111.1	47.4	26.3	9.8	2.57
60	70.4	70.4	47.4	33.4	11.3	3.78
90	78.3	52.2	50.2	39.3	12.5	4.92
120	83.5	41.8	52.1	43.5	13.3	5.79
150	87.4	35.0	53.5	46.7	13.9	6.50
180	90.4	30.1	54.7	49.4	14.4	7.11
210	92.9	26.6	55.7	51.8	14.8	7.65
240	95.1	23.8	56.6	53.8	15.1	8.14

0.70	06.0	01 5	50.4	55.6	15.4	0 50
270 300	96.9 98.6	21.5 19.7	57.4 58.1	55.6 57.3	15.4 15.7	8.58 9.00
330	100.0	18.2	58.8	58.8	16.0	9.39
360	101.4	16.9	59.5	60.3	16.2	9.75
390	102.6	15.8	60.0	61.6	16.4	10.10
420	103.7	14.8	60.6	62.9	16.6 16.8	10.43
450 480	104.8 105.7	14.0 13.2	61.1 61.6	64.1 65.2	17.0	10.75 11.05
510	106.7	12.5	62.1	66.2	17.1	11.34
540	107.5	11.9	62.6	67.3	17.3	11.62
570	108.3	11.4	63.0	68.3	17.4	11.89
600 630	109.1 109.8	10.9 10.5	63.4 63.8	69.2 70.1	17.6 17.7	12.16 12.41
660	110.5	10.0	64.2	71.0	17.8	12.41
690	111.2	9.7	64.6	71.8	18.0	12.90
720	111.8	9.3	64.9	72.6	18.1	13.13
750 780	112.4	9.0	65.3	73.4	18.2	13.36
780 810	113.0 113.6	8.7 8.4	65.6 66.0	74.2 74.9	18.3 18.4	13.59 13.80
840	114.1	8.2	66.3	75.6	18.5	14.02
870	114.7	7.9	66.6	76.3	18.6	14.22
900	115.2	7.7	66.9	77.0	18.7	14.43
930 960	115.7 116.2	7.5 7.3	67.2 67.4	77.7 78.3	18.8 18.9	14.63 14.82
990	116.2	7.1	67.7	79.0	19.0	15.02
1020	117.1	6.9	68.0	79.6	19.1	15.20
1050	117.5	6.7	68.2	80.2	19.2	15.39
1080	117.9	6.6	68.5	80.8	19.3	15.57
1110 1140	118.4 118.8	6.4 6.3	68.8 69.0	81.4 81.9	19.4 19.4	15.75 15.92
1170	119.2	6.1	69.2	82.5	19.5	16.10
1200	119.5	6.0	69.5	83.0	19.6	16.27
1230	119.9	5.8	69.7	83.6	19.7	16.43
1260	120.3	5.7	69.9	84.1	19.7	16.60
1290 1320	120.6 121.0	5.6 5.5	70.1 70.3	84.6 85.1	19.8 19.9	16.76 16.92
1350	121.3	5.4	70.5	85.6	19.9	17.08
1380	121.7	5.3	70.8	86.1	20.0	17.23
1410	122.0	5.2	71.0	86.6	20.1	17.38
1440	122.3	5.1	71.1	87.0	20.1	17.54
1470 1500	122.6 123.0	5.0 4.9	71.3 71.5	87.5 87.9	20.2 20.3	17.68 17.83
1530	123.3	4.8	71.7	88.4	20.3	17.98
1560	123.6	4.8	71.9	88.8	20.4	18.12
1590	123.9	4.7	72.1	89.3	20.5	18.26
1620 1650	124.1 124.4	4.6 4.5	72.2 72.4	89.7 90.1	20.5 20.6	18.40 18.54
1680	124.7	4.5	72.6	90.5	20.6	18.67
1710	125.0	4.4	72.8	90.9	20.7	18.81
1740	125.2	4.3	72.9	91.3	20.7	18.94
1770 1800	125.5	4.3	73.1	91.7 92.1	20.8	19.07
1830	125.8 126.0	4.2 4.1	73.2 73.4	92.5	20.8 20.9	19.20 19.33
1860	126.3	4.1	73.5	92.9	20.9	19.46
1890	126.5	4.0	73.7	93.3	21.0	19.58
1920	126.8	4.0	73.8	93.6	21.0	19.71
1950 1980	127.0 127.3	3.9 3.9	74.0 74.1	94.0 94.3	21.1 21.1	19.83 19.95
2010	127.5	3.8	74.3	94.7	21.2	20.07
2040	127.7	3.8	74.4	95.1	21.2	20.19
2070	128.0	3.7	74.6	95.4	21.3	20.31
2100	128.2	3.7 3.6	74.7 74.8	95.7 96.1	21.3	20.42
2130 2160	128.4 128.6	3.6	75.0	96.4	21.4 21.4	20.54 20.65
2190	128.8	3.5	75.1	96.7	21.5	20.77
2220	129.1	3.5	75.2	97.1	21.5	20.88
2250	129.3	3.4	75.3	97.4	21.6	20.99
2280 2310	129.5 129.7	3.4 3.4	75.5 75.6	97.7 98.0	21.6 21.6	21.10 21.21
2340	129.9	3.3	75.7	98.3	21.7	21.32
2370	130.1	3.3	75.8	98.6	21.7	21.43
2400	130.3	3.3	75.9	99.0	21.8	21.53
2430	130.5	3.2	76.1	99.3 99.6	21.8	21.64
2460 2490	130.7 130.9	3.2 3.2	76.2 76.3	99.8	21.8 21.9	21.74 21.84
2520	131.1	3.1	76.4	100.1	21.9	21.95
2550	131.3	3.1	76.5	100.4	22.0	22.05
2580	131.5	3.1	76.6	100.7	22.0	22.15
2610 2640	131.6 131.8	3.0 3.0	76.7 76.8	101.0 101.3	22.0 22.1	22.25 22.35
2640 2670	131.8	3.0	76.8 76.9	101.3	22.1	22.35
2700	132.2	2.9	77.0	101.8	22.1	22.54
2730	132.4	2.9	77.1	102.1	22.2	22.64
2760	132.5	2.9	77.2	102.4	22.2	22.73
2790 2820	132.7 132.9	2.9 2.8	77.3 77.4	102.6 102.9	22.2 22.3	22.83 22.92
2850	132.9	2.8	77.4 77.5	102.9	22.3	23.02
2880		2.8		103.4	22.3	23.11
	_					
Return peri	od = 1:50 year	: 				

Storm Point Point ARF Average Runoff Effective

duration (minutes)	rainfall (mm)	intensity (mm/h)	(%)	rainfall (mm)	factor (%)	rain (mm)
30	72.2	144.4	47.4	34.2	11.5	3.94
60 90	91.5 101.8	91.5 67.9	47.4 50.2	43.4 51.1	13.3 14.7	5.76 7.49
120	108.6	54.3	52.1	56.5	15.6	8.80
150 180	113.6	45.4	53.5	60.8	16.3	9.88
210	117.6 120.8	39.2 34.5	54.7 55.7	64.3 67.3	16.8 17.3	10.81 11.63
240	123.6	30.9	56.6	69.9	17.7	12.37
270	126.0	28.0	57.4	72.3	18.0	13.05
300 330	128.1 130.1	25.6 23.6	58.1 58.8	74.5 76.5	18.4 18.7	13.68 14.27
360	131.8	22.0	59.5	78.4	18.9	14.83
390	133.4	20.5	60.0	80.1	19.2	15.36
420 450	134.8 136.2	19.3 18.2	60.6 61.1	81.7 83.3	19.4 19.6	15.86 16.34
480	137.5	17.2	61.6	84.7	19.8	16.80
510	138.7	16.3	62.1	86.1	20.0	17.24
540 570	139.8 140.8	15.5 14.8	62.6 63.0	87.5 88.7	20.2 20.4	17.67 18.08
600	141.8	14.2	63.4	90.0	20.5	18.48
630	142.8	13.6	63.8	91.1	20.7	18.87
660 690	143.7 144.6	13.1 12.6	64.2 64.6	92.3 93.4	20.9 21.0	19.25 19.62
720	145.4	12.1	64.9	94.4	21.2	19.97
750	146.2	11.7	65.3	95.4	21.3	20.32
780 810	146.9 147.7	11.3 10.9	65.6 66.0	96.4 97.4	21.4 21.6	20.66 20.99
840	148.4	10.6	66.3	98.3	21.7	21.32
870	149.1	10.3	66.6	99.3	21.8	21.64
900 930	149.7 150.4	10.0 9.7	66.9 67.2	100.1 101.0	21.9 22.0	21.95 22.25
960	151.0	9.4	67.4	101.8	22.1	22.55
990	151.6	9.2	67.7	102.7	22.2	22.84
1020	152.2	9.0 8.7	68.0 68.2	103.5 104.3	22.4 22.5	23.13
1050 1080	152.8 153.3	8.5	68.5	105.0	22.6	23.41 23.69
1110	153.9	8.3	68.8	105.8	22.6	23.96
1140	154.4	8.1	69.0	106.5	22.7	24.23
1170 1200	154.9 155.4	7.9 7.8	69.2 69.5	107.2 107.9	22.8 22.9	24.49 24.75
1230	155.9	7.6	69.7	108.6	23.0	25.00
1260	156.4	7.4	69.9	109.3	23.1	25.25
1290 1320	156.8 157.3	7.3 7.1	70.1 70.3	110.0 110.6	23.2 23.3	25.50 25.74
1350	157.7	7.0	70.5	111.3	23.4	25.98
1380		6.9			23.4	26.22
1410 1440	158.6 159.0	6.7 6.6	71.0 71.1	112.5 113.1	23.5 23.6	26.45 26.68
1470	159.4	6.5	71.3	113.7	23.7	26.91
1500	159.8	6.4	71.5	114.3	23.7	27.13
1530 1560	160.2 160.6	6.3 6.2	71.7 71.9	114.9 115.5	23.8 23.9	27.36 27.57
1590	161.0	6.1	72.1	116.0	23.9	27.79
1620	161.4	6.0	72.2	116.6	24.0	28.00
1650 1680	161.8 162.1	5.9 5.8	72.4 72.6	117.1 117.7	24.1 24.2	28.21 28.42
1710	162.5	5.7	72.8	118.2	24.2 24.2 24.3	28.62
1740	162.8 163.2	5.6 5.5	72.9			28.83
1770 1800	163.5	5.5	73.1 73.2	119.2 119.8	24.3 24.4	29.03 29.23
1830	163.8	5.4	73.4	120.3	24.5	29.42
1860 1890	164.2	5.3 5.2	73.5 73.7	120.7 121.2	24.5 24.6	29.62
1920	164.5 164.8	5.2	73.8	121.7	24.6	29.81 30.00
1950	165.1	5.1	74.0	122.2	24.7	30.18
1980	165.4	5.0	74.1		24.8	30.37
2010 2040	165.7 166.1	4.9 4.9	74.3 74.4	123.1 123.6	24.8 24.9	30.55 30.74
2070	166.4	4.8	74.6	124.0	24.9	30.92
2100	166.6	4.8	74.7	124.5	25.0	31.09
2130 2160	166.9 167.2	4.7 4.6	74.8 75.0	124.9 125.3	25.0 25.1	31.27 31.44
2190	167.5	4.6	75.1	125.8	25.1	31.62
2220	167.8	4.5	75.2	126.2	25.2	31.79
2250 2280	168.1 168.3	4.5 4.4	75.3 75.5	126.6 127.0	25.2 25.3	31.96 32.13
2310	168.6	4.4	75.6	127.4	25.3	32.29
2340	168.9	4.3	75.7	127.8	25.4	32.46
2370 2400	169.1 169.4	4.3 4.2	75.8 75.9	128.2 128.6	25.4 25.5	32.62 32.78
2430	169.4	4.2	76.1	129.0	25.5	32.94
2460	169.9	4.1	76.2	129.4	25.6	33.10
2490 2520	170.2 170.4	4.1 4.1	76.3 76.4	129.8 130.2	25.6 25.7	33.26 33.42
2520 2550	170.4	4.0	76.4 76.5	130.2	25.7 25.7	33.42
2580	170.9	4.0	76.6	130.9	25.8	33.72
2610 2640	171.1 171.4	3.9 3.9	76.7 76.8	131.3 131.7	25.8 25.8	33.88 34.03
2670	171.4	3.9	76.8 76.9	131.7	25.8 25.9	34.18

2700	171.8	3.8	77.0	132.4	25.9	34.33
2730	172.1	3.8	77.1	132.7	26.0	34.47
2760	172.3	3.7	77.2	133.1	26.0	34.62
2790	172.5	3.7	77.3	133.4	26.1	34.76
2820	172.7	3.7	77.4	133.8	26.1	34.91
2850	173.0	3.6	77.5	134.1	26.1	35.05
2880	173.2	3.6	77.6	134.5	26.2	35.19

Return period = 1:100 year

Return period :	= 1:100 yea:	r 				
Storm	Point	Point	ARF	Average		Effective
duration	rainfall	intensity		rainfall	factor	rain
(minutes)	(mm)	(mm/h)	(%)	(mm)	(%)	(mm)
30	88.8	177.7	47.4	42.1	13.1	5.50
60	112.6	112.6	47.4	53.4	15.0	8.03
90	125.3	83.5	50.2	62.9	16.6	10.43
120	133.6	66.8	52.1	69.6	17.6	12.26
150	139.8	55.9	53.5	74.8	18.4	13.76
180	144.7	48.2	54.7 55.7	79.1	19.0	15.06
210 240	148.7 152.1	42.5 38.0	56.6	82.8 86.1	19.6 20.0	16.20 17.23
270	155.1	34.5	57.4	89.0	20.4	18.18
300	157.7	31.5	58.1	91.7	20.8	19.06
330	160.1	29.1	58.8	94.2	21.1	19.89
360	162.2	27.0	59.5	96.4	21.4	20.66
390	164.2	25.3	60.0	98.6	21.7	21.40
420 450	166.0 167.6	23.7 22.4	60.6 61.1	100.6 102.5	22.0 22.2	22.10 22.77
480	169.2	21.1	61.6	104.3	22.5	23.42
510	170.7	20.1	62.1	106.0	22.7	24.04
540	172.0	19.1	62.6	107.6	22.9	24.63
570	173.3	18.2	63.0	109.2	23.1	25.21
600	174.6	17.5	63.4	110.7	23.3	25.77
630	175.7	16.7	63.8	112.2	23.5	26.31
660 690	176.8 177.9	16.1 15.5	64.2 64.6	113.6 114.9	23.6 23.8	26.84 27.35
720	178.9	14.9	64.9	116.2	24.0	27.85
750	179.9	14.4	65.3	117.5	24.1	28.34
780	180.9	13.9	65.6	118.7	24.3	28.81
810	181.8	13.5	66.0	119.9	24.4	29.28
840	182.6	13.0	66.3	121.0	24.6 24.7	29.73 30.17
870 900	183.5 184.3	12.7 12.3	66.6 66.9	122.2 123.2	24.7	30.17
930	185.1	11.9	67.2	124.3	25.0	31.03
960	185.9	11.6	67.4	125.4	25.1	31.45
990	186.6	11.3	67.7	126.4	25.2	31.86
1020	187.3	11.0	68.0	127.4	25.3	32.26
1050 1080	188.0 188.7	10.7 10.5	68.2 68.5	128.3 129.3	25.4 25.6	32.65 33.04
1110	189.4	10.2	68.8	130.2	25.7	33.42
1140	190.0	10.0	69.0	131.1	25.8	33.79
1170	190.6	9.8	69.2	132.0	25.9	34.16
1200	191.3	9.6	69.5	132.9	26.0	34.52
1230	191.9	9.4 9.2	69.7 69.9	133.7	26.1	34.88 35.23
1260 1290	192.4 193.0	9.0	70.1	134.5 135.4	26.2 26.3	35.58
1320	193.6	8.8	70.3	136.2	26.4	35.92
1350	194.1	8.6	70.5	137.0	26.5	36.25
1380	194.7	8.5	70.8	137.7	26.6	36.58
1410	195.2	8.3	71.0	138.5	26.6	36.91
1440 1470	195.7 196.2	8.2 8.0	71.1 71.3	139.3 140.0	26.7 26.8	37.23 37.55
1500	196.7	7.9	71.5	140.7	26.9	37.86
1530	197.2	7.7	71.7	141.4	27.0	38.17
1560	197.7	7.6	71.9	142.1	27.1	38.48
1590	198.2	7.5	72.1	142.8	27.2	38.78
1620	198.6	7.4	72.2	143.5	27.2	39.07
1650 1680	199.1 199.5	7.2 7.1	72.4 72.6	144.2 144.8	27.3 27.4	39.37 39.66
1710	200.0	7.1 7.0	72.8	144.8	27.4 27.5	39.66 39.95
1740	200.4	6.9	72.9	146.1	27.5	40.23
1770	200.8	6.8	73.1	146.8	27.6	40.51
1800	201.2	6.7	73.2	147.4	27.7	40.79
1830	201.7	6.6	73.4	148.0	27.7	41.06
1860 1890	202.1 202.5	6.5	73.5	148.6	27.8	41.33
1920	202.5	6.4 6.3	73.7 73.8	149.2 149.8	27.9 27.9	41.60 41.86
1950	203.2	6.3	74.0	150.4	28.0	42.13
1980	203.6	6.2	74.1	151.0	28.1	42.39
2010	204.0	6.1	74.3	151.5	28.1	42.64
2040	204.4	6.0	74.4	152.1	28.2	42.90
2070 2100	204.7 205.1	5.9 5.9	74.6 74.7	152.6 153.2	28.3 28.3	43.15 43.40
2130	205.1	5.8	74.7 74.8	153.2	28.3 28.4	43.40
2160	205.8	5.7	75.0	154.3	28.5	43.89
2190	206.2	5.6	75.1	154.8	28.5	44.13
2220	206.5	5.6	75.2	155.3	28.6	44.37
2250	206.8	5.5	75.3	155.8	28.6	44.61
2280 2310	207.2 207.5	5.5 5.4	75.5 75.6	156.3 156.8	28.7 28.7	44.84 45.08
2340	207.8	5.3	75.7	157.3	28.8	45.31
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2370	208.2	5.3	75.8	157.8	28.8	45.53
2400	208.5	5.2	75.9	158.3	28.9	45.76
2430	208.8	5.2	76.1	158.8	29.0	45.99
2460	209.1	5.1	76.2	159.3	29.0	46.21
2490	209.4	5.0	76.3	159.8	29.1	46.43
2520	209.7	5.0	76.4	160.2	29.1	46.65
2550	210.0	4.9	76.5	160.7	29.2	46.86
2580	210.3	4.9	76.6	161.1	29.2	47.08
2610	210.6	4.8	76.7	161.6	29.3	47.29
2640	210.9	4.8	76.8	162.0	29.3	47.50
2670	211.2	4.7	76.9	162.5	29.4	47.71
2700	211.5	4.7	77.0	162.9	29.4	47.92
2730	211.8	4.7	77.1	163.4	29.5	48.13
2760	212.1	4.6	77.2	163.8	29.5	48.33
2790	212.3	4.6	77.3	164.2	29.6	48.53
2820	212.6	4.5	77.4	164.6	29.6	48.73
2850	212.9	4.5	77.5	165.1	29.6	48.93
2880	213.2	4.4	77.6	165.5	29.7	49.13

S-curve calculations

Dimensionless one-hour unit hydrograph

Dimensi	onless	one-hour	unit	hydrogr
T/TL	Q/Qp			
0.000	0.000	00		
0.063	0.008			
0.127	0.019			
0.190	0.033			
0.254	0.051			
0.317	0.079			
0.381	0.130			
0.444	0.233			
0.508	0.693	30		
0.571	0.936	56		
0.634	0.989	97		
0.698	0.991	L1		
0.761	0.941	L8		
0.825	0.807	78		
0.888	0.678	34		
0.952	0.562			
1.015	0.481			
1.079	0.412			
1.142	0.360			
1.206	0.318			
1.269	0.284			
1.332	0.25			
1.396				
	0.232			
1.459	0.212			
1.523	0.193			
1.586	0.177			
1.650	0.164			
1.713	0.152			
1.777	0.141	L2		
1.840	0.131	L 4		
1.903	0.121	L5		
1.967	0.113	33		
2.030	0.105	57		
2.094	0.098	36		
2.157	0.090	3		
2.221	0.083	39		
2.284	0.076	59		
2.348	0.070			
2.411	0.065			
2.475	0.060			
2.538	0.055			
2.601	0.049			
2.665	0.046			
2.728	0.042			
2.792	0.038			
2.855	0.034			
2.919	0.030			
2.982	0.027			
3.046	0.024			
3.109	0.02			
3.172	0.019			
3.236	0.017			
3.299	0.015			
3.363	0.012			
3.426	0.009			
3.490	0.00			
3.553	0.004			
3.617	0.003			
3.680	0.001			
3.744	0.000	01		
3.807	0.000	00		
3.870	0.000	00		
3.934	0.000			
3.997	0.000			
4.061	0.000			
4.124	0.000			
4.188	0.000			
		-		

T/TL	Original S-curve	Mofified S-curve
0.000	0.0000	0.0000
0.063	0.0082	0.0082
0.127	0.0199	0.0199
0.190	0.0412	0.0412
0.254 0.317	0.0714 0.1209	0.0714 0.1209
0.317	0.2021	0.2021
0.444	0.3548	0.3548
0.508	0.8950	0.8950
0.571	1.2914	1.2914
0.634	1.8847	1.8847
0.698 0.761	2.2825 2.8265	2.2825 2.8265
0.825	3.0903	3.0903
0.888	3.5050	3.5050
0.952	3.6530	3.6530
1.015	3.9867	3.9867
1.079	4.0656	4.0656
1.142	4.3476	4.3476
1.206 1.269	4.3844 4.6325	4.3844 4.6325
1.332	4.6415	4.6415
1.396	4.8650	4.8650
1.459	4.8537	4.8650
1.523	5.0586	5.0586
1.586	5.0310	5.0586
1.650 1.713	5.2227 5.1836	5.2227 5.2227
1.777	5.3639	5.3639
1.840	5.3150	5.3639
1.903	5.4854	5.4854
1.967	5.4283	5.4854
2.030	5.5912	5.5912
2.094 2.157	5.5269 5.6814	5.5912 5.6814
2.221	5.6108	5.6814
2.284	5.7583	5.7583
2.348	5.6811	5.7583
2.411	5.8235	5.8235
2.475 2.538	5.7411	5.8235
2.601	5.8784 5.7910	5.8784 5.8784
2.665	5.9245	5.9245
2.728	5.8333	5.9245
2.792	5.9630	5.9630
2.855	5.8680	5.9630
2.919	5.9939	5.9939
2.982 3.046	5.8951 6.0181	5.9939 6.0181
3.109	5.9167	6.0181
3.172	6.0376	6.0376
3.236	5.9343	6.0376
3.299	6.0526	6.0526
3.363	5.9468 6.0626	6.0526 6.0626
3.426 3.490	5.9542	6.0626
3.553	6.0675	6.0675
3.617	5.9575	6.0675
3.680	6.0689	6.0689
3.744	5.9577	6.0689
3.807	6.0689 5.0577	6.0689
3.870 3.934	5.9577 6.0689	6.0689 6.0689
3.997	5.9577	6.0689
4.061	6.0689	6.0689
4.124	5.9577	6.0689
4.188	6.0689	6.0689
4.251	5.9577	6.0689
Return	period = 1:2 year	

Storm duration (minutes)	Unit hydrograph peak (Qe) (m³/s)	Peak discharge (m³/s)
30	1.187	61.469
60	0.991	77.818
90	1.023	106.237
120	0.966	118.817
150	0.989	137.216
180	0.912	138.871
210	0.900	147.826
240	0.826	144.523
270	0.807	149.238
300	0.757	146.898
330	0.726	147.107
360	0.691	145.583

390	0.658	143.700
420	0.633	142.805
450 480	0.602 0.583	139.908 139.451
510	0.558	137.109
540	0.540	135.894
570	0.520	133.993
600	0.502	132.330
630	0.486	130.784
660	0.469	128.859
690	0.456	127.602
720	0.441	125.709
750	0.429	124.471
780	0.416	122.824
810 840	0.405 0.394	121.436 119.998
870	0.383	118.463
900	0.374	117.204
930	0.364	115.623
960	0.355	114.460
990	0.346	113.035
1020	0.338	111.775
1050	0.330	110.486
1080	0.323	109.159
1110 1140	0.316 0.308	107.991 106.716
1170	0.302	105.557
1200	0.295	104.386
1230	0.289	103.191
1260	0.283	102.113
1290	0.277	100.916
1320	0.272	99.885
1350	0.266	98.771
1380 1410	0.261 0.256	97.707 96.669
1440	0.250	95.608
1470	0.246	94.633
1500	0.242	93.639
1530	0.237	92.656
1560	0.233	91.723
1590	0.228	90.722
1620	0.225	89.845
1650	0.220	88.873
1680 1710	0.217 0.213	88.000 87.080
1740	0.213	86.204
1770	0.206	85.332
1800	0.202	84.482
1830	0.199	83.653
1860	0.196	82.845
1890	0.193	82.057
1920	0.190	81.288
1950	0.187	80.537
1980 2010	0.184 0.181	79.804 79.087
2040	0.178	78.387
2070	0.176	77.702
2100	0.173	77.032
2130	0.171	76.377
2160	0.169	75.736
2190	0.166	75.108
2220	0.164	74.493
2250 2280	0.162 0.160	73.891 73.301
2310	0.158	72.723
2340	0.156	72.157
2370	0.154	71.601
2400	0.152	71.056
2430	0.150	70.521
2460		
	0.148	69.996
2490	0.148 0.146	69.996 69.481
2520	0.148 0.146 0.144	69.996 69.481 68.976
2520 2550	0.148 0.146 0.144 0.143	69.996 69.481 68.976 68.479
2520	0.148 0.146 0.144	69.996 69.481 68.976
2520 2550 2580	0.148 0.146 0.144 0.143 0.141	69.996 69.481 68.976 68.479 67.991
2520 2550 2580 2610	0.148 0.146 0.144 0.143 0.141	69.996 69.481 68.976 68.479 67.991
2520 2550 2580 2610 2640 2670 2700	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124
2520 2550 2580 2610 2640 2670 2700 2730	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677
2520 2550 2580 2610 2640 2670 2700 2730 2760	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132 0.131	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.135 0.132 0.131	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820 2850	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.135 0.132 0.131 0.129 0.128	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380 63.961
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132 0.131 0.129 0.128 0.126	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820 2850 2880 Return period =	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132 0.131 0.129 0.128 0.126	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380 63.961
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820 2850 2880 Return period =	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.135 0.135 0.133 0.132 0.131 0.129 0.128 0.126 1:5 year	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380 63.961 63.550
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820 2850 2880 Return period =	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132 0.131 0.129 0.128 0.126 1:5 year	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380 63.961 63.550 Peak discharge
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820 2850 2880 Return period =	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132 0.131 0.129 0.128 0.126 1:5 year	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380 63.961 63.550
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820 2850 2880 Return period =	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132 0.131 0.129 0.128 0.126 1:5 year Unit hydrograph peak (Qe) (m³/s)	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380 63.961 63.550 Peak discharge (m³/s)
2520 2550 2580 2610 2640 2670 2700 2730 2760 2790 2820 2850 2880 Return period =	0.148 0.146 0.144 0.143 0.141 0.140 0.138 0.136 0.135 0.133 0.132 0.131 0.129 0.128 0.126 1:5 year	69.996 69.481 68.976 68.479 67.991 67.512 67.042 66.579 66.124 65.677 65.238 64.805 64.380 63.961 63.550 Peak discharge

90	1.023	177.501
120	0.966	197.649
150	0.989 0.912	227.632 229.939
180 210	0.912	244.421
240	0.826	238.695
270	0.807	246.264
300	0.757	242.223
330	0.726	242.418
360	0.691	239.778
390	0.658	236.566
420	0.633	234.997
450	0.602	230.147
480	0.583	229.321
510	0.558	225.403
540	0.540	223.348
570	0.520	220.172
600 630	0.502 0.486	217.391 214.810
660	0.469	211.609
690	0.456	209.509
720	0.441	206.368
750	0.429	204.307
780	0.416	201.576
810	0.405	199.273
840	0.394	196.890
870	0.383	194.351
900	0.374	192.265
930	0.364	189.652
960	0.355	187.728
990	0.346 0.338	185.374 183.294
1020 1050	0.330	181.167
1080	0.323	178.978
1110	0.316	177.050
1140	0.308	174.947
1170	0.302	173.038
1200	0.295	171.108
1230	0.289	169.139
1260	0.283	167.364
1290	0.277	165.393
1320	0.272	163.696
1350	0.266	161.863
1380	0.261	160.111
1410	0.256 0.251	158.404
1440 1470	0.251	156.660 155.056
1500	0.242	153.421
1530	0.237	151.806
1560	0.233	150.272
1590	0.228	148.628
1620	0.225	147.185
1650	0.220	145.589
1680	0.217	144.155
1710	0.213	142.643
1740	0.209	141.205
1770	0.206	139.773
1800 1830	0.202 0.199	138.377 137.017
1860	0.196	135.691
1890	0.193	134.397
1920	0.190	133.134
1950	0.187	131.902
1980	0.184	130.698
2010	0.181	129.522
2040	0.178	128.373
2070	0.176	127.249
2100	0.173	126.150
2130	0.171	125.075
2160 2190	0.169 0.166	124.023 122.994
2220	0.164	121.985
2250	0.162	120.998
2280	0.160	120.030
2310	0.158	119.082
2340	0.156	118.152
2370	0.154	117.241
2400	0.152	116.347
2430	0.150	115.470
2460	0.148	114.610
2490	0.146	113.765
2520 2550	0.144	112.936
2550 2580	0.143 0.141	112.122
2580 2610	0.141	111.323 110.537
2640	0.138	109.765
2670	0.136	109.703
2700	0.135	108.262
2730	0.133	107.529
2760	0.132	106.808
2790	0.131	106.100
2820	0.129	105.402

2850	0.128	104.716
2880	0.126	104.042
Return period =	1:10 year	
Storm	 Unit hydrograph	Peak
duration	peak (Qe)	discharge
(minutes)	(m³/s)	(m³/s)
30 60	1.187 0.991	156.575 193.321
90	1.023	260.517
120	0.966	289.483
150	0.989	332.982
180	0.912	336.077
210 240	0.900 0.826	357.028 348.506
270	0.807	359.428
300	0.757	353.427
330 360	0.726	353.628
390	0.691 0.658	349.707 344.965
420	0.633	342.629
450	0.602	335.516
480 510	0.583 0.558	334.276
540	0.540	328.534 325.512
570	0.520	320.860
600	0.502	316.786
630 660	0.486 0.469	313.006 308.326
690	0.456	305.253
720	0.441	300.664
750	0.429	297.650
780 810	0.416 0.405	293.662 290.298
840	0.394	286.819
870	0.383	283.112
900	0.374	280.067
930 960	0.364 0.355	276.256 273.449
990	0.346	270.016
1020	0.338	266.981
1050	0.330	263.880
1080 1110	0.323 0.316	260.688 257.878
1140	0.308	254.813
1170	0.302	252.029
1200	0.295	249.216
1230 1260	0.289 0.283	246.347 243.760
1290	0.277	240.888
1320	0.272	238.415
1350	0.266	235.745
1380 1410	0.261 0.256	233.194 230.706
1440	0.251	228.165
1470	0.246	225.829
1500 1530	0.242 0.237	223.448 221.095
1560	0.237	218.860
1590	0.228	216.466
1620	0.225	214.365
1650 1680	0.220 0.217	212.041 209.951
1710	0.213	207.751
1740	0.209	205.656
1770 1800	0.206 0.202	203.570
1830	0.199	201.538 199.557
1860	0.196	197.626
1890	0.193	195.742
1920 1950	0.190 0.187	193.904 192.109
1980	0.184	190.357
2010	0.181	188.644
2040	0.178	186.971
2070 2100	0.176 0.173	185.335 183.735
2130	0.171	182.170
2160	0.169	180.639
2190	0.166	179.139
2220 2250	0.164 0.162	177.671 176.234
2280	0.162	174.825
2310	0.158	173.445
2340	0.156	172.091
2370 2400	0.154 0.152	170.765 169.463
2430	0.150	168.187
2460	0.148	166.934
2490	0.146	165.705
2520	0.144	164.498

2550	0.143	163.313
2580	0.141	162.149
2610	0.140	161.006
2640	0.138	159.882
2670	0.136	158.778
2700	0.135	157.693
2730	0.133	156.626
2760	0.132	155.578
2790	0.131	154.546
2820	0.129	153.531
2850	0.128	152.533
2880	0.126	151.550
Return period =	1:20 year	
Storm	Unit hydrograph	Peak
		discharge
		-
(minutes)	(m^3/s)	(m^3/s)
30	1.187	221.624
60	0.991	272.167
90	1.023	365.854
120	0.966	406.073
150	0.989	466.796
180	0.912	470.945
210	0.900	500.166
240	0.826	488.132
270	0.807	503.357
300	0.757	494.900
330	0.726	495.139
360	0.691	489.618
390	0.658	482.954
420	0.633	479.664
450	0.602	469.691
480	0.583	467.944
510	0.558	459.898
540	0.540	455.661
570	0.520	449.144
600	0.502	443.439
630	0.486	438.146
660	0.469	431.594
690	0.456	427.292
720	0.441	420.869
750	0.429	416.651
780	0.416	411.072
810	0.405	406.364
840	0.394	401.496
870	0.383	396.311
900	0.374	392.051
930	0.364	386.720
960	0.355	382.793
990	0.346	377.991
1020	0.338	373.746
1050	0.330	369.407
1080	0.323	364.944
1110	0.316	361.014
1140	0.308	356.726
1170	0.302	352.832
1200	0.295	348.898
1230	0.289	344.885
1260	0.283	341.266
1290	0.277	337.250
1320	0.272	333.791
1350	0.266	330.056
1380	0.261	326.488
1410	0.256	323.008
1440	0.251	319.454
1470	0.246	316.187
1500	0.242	312.857
1530	0.237	309.566
1560	0.233	306.440
1590	0.228	303.091
1620	0.225	300.153
1650	0.220	296.901
1680	0.217	293.979
1710	0.213	290.901
1740	0.209	287.971
1770	0.206	285.053
1800	0.202	282.210
1830	0.199	279.439
1860	0.196	276.738
1890	0.193	274.103
1920	0.190	271.531
1950	0.187	269.021
1980	0.184	266.569
2010	0.181	264.174
2040	0.178	261.833
2070	0.176	259.545
2100	0.173	257.307
2130	0.171	255.117
2160	0.169	252.975
2190	0.166	250.878
2220	0.164	248.824

2250	0.162	246.813
2280	0.160	244.842
2310	0.158	242.911
2340	0.156	241.018
2370	0.154	239.162
2400	0.152	237.341
2430	0.150	235.556
2460	0.148	233.803
2490	0.146	232.083
2520	0.144	230.395
2550	0.143	228.737
2580	0.141	227.109
2610	0.140	225.510
2640	0.138	223.938
2670	0.136	222.394
2700	0.135	220.876
2730	0.133	219.383
2760	0.132	217.916
2790	0.131	216.472
2820	0.129	215.053
2850	0.128	213.656
2880	0.126	212.282
Return period =	1:50 year	
Storm	Unit hydrograph	Peak
	peak (Qe)	
	(2)	() ()

Return period =	: 1:50 year	212.202
Storm	Unit hydrograph	Peak
duration (minutes)	peak (Qe) (m³/s)	discharge (m³/s)
(MINUCES)	(m²/s)	(m-75)
30	1.187	339.320
60	0.991	414.964
90	1.023	556.852
120	0.966	617.659
150 180	0.989 0.912	709.796 715.986
210	0.900	760.346
240	0.826	742.019
270	0.807	765.150
300	0.757	752.294
330	0.726	752.666
360 390	0.691 0.658	744.288 734.176
420	0.633	729.195
450	0.602	714.056
480	0.583	711.422
510	0.558	699.213
540	0.540	692.796
570 600	0.520 0.502	682.910 674.260
630	0.486	666.234
660	0.469	656.293
690	0.456	649.774
720	0.441	640.028
750	0.429	633.634
780 810	0.416 0.405	625.169
840	0.394	618.030 610.646
870	0.383	602.778
900	0.374	596.317
930	0.364	588.226
960	0.355	582.269
990 1020	0.346 0.338	574.981 568.541
1050	0.330	561.957
1080	0.323	555.182
1110	0.316	549.217
1140	0.308	542.708
1170	0.302	536.799
1200 1230	0.295 0.289	530.827 524.734
1260	0.283	519.242
1290	0.277	513.143
1320	0.272	507.892
1350	0.266	502.221
1380	0.261	496.803
1410 1440	0.256 0.251	491.519 486.122
1470	0.246	481.160
1500	0.242	476.103
1530	0.237	471.104
1560	0.233	466.357
1590 1620	0.228 0.225	461.269 456.807
1620	0.225	456.807 451.867
1680	0.217	447.428
1710	0.213	442.752
1740	0.209	438.301
1770	0.206	433.868
1800	0.202	429.549
1830 1860	0.199 0.196	425.339 421.234
1890	0.193	417.230
1920	0.190	413.323

1950	0.187	409.509
1980	0.184	405.783
2010	0.181	402.144
2040	0.178	398.587
2070	0.176	395.110
2100	0.173	391.709
2130	0.171	388.382
2160	0.169	385.126
2190	0.166	381.939
2220	0.164	378.819
2250	0.162	375.762
2280	0.160	372.767
2310	0.158	369.832
2340	0.156	366.955
2370	0.154	364.134
2400	0.152	361.368
2430	0.150	358.653
2460	0.148	355.990
2490	0.146	353.376
2520	0.144	350.810
2550	0.143	348.290
2580	0.141	345.815
2610	0.140	343.384
2640	0.138	340.995
2670	0.136	338.648
2700	0.135	336.340
2730	0.133	334.072
2760	0.132	331.841
2790		329.647
2820		327.489
2850	0.128	325.365
2880	0.126	323.276
Return period =	1:100 year	

Storm duration (minutes)	Unit hydrograph peak (Qe) (m³/s)	Peak discharge (m³/s)
30	1.187	473.778
60	0.991	578.377
90	1.023	775.736
120	0.966	860.358
150	0.989	988.709
180	0.912	997.382
210	0.900	1059.243
240	0.826	1033.782
270	0.807	1066.082
300	0.757	1048.242
330	0.726	1048.829
360	0.691	1037.219
390	0.658	1023.189
420	0.633	1016.306
450	0.602	995.261
480	0.583	991.643
510	0.558	974.675
540	0.540	965.776
570	0.520	952.039
600	0.502	940.021
630	0.486	928.872
660	0.469	915.051
690	0.456	905.997
720	0.441	892.442
750	0.429	883.559
780	0.416	871.786
810	0.405	861.861
840	0.394	851.591
870	0.383	840.646
900	0.374	831.662
930	0.364	820.401
960	0.355	812.118
990	0.346	801.976
1020	0.338	793.015
1050	0.330	783.852
1080	0.323	774.421
1110	0.316	766.121
1140	0.308	757.061
1170	0.302	748.835
1200	0.295	740.521
1230	0.289	732.039
1260	0.283	724.392
1290	0.277	715.898
1320	0.272	708.589
1350	0.266	700.690
1380	0.261	693.145
1410	0.256	685.786
1440	0.251	678.269
1470	0.246	671.358
1500	0.242	664.314
1530	0.237	657.351
1560	0.233	650.739
1590	0.228	643.651
1620	0.225	637.435

1650	0.220	630.552
1680	0.217	624.368
1710	0.213	617.851
1740	0.209	611.650
1770	0.206	605.472
1800	0.202	599.454
1830	0.199	593.588
1860	0.196	587.868
1890	0.193	582.288
1920	0.190	576.843
1950	0.187	571.527
1980	0.184	566.335
2010	0.181	561.263
2040	0.178	556.306
2070	0.176	551.459
2100	0.173	546.720
2130	0.171	542.083
2160	0.169	537.545
2190	0.166	533.103
2220	0.164	528.753
2250	0.162	524.492
2280	0.160	520.318
2310	0.158	516.227
2340	0.156	512.217
2370	0.154	508.284
2400	0.152	504.428
2430	0.150	500.644
2460	0.148	496.931
2490	0.146	493.287
2520	0.144	489.710
2550	0.143	486.197
2580	0.141	482.747
2610	0.140	479.357
2640	0.138	476.027
2670		
	0.136	472.754
2700	0.136 0.135	472.754 469.537
2700	0.135	469.537
2700 2730	0.135 0.133	469.537 466.374
2700 2730 2760	0.135 0.133 0.132	469.537 466.374 463.264
2700 2730 2760 2790 2820 2850	0.135 0.133 0.132 0.131	469.537 466.374 463.264 460.205
2700 2730 2760 2790 2820	0.135 0.133 0.132 0.131 0.129	469.537 466.374 463.264 460.205 457.195
2700 2730 2760 2790 2820 2850	0.135 0.133 0.132 0.131 0.129 0.128	469.537 466.374 463.264 460.205 457.195 454.235
2700 2730 2760 2790 2820 2850 2880	0.135 0.133 0.132 0.131 0.129 0.128 0.126	469.537 466.374 463.264 460.205 457.195 454.235 451.321
2700 2730 2760 2790 2820 2850 2880 	0.135 0.133 0.132 0.131 0.129 0.128 0.126	469.537 466.374 463.264 460.205 457.195 454.235 451.321
2700 2730 2760 2790 2820 2850 2880 	0.135 0.133 0.132 0.131 0.129 0.128 0.126 Storm duration (minutes)	469.537 466.374 463.264 460.205 457.195 454.235 451.321 Peak discharge (m ³ /s)
2700 2730 2760 2790 2820 2850 2880 	0.135 0.133 0.132 0.131 0.129 0.128 0.126 	469.537 466.374 463.264 460.205 457.195 454.235 451.321 Peak discharge (m³/s)
2700 2730 2760 2790 2820 2850 2880 	0.135 0.133 0.132 0.131 0.129 0.128 0.126 	469.537 466.374 463.264 460.205 457.195 454.235 451.321 Peak discharge (m³/s)
2700 2730 2760 2790 2820 2850 2880	0.135 0.133 0.132 0.131 0.129 0.128 0.126 	469.537 466.374 463.264 460.205 457.195 454.235 451.321 Peak discharge (m³/s) 149.24 246.26 359.43
2700 2730 2760 2790 2820 2850 2880	0.135 0.133 0.132 0.131 0.129 0.128 0.126 	469.537 466.374 463.264 460.205 457.195 454.235 451.321 Peak discharge (m³/s) 149.24 246.26 359.43 503.36
2700 2730 2760 2790 2820 2850 2880	0.135 0.133 0.132 0.131 0.129 0.128 0.126 	469.537 466.374 463.264 460.205 457.195 454.235 451.321 Peak discharge (m³/s) 149.24 246.26 359.43

Calculated using Utility Programs for Drainage 1.1.0 $\,$

The software programs were developed for the convenience of its users. Although every reasonable effort has been made to ensure that the programs are accurate and reliable the program developers, Sinotech CC, accept no liability of any kind for any results, interpretation thereof or any use made of the results obtained with these programs. All users of these programs do so entirely at their own risk. Copyright (C) 2009 SINOTECH CC, www.sinotechcc.co.za, software@sinotechcc.co.za

Plan: Plan 05 Sand river River RS: 280.74 Profile: PF 1

E.G. Elev (m)	300.60	Element	Left OB	Channel	Right OB
Vel Head (m)	0.35	Wt. n-Val.	0.070	0.040	0.070
W.S. Elev (m)	300.25	Reach Len. (m)	27.57	27.57	27.57
Crit W.S. (m)	298.95	Flow Area (m2)	7.74	611.21	1.75
E.G. Slope (m/m)	0.002336	Area (m2)	7.74	611.21	1.75
Q Total (m3/s)	1615.00	Flow (m3/s)	4.23	1610.00	0.76
Top Width (m)	203.07	Top Width (m)	10.87	188.89	3.31
Vel Total (m/s)	2.60	Avg. Vel. (m/s)	0.55	2.63	0.44
Max Chl Dpth (m)	4.44	Hydr. Depth (m)	0.71	3.24	0.53
Conv. Total (m3/s)	33413.9	Conv. (m3/s)	87.6	33310.5	15.8
Length Wtd. (m)	27.57	Wetted Per. (m)	10.96	189.90	3.47
Min Ch El (m)	295.81	Shear (N/m2)	16.17	73.74	11.53
Alpha	1.02	Stream Power (N/m s)	17630.35	0.00	0.00
Frctn Loss (m)	0.06	Cum Volume (1000 m3)	1.83	112.02	0.86
C & E Loss (m)	0.01	Cum SA (1000 m2)	1.99	33.62	1.44

Plan: Plan 05 Sand river River RS: 253.17 Profile: PF 1

E.G. Elev (m)	300.53	Element	Left OB	Channel	Right OB
Vel Head (m)	0.33	Wt. n-Val.	0.070	0.040	0.070
W.S. Elev (m)	300.20	Reach Len. (m)	43.96	43.96	43.96
Crit W.S. (m)		Flow Area (m2)	2.98	634.41	0.13
E.G. Slope (m/m)	0.002139	Area (m2)	2.98	634.41	0.13
Q Total (m3/s)	1615.00	Flow (m3/s)	1.07	1613.91	0.02
Top Width (m)	201.52	Top Width (m)	7.37	192.91	1.24
Vel Total (m/s)	2.53	Avg. Vel. (m/s)	0.36	2.54	0.15
Max Chl Dpth (m)	4.37	Hydr. Depth (m)	0.40	3.29	0.11
Conv. Total (m3/s)	34920.3	Conv. (m3/s)	23.2	34896.7	0.4
Length Wtd. (m)	43.96	Wetted Per. (m)	7.42	194.38	1.26
Min Ch El (m)	295.83	Shear (N/m2)	8.43	68.46	2.20
Alpha	1.01	Stream Power (N/m s)	17201.85	0.00	0.00
Frctn Loss (m)	0.12	Cum Volume (1000 m3)	1.68	94.85	0.84
C & E Loss (m)	0.02	Cum SA (1000 m2)	1.74	28.36	1.38

Plan: Plan 05 Sand river River RS: 209.21 Profile: PF 1

i iaii. I iaii 05 Garia ii	an. Flair 65 Gand fiver TRUE TRO. 203.21 Floring. 11 F							
E.G. Elev (m)	300.40	Element	Left OB	Channel	Right OB			
Vel Head (m)	0.50	Wt. n-Val.		0.040	0.070			
W.S. Elev (m)	299.89	Reach Len. (m)	64.57	64.57	64.57			
Crit W.S. (m)		Flow Area (m2)		513.40	2.22			
E.G. Slope (m/m)	0.003677	Area (m2)		513.40	2.22			
Q Total (m3/s)	1615.00	Flow (m3/s)		1614.35	0.65			
Top Width (m)	177.10	Top Width (m)		165.91	11.20			
Vel Total (m/s)	3.13	Avg. Vel. (m/s)		3.14	0.29			
Max Chl Dpth (m)	4.32	Hydr. Depth (m)		3.09	0.20			
Conv. Total (m3/s)	26631.8	Conv. (m3/s)		26621.0	10.8			
Length Wtd. (m)	64.57	Wetted Per. (m)		171.87	11.23			
Min Ch El (m)	295.57	Shear (N/m2)		107.72	7.13			
Alpha	1.01	Stream Power (N/m s)	17473.94	0.00	0.00			
Frctn Loss (m)	0.16	Cum Volume (1000 m3)	1.61	69.62	0.79			
C & E Loss (m)	0.06	Cum SA (1000 m2)	1.58	20.47	1.11			

Plan: Plan 05 Sand river River RS: 144.64 Profile: PF 1

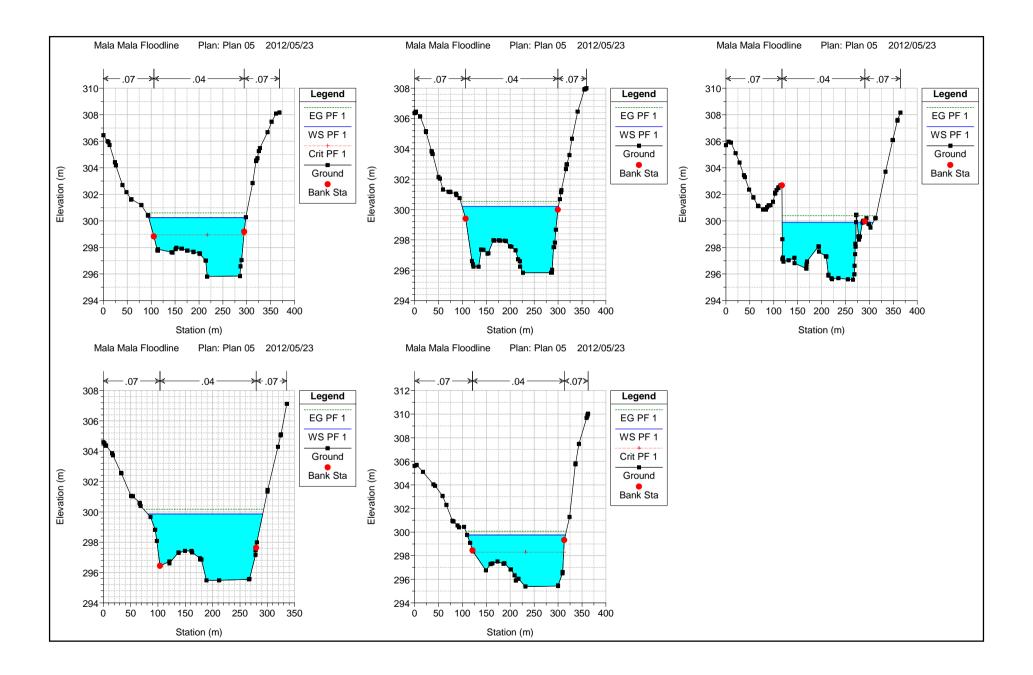
E.G. Elev (m)	300.18	Element	Left OB	Channel	Right OB
Vel Head (m)	0.32	Wt. n-Val.	0.070	0.040	0.070
W.S. Elev (m)	299.86	Reach Len. (m)	51.24	51.24	51.24
Crit W.S. (m)		Flow Area (m2)	24.66	630.77	12.09
E.G. Slope (m/m)	0.001865	Area (m2)	24.66	630.77	12.09
Q Total (m3/s)	1615.00	Flow (m3/s)	16.19	1591.32	7.49

Plan: Plan 05 Sand river RS: 144.64 Profile: PF 1 (Continued)

Top Width (m)	210.08	Top Width (m)	22.08	176.21	11.79
Vel Total (m/s)	2.42	Avg. Vel. (m/s)	0.66	2.52	0.62
Max Chl Dpth (m)	4.37	Hydr. Depth (m)	1.12	3.58	1.03
Conv. Total (m3/s)	37396.0	Conv. (m3/s)	375.0	36847.6	173.5
Length Wtd. (m)	51.24	Wetted Per. (m)	22.45	176.60	12.02
Min Ch El (m)	295.49	Shear (N/m2)	20.09	65.33	18.40
Alpha	1.07	Stream Power (N/m s)	16068.24	0.00	0.00
Frctn Loss (m)	0.10	Cum Volume (1000 m3)	0.82	32.68	0.32
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.87	9.43	0.36

Plan: Plan 05 Sand river River RS: 93.4 Profile: PF 1

E.G. Elev (m)	300.08	Element	Left OB	Channel	Right OB
Vel Head (m)	0.32	Wt. n-Val.	0.070	0.040	0.070
W.S. Elev (m)	299.76	Reach Len. (m)			
Crit W.S. (m)	298.31	Flow Area (m2)	7.19	644.86	0.54
E.G. Slope (m/m)	0.002000	Area (m2)	7.19	644.86	0.54
Q Total (m3/s)	1615.00	Flow (m3/s)	3.31	1611.57	0.13
Top Width (m)	205.93	Top Width (m)	11.70	191.78	2.45
Vel Total (m/s)	2.47	Avg. Vel. (m/s)	0.46	2.50	0.23
Max Chl Dpth (m)	4.37	Hydr. Depth (m)	0.61	3.36	0.22
Conv. Total (m3/s)	36112.4	Conv. (m3/s)	74.0	36035.6	2.8
Length Wtd. (m)		Wetted Per. (m)	11.78	192.97	2.49
Min Ch El (m)	295.39	Shear (N/m2)	11.98	65.54	4.27
Alpha	1.02	Stream Power (N/m s)	17374.69	0.00	0.00
Frctn Loss (m)		Cum Volume (1000 m3)			
C & E Loss (m)		Cum SA (1000 m2)			



HEC-RAS Plan: Plan 05 River: Sand river Reach: River Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
River	280.74	PF 1	1615.00	295.81	300.25	298.95	300.60	0.002336	2.63	620.70	203.07	0.47
River	253.17	PF 1	1615.00	295.83	300.20		300.53	0.002139	2.54	637.52	201.52	0.45
River	209.21	PF 1	1615.00	295.57	299.89		300.40	0.003677	3.14	515.62	177.10	0.57
River	144.64	PF 1	1615.00	295.49	299.86		300.18	0.001865	2.52	667.52	210.08	0.43
River	93.4	PF 1	1615.00	295.39	299.76	298.31	300.08	0.002000	2.50	652.60	205.93	0.44

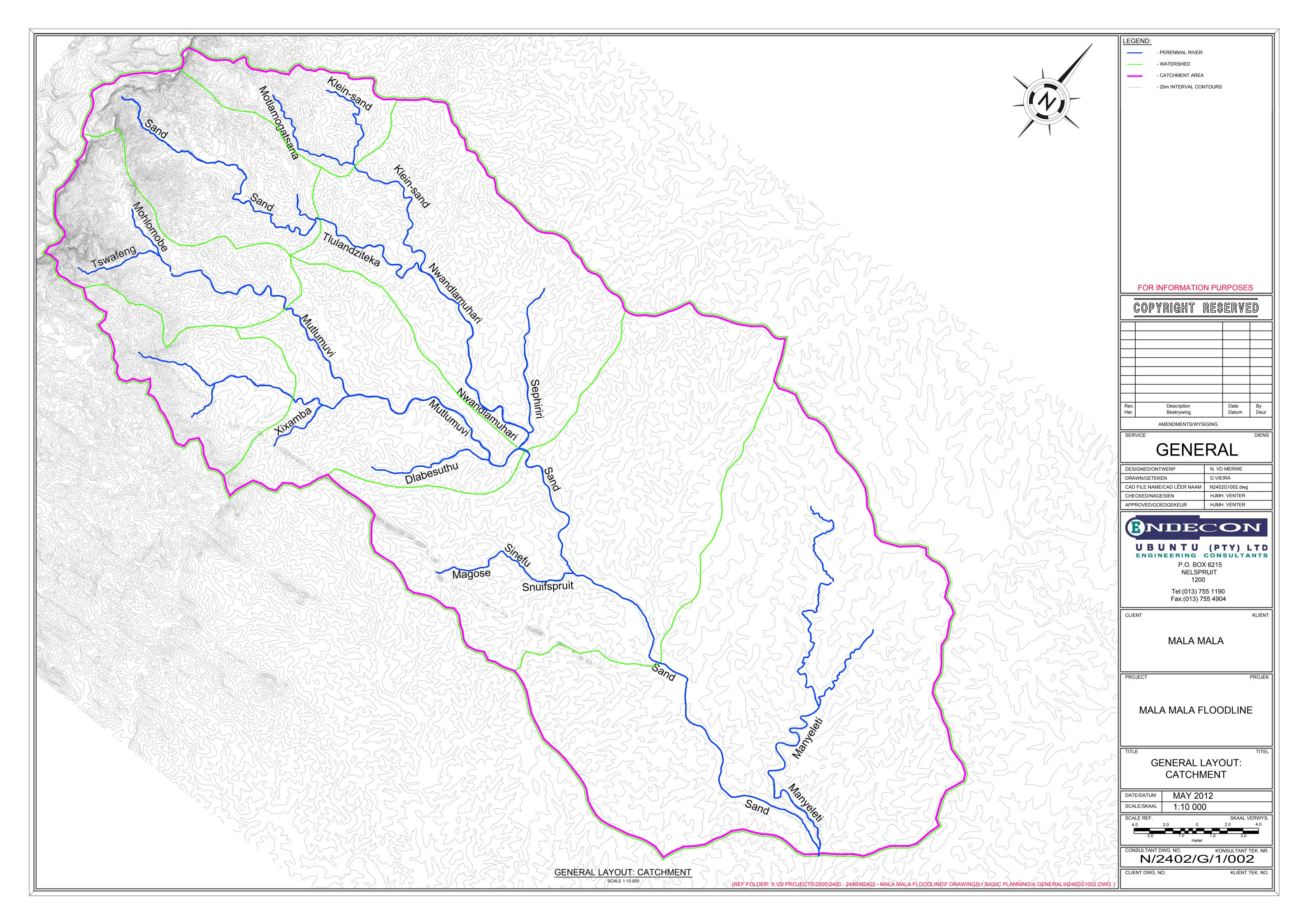
FLOODLINE REPORT: MALA MALA, SABI SAND GAME RESERVE, MPUMALANGA

ANNEXURE B: 1:100 YEAR RECURRENCE INTERVAL FLOOD LINES



FLOODLINE REPORT: MALA MALA, SABI SAND GAME RESERVE, MPUMALANGA

ANNEXURE C: CATCHMENT AREAS LAYOUT





Appendix E

Public Participation Process

Annexure A Site Notice Text

PUBLIC PARTICIPATION PROCESS

MDEDET Ref No.: 17/2/3/E-136

For the reconstruction and modification of the West-St Bridge on Flockfield Farm 414KU on MalaMala.

MalaMala Ranch (Pty) Ltd plans to reconstruct and modify the West-St bridge on the farm Flockfield 414 KU MalaMala. The proposed project is to ensure access into the traversing areas on the western fringes of the Kruger National Park

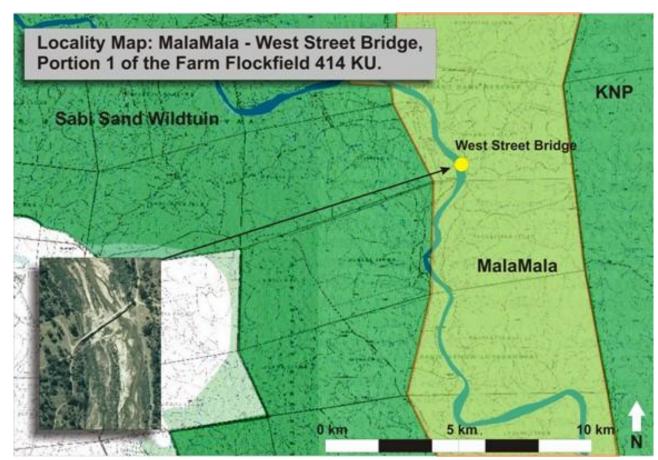
According to the National Environmental Management Act (NEMA) (NO. 107 of 1998), the project requires authorisation from the Mpumalanga Department of Economic Development, Environment and Tourism via the EIA process (GN No. R543). Activity 11, 18 and 39 of GN No. R544 published in terms of NEMA are triggered.

Aurecon (Pty) Ltd has been appointed to undertake the required EIA process.

For more information, to raise any initial issues or concerns or register as an Interested and Affected Party, please contact Aurecon:

<u>kulani.mabaso@aurecongroup.com</u> or PO Box 3135, Nelspruit, 1200.

ATT: Kulani Mabaso, before **17 May 2012**. Tel: (013) 752 7055, Fax: (013) 753 2116



Annexure B Proof of Displayed Notice Boards



Figure 5 | Site Notice at Shaw's Gate – Sabi Sand Wildtuin



Figure 6 | Site Notice at Shaw's Gate – Sabi Sand Wildtuin



Figure 7 | Site Notice at junction of road to Paul Kruger Gate and gravel road to Shaw's Gate



Figure 8 | Site Notice at junction of road to Paul Kruger Gate and gravel road to Shaw's Gate.

Annexure C Background Information Document



Leading. Vibrant. Global.

MDEDET REF No: 17/2/3/E-136 AURECON REF NO:108200

BACKGROUND INFORMATION DOCUMENT

Proposed Reconstruction and modification of the west St Bridge on MalaMala



This document serves to provide you with information regarding the proposed reconstruction and modification of the West St Bridge on MalaMala and invites you to get involved in the environmental impact assessment Process

Background to the Project

Due to the torrential rainfall experienced within the eastern areas of Mpumalanga and Limpopo province during January and February 2012, the MalaMala West St Bridge, which was constructed during mid-1997, was recently destroyed.

The bridge was constructed over the Sand River, which is one of the primary watercourses within the Game Reserve, to ensure access into the traversing areas on the western fringes of the Kruger National Park. Being a premier commercial game lodge, access into this game rich area is critical for the economic viability of the business.

Project Description

The project site is situated on the farm Flockfield 414KU on the eastern portion of the Game Reserve, adjacent to the Kruger National Park. The co-ordinates of the

Bridge are S 24 49' 34.1" E 31 33'27.4" please refer to locality plan attached).

This project includes the following activities which will be investigated through the EIA process:

- Reconstruction of the bridge on the same footprint;
- The raising of the bridge by approximately 2m
- The extension of the bridges stays and approaches.

Legal Requirement

The proposed project triggers activities listed in GN 544 and therefore environmental authorisation from the relevant government department, i.e. the Mpumalanga Department, Economic Development, Environment & Tourism (MDEDET) is required as per sections 21 to 25 of GN 543.

The following activities (and a description of each) in GN R544 will be triggered by the proposed project:

Activity 18

The infilling or moving of materials exceeding 5 cubic meters within a watercourse.

Activity 39

Expansion of the eastern stay to ensure that the approaches to the bridge are not impacted on by flood waters in future.

Accordingly, the proposed project will require the submission of a Basic Assessment Report (BAR) as outlined in sections 21 to 25 of Regulations 543.

Aurecon (Pty) Ltd, as the independent Environmental Assessment Practitioner (EAP), has been appointed by the proponent/applicant to compile the Basic Assessment (BAR), which will be reviewed by the relevant competent authority (i.e. Mpumalanga Department of Economic Development, Environment and Tourism; (MDEDET) after a thorough public participation process has been conducted. This includes the opportunity to review all documentation before submission to MDEDET.

Public Participation

You have been identified as a potential Interested and/or Affected Party (I&AP) for this project, either because you represent an affected organisation or because of your proximity/location to the proposed project. Public participation is a key component of this environmental

process and will take place at various stages throughout the project. This process will include the following steps:

- Advertising the project in the local newspaper (The Lowvelder-20 April 2012);
- Distributing this background information document to all identified stakeholders;
- Lodging the draft BAR with I&AP's and on the Aurecon website and informing the public regarding the availability of the Draft BAR for a 40 day comment period during which the public has the opportunity to review the draft document and raise issues or concerns;
- Finalising the Draft BAR, taking cognisance of comments received from I&APs, key stakeholders and relevant organs of state;
- Lodging the Final BAR with I&AP's and on the Aurecon website for a 21 day comment period;
- Inviting all I&APs to comment on the report via letters and/or email; and
- Submitting the Final BAR to the MDEDET to inform their decision about the proposed development.

All comments received will be summarised and collated in a Comments and Responses Report that will also be submitted to MDEDET.

Way Forward

If you would like to register as an I&AP for this environmental process or submit any issues and/or concerns on the Draft BAR, please submit your comments by fax, post or email to Aurecon, by no later than 23 May 2012. If you have any queries, comments or require any other assistance, please contact Kulani Mabaso of Aurecon at the details provided below.

A public meeting is proposed for the project, and you are cordially invited to attend:

Date : 04 May 2012

Time : 13:00 pm

Venue : Nelspruit Public Library

Please confirm your attendance not later than the 03rd May 2012.For more information feel free to contact Aurecon Public Participation office on the details provided:

Public Participation Office: Aurecon

Kulani Mabaso

Tel: (013) 755 2218 Fax: (013) 753 2216

Email: kulani.mabaso@aurecongroup.com

PO Box 3135, Nelspruit, 1200

aurecon

Leading. Vibrant. Global. MDEDET REF.No.: 17/2/3/E-136 AURECONs REF. NO.: 108200

REGISTRATION AND COMMENT SHEET

To the proposed Reconstruction of the West St Bridge MalaMala Private Game Reserve Mpumalanga



TitleName	Please indicate with an x whether you		
Surname	would like to be kept informed of the EIA		
Company Name/Interest	process		
group	YES, I would like to informed. YES		
Postal or Residential	NO, I am not interested NO		
Address			
Town/City			
Postal Code	Should you know of anyone else who may		
Tel ()	be interested in obtaining information		
Cell	with regards to the development's EIA		
Fax ()	process, please provide us with their		
E-mail	contact details below:		
address	1.		
	Name:		
In accordance with NEMA – Section 58 no.	Company:		
1 – A registered interested and affected	Fax:		
party is entitled to comment, in writing, on	Email:		
all written submissions made to the	2.		
competent authority, provided that (c) –	Name:		
the interested and affected party discloses	Company:		
any direct business, financial, personal or	Fax:		
other interest which that party may have	Email:		
in the approval or refusal of the	COMMENTS: (If you require more space		
application. Please supply such	than that which is provided, please attach		
information in the space provided below.	additional pages)		
· · · · · · · · · · · · · · · · · · ·	1 3 7		
	Thank you for your participation!		

Please be assured that your comments will form part of the final document to be submitted to the decision-making authority

Please complete and return this response sheet to the Public Participation office:

P.O. Box 3135

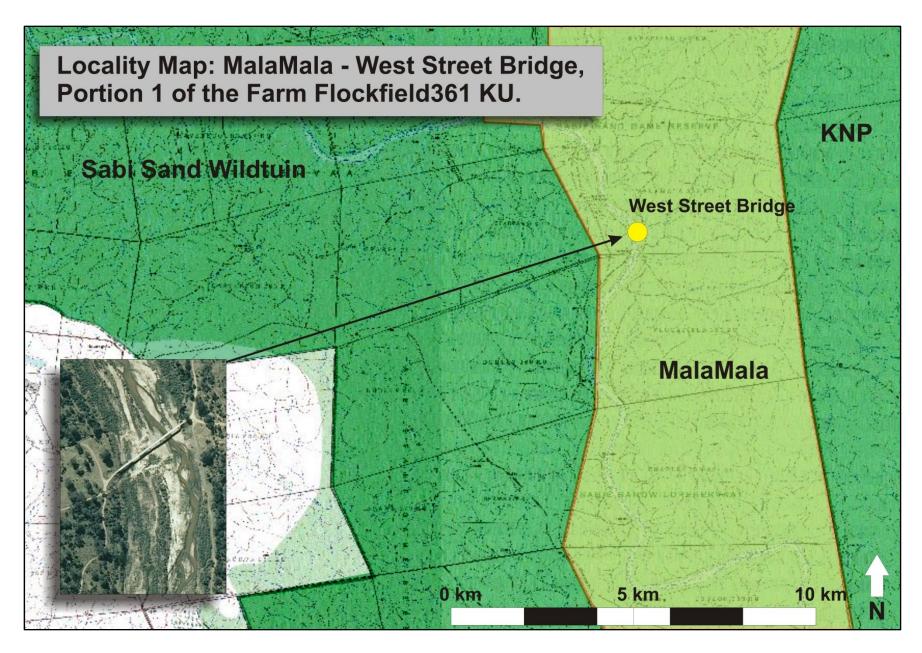
Nelspruit

1200

Fax: (013) 753 2116

E-mail: kulani.mabaso@aurecongroup.com

Feel free to phone us on (013) 755 2218, should you not have access to fax or e-mail



Annexure D Advertisement Text

PUBLIC PARTICIPATION PROCESS

MDEDET Ref No.: 17/2/3/E-136

Basic Environmental Impact Assessment for the proposed Reconstruction and modification of the West St bridge on the Farm MalaMala 359 KU, Mpumalanga MalaMala Ranch (Pty) Ltd plans to reconstruct and modify the West St Bridge on Malamala Farm 359KU to ensure access into the eastern sides of the Sabi River adjoining western boundary of the Kruger National Park.

According to the National Environmental Management Act (NEMA) (NO. 107 of 1998) the project requires authorisation from the Mpumalanga Department of Economic Development, Environment and Tourism via the EIA process (GN No. R543). Activity 11, 18, 39 AND 40 of GN No. R544 published in terms of NEMA are triggered.

Aurecon (Pty) Ltd has been appointed to undertake the required EIA process.

For more information regarding the public meeting, to raise any initial issues or concerns or register as an Interested and Affected Party, please contact Aurecon before 03 May **2012**.

Contact Details:

Kulani.mabaso@aurecongroup.com PO Box 3135, Nelspruit, 1200

Tel: (013) 752 7055 Fax: (013) 753 2116



Annexure E Proof of Advertisement Placement

ifieds



GERESTOUREERDE MINI 1275 GT

In pragtige oorspronklike toestand. R17,500 083-462-0437 013-257-0223



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- SUSPENSION • TYRE WEAR

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> > 90.4

Legals

0915 Auctioneers
0910 Public & Legal
Notices
0915 Sales In Execution
0920 Tenders
0925 Estates
0930 Liquidations
0935 Town Planning

NOTICE
PUBLIC PARTICIPATION
PROCESS
MDEDET Ref No.: 17/2/3/E-136
Basic Environmental Impact
Assessment for the proposed
Reconstruction and modification
of the West St bridge on the
Farm Malamala 359 KU,
Mpumalanga
MalaMala Ranch (Pty) Ltd plans
to reconstruct and modify the
West St Bridge on Malamala
Farm 359KU to ensure access
into the eastern sides of the
Sabi River adjoining western
boundary of the
Kunger National Park

Sabi River adjoining western boundary of the Kruger National Park. According to the National Environmental Management Act (NEMA) (NO. 107 of 1998) the project requires authorisation from the Mpumalanga Department of Economic Development, Environment and Tourism via the EIA process (GN No. R543). Activity 11, 18, 39 AND 40 of GN No. R544

published in terms of NEMA are triggered. Aurecon (Pty) Ltd has been appointed to undertake the required EIA process. For more information regarding the public meeting, to raise any initial issues or concerns or register as an Interested and Affected Party, please contact Aurecon before 03 May 2012. Contact Details: Kulani.mabaso

@aurecongroup.com PO Box 3135, Nelspruit, 1200 Tel: 013-752-7055 Fax: 013-753-2116

----BV003586

aangegee, maar is nie gewaarborg nie: Die eiendom is ONVERBETERD Die voorgenoemde geregtelike verkoping sal onderhewig wees aan die Voorwaardes van Verkoping wat geinspekteer kan word by die kantore van die Balju van die Landdroshof te BARBERTON. GEDATEER te MALALANE op 3 April 2012 Eksekusieskuldeiser se Prokureur FRANS MEYER PROKUREURS P/A P.J LEMMER
PROKUREURS, BARBERTON
POSBUS 130 MALELANE 1320 Telnr: 013-790-0261, Faksnr: 013-790-0427 Verw: MNR MEYER/Leandre Bester/AO608-NKO4/0587 Adres van Eksekusieskuldenaar: MR MONTGOMERY GABRIEL TIISETSO CELE Identiteits-nommer 781208 5296 086 van 20 DA GAMA STREET CULEMBORG PARK, RANDFONTEIN

BV003495 KENNISGEWING KENNISGEWING VAN GEREGTELIKE VERKOPING In die LANDDROSHOF vir die DISTRIK BARBERTON GEHOU te BARBERTON Saak No. 2704/10 In die saak tussen NKOMAZI LOCAL MUNICIPALITY Eksekusieskuldeiser en SIZWE FRANK FAKUDE Eksekusieskuldenaar Ingevolge 'n Vonnis gelewer op 13de dag van Januarie 2011, in die BARBERTON Landdroshof en 'n Lasbrief van Eksekusie daarna uitgereik, word die eiendom hieronder beskryf in eksekusie verkoop op 18de dag van Mei 2012 om 10:00 AM te 3086 OTTER WEG MARLOTH PARK HOLIDAY TOWNSHIP, aan die hoogste bieër, met geen reserweprys. BESKRYWING: ERF 3086. MARLOTH PARK HOLIDAY TOWNSHIP REGISTRATION DIVISION J.U. PROVINCE OF MPUMALANGA Groot 1836 (EEN DUISEND AGT HONDÈRD SES EN DERTIG) Vierkante Meter; Gehou kragtens Akte van

Transport Nr. T124380/1999

FRANS MEYER
PROKUREURS
P/A P. J. LEMMER
PROKUREURS, BARBERTON
POSBUS 130 MALELANE 1320
Teln: 013-790-0261,
Faksnr: 013-790-0427
Verw: NKO4/0490/IR
Adres van
Eksekusieskuldenaar:
MR ALISTAIR CAVANAGH van
1533 VINK WEG, MARLOTH
PARK HOLIDAY TOWNSHIP

KENNISGEWING KENNISGEWING VAN GEREGTELIKE VERKOPING In die LANDDROSHOF vir die DISTRIK BARBERTON GEHOU te BARBERTON Saak No. 1095/2011 In die saak tussen: NKOMAZI LOCAL MUNICIPALITY Eksekusieskuldeiser en WILLIAM JOHN HAWLEY Eksekusieskuldenaar Ingevolge 'n Vonnis gelewer op 25ste dag van Augustus 2011, in die BARBERTON anddroshof en `n Lasbrief var Eksekusie daarna uitgereik ensekusie daarna ungereik, word die eiendom hieronder beskryf in eksekusie verkoop op 11de dag van Mei 2012 om 11:00 AM te 2101 MUISWEG, MARLOTH PARK HOLIDAY TOWNSHIP, aan die hoogste biese met veen keep veer bieër, met geen reserweprys. BESKRYWING: ERF 2101 MARLOTH PARK HOLIDAY **TOWNSHIP** REGISTRATION DIVISION JU, PROVINSIE MPUMALANGA Groot 2084 (TWEE DUISEND EN VIER EN TAGTIG) Vierkante Meter; Vierkartie Weter, Gehou Kragtens Akte van Transport Nr. T18833/2002 STRAATADRES: 2101 MUISWEG, MARLOTH PARK HOLIDAY TOWNSHIP Die volgende inligiting word aangegee, maar is nie gewaarborg nie: Die eiendom is ONVERBETERD. Die voorgenoemde geregtelike verkoping sal onderhewig wees aan die Voorwaardes van Verkoping wat geinspekteer kan word by die kantore van die Balju van die Landdroshof te BARBERTON.

GEDATEER te MALALANE op

Eksekusieskuldeiser se

3 April 2012

Prokureur

For aximum sponse ver two ediums t once

ZWS ZWI

Phor consultants Tel 013-754-1669 Fax 013-753-2422

institution, the purchaser shall, no th day of the sale, produce written confirmation from the said financial institution to the

in his/hei/his anme under Deed of Trensfer No. 141501/2005, 1. The sale hall be subject to his feet and conditions of the terms and conditions of the Magistrale's Count Act and the Unites made threteunder.

2. The Purchaser shall pay the bank guaranteed cheque on the Dank guaranteed cheque on the Day of the sale. In the event of the Purchaser having to obtain institution, the purchaser shall institution, the purchaser shall

Square Metres: 733
Square Metres: 733
GHOCODILE ROAD MARLOTH
PARK HOLIDAY TOWNSHIP
Improvements: UNIMPROVED
in his/her/fils name under Debtor
in his/her/fils name under Debtor

HOLIDAY TOWNSHIP to the HOLIDAY TOWNSHIP to the Description: ERF 733 MARLOTH PARK HOLIDAY TOWNSHIP, REGISTRATION DIVISION JU, PROVINCE MY STAND THOUSAND AND PIETY TWO Square Metres;

Description: EBE 233

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Court and under a wint of secoution is stated the seadflet the immovable property listed hereurion on Seth day of May 2012 at 25th day of May 2032 at 10:00 AM at 733 CROCODILE

Confact: André 083 737 6906 Hermann 083 797 9982 0861 28 28 46 Views Menutay, S3 April till Apm.
Registration Requirements: Each buyer has to be registeed in order to bid. Proof of residence & ID required for PICA registration. R20,000 registration deposit payable by bank guaranteed cheque, bank tragsfer, orgalitation deposit payable by bank guaranteed cheque, bank tragsfer, oredit/debit card, NO CASH ACCEPTED! TERMS & CONDITIONS APPLY.

Also on auction: Large selection of smaller items - Scaffolding, Hardware, Power Voshs; Water Pumps, Spares, Pumps, Power Washers!

2009 CAT Challenger



Rigids & Closed body
 Volume Vans
 Volume Vans
 XX007 International 7600
 I4m² Rigid Tippers
 Mechanical Horses
 Mechanical Horses
 Freightliner Argosy
 Mechanical Horses

Diesel Bowsers
 Water Carts
 Excavators & Graders
 Excavators & Graderink
 Side Tip Trailers
 Side Tip Railers
 Rigids & Closed body

2007 Mercedes-Sent 1926 6m³ Tipper Missan Diesel / Gas Forklifts Bobcat Skidsteers Volvo, CAT & Gase TLBs

Foot Rollers

Bornsg Walk Behind Compactor

Bornsg Welredes-Benz 1528

bucket
Liugong CLG 856 Wheel Loader
2005 Yoko FM12 Truck Tractor
2005 Yoko FM32 Truck Tractor
CAT, Long Gong and Deutz Pad

2009 CAT Challenger MT875
 Reynolds Ejector Scraper
 17E10.5
 Liugong 856 F.E.L with coal

CONSTRUCTION & EARTHMOVING

• A x 47m³ 4 Room Combination
• 4x 47m³ 4 Room Combination
• 4x 47m³ 4 Room Combination with Patio
• 2x 120m² Prefab Building
• 5x 150m² Prefab Building
• 6x 16m² (3 Toilets & 3 Showers)
• 6x 16m² (6 Toilets & 3 Showers)
• 7x 16m² (6 Toilets)
• 7x 16m² (6 Toilets)



Extent: 992mz

Portion 5 Erf 4 Registration Di Mpumalanga

NENN



Annexure F Public and Departmental Meeting Minutes



Attendance register and Minutes of the Public meeting for the

Proposed Reconstruction and modification of the west St Bridge on MalaMala



MDEDET REF No: 17/2/3/E-136 AURECON REF NO:108200

Attendance

Attendance:

NAME	ORGANISATION	CONTACT DETAILS
A. Parker (AP)	Sabi-Sands(SSW	Cell: 083 735 5994
		Tel No: 013 735 5102
P. Odendaal (PO)	Waterresources	Cell No: 073 163 4074
K. Mabaso(KM)	Aurecon	Cell No: 082 797 0013
		Tel: 013 752 7055
I. Garratt (IG)	Aurecon	084 514 9169
S. Henwood (SH)	Aurecon	078 672 3645

MINUTES

(The meeting was guided by the attached PowerPoint Presentation)

- 1. Opening and Welcome by:
 - 1.1 Steven Henwood (SH) welcomed and thanked everybody for attending and then handed over to Iain Garratt (IG)
- 2. Introduction:
 - 2.1 A public meeting was held to explain the proposed development of the proposed reconstruction and modification of the West St Bridge on MalaMala.

The environmental impact assessment (EIA) process and the proposed public participation process were explained. This was done with the assistance of a PowerPoint presentation that is available and has been attached as an Appendix to this document.

3. Questions and answers:

3.1. **AP**: Raised the issue of vehicle movement and control thereof through the reserve. Concern was raised that vehicular movement (construction vehicles large and small, contractors etc...) needs to be properly controlled. In this regards it was recommended that gate times, entrance protocol as well as general rules regarding vehicle weight, use of roads suited to heavy load transport and travel times be adhered to. Andrew under took to forward these requirements to the EAP.

It was suggested that Shaw's Gate be used for entrance and that military road be used the link between the gate and MalaMala.

- 3.2. **AP:** Wanted to know where building materials for the bridge were going to be sourced. More specifically, was the applicant intending to source any materials within the reserve. Excavation of sand for construction was of concern and it would be preferred that all materials be sourced from external sources. Exception to this would be the reuse of concrete and material that could be salvaged from the old bridge.
- 3.3. **AP:** Highlighted that all construction impacts, both direct and cumulative should be evaluated and that the management plan for the Sabi Sands be incorporated into the EIA and EMP for the project. The current EMP should inform all documentation and mitigatory measures emerging from the EIA process.
- 3.4. **AP:** Reiterated that access of contractual staff into the reserve and proper control thereof is of the utmost importance. All staff movement should be controlled. Additional to this the issue of contract staff accommodation was raised. Andrew requested that the client inform all parties about details pertaining to temporary staff accommodation. It was highlighted that accommodation outside the reserve would be preferable.
- 3.5. **AP:** Wanted to know what would be done with building rubble, both left over from the bridge ruins as well as waste generated during and after completion of the new bridge? Would concrete sections too large to remove from site be re-used, if possible, for the re-construction? Such rubble as is possible to remove should be done so and disposed of at a registered waste facility. Again the EMP should inform the mitigation of this impact.
- **IG:** Removal of large concrete slabs washed downstream may be problematic. The possible negative impacts related to the removal of these concrete pieces from the river will have to be evaluated against the possible positive impacts that the removal will create.

- 3.6. **IG:** Asked Andrew for clarification on the current status of MalaMala and its being a part of the Sabi sands Association.
- **AP:** Andrew informed Iain, that in the simplest terms, that MalaMala was no longer part of the Sabi Sands Association, but that they were still part of the formally protected area as gazetted.
- 3.7. **AP:** Asked what recourse the Sabi Sand would have, should roads used to access MalaMala and the site be damaged by construction vehicles and transport? He requested that this be minuted.
 - **IG:** Answered that this issue would be investigated further. Further to this Iain added that "Normally as EIA consultants conducting the EIA process we design or develop standard mitigation strategies that ensures the security and assurance to the neighbors".
- 3.8. **IG**: Asked about the reaction of the people within the Sabi-Sands and the surrounding areas to this proposed project?
 - **AP**: Responded that the Sabi Sand Wildtuin people are in general enthusiastic about the project and would prefer that the project commence during the dry season as the wet seasons could really impact on the construction process. The commencement of construction through the wet season could lead to unnecessary damage to roads and other infrastructure.
- **IG**: Furthermore IG asked AP to let the community and the Sabi Sand Association members know that they are very welcome to assist with any relevant information they might have and that could assist with the compilation of a meaningful EIA report. Should anyone require that they have input into the EIA process and would like it to be included; they should forward correspondence to the EAP. A request to be registered as an I&AP should also be forward to the EAP. Contact details are made available on the BID as circulated.
- 3.9. **SH:** Steven Henwood informed the meeting that as soon as Aurecon had received the detailed engineering report, that submission of the draft BAR for public review would take place. Subsequent to this and on receipt of comment on this report, the final BAR report would again be submitted to the public for review and only then to MDEDET for authorization. Time frames related to this process were highlighted. In this regard please see the attached slide presentation.
- 3.10. **AP:** Wanted to know how long or how many months it would be before commencement of construction would take place?

- 3.11. **IG**: replied that the EIA (Basic Assessment) process would take about 4 months to complete. Thereafter construction could commence. Again time frames were indicated in the slide presentation.
- 3.12. **AP:** wanted to know approximately how long the construction period would last?
- 3.13. **IG:** lain estimated that it may last approximately seven months.
- 3.14. **AP:** Andrew wanted to know who had the right to comment on the EIA documentation and process.
- 3.15. **IG:** Iain responded that EIA legislation "states interested, affected parties (surrounding landowners, residents within a 100 m radius of the proposed activity as well as appropriate stake holders, which may be organs of state) are allowed to comment.

3. Meeting Closure:

lain Garratt and Steven Henwood reiterated that any further submissions were welcome throughout the process. They then thanked everyone for their participation.

The meeting was closed at 14h05

Appendix 1:

Proposed Reconstruction and Modification of the West St Bridge on MalaMala - Stakeholder Meeting

May 2012









Agenda

1.	Welcome	Aurecon
2.	Overview of the meeting	Aurecon
3.	Introduction of project team	Aurecon
4.	Project Background	Aurecon
5.	Project Details and Information	Aurecon
6.	Specialist Involvement	Aurecon
7.	Overview of EIA and PPP	Aurecon
<i>8.</i>	Way Forward	Aurecon
9.	Questions	Aurecon
10.	Conclusion	Aurecon



Content

- Background
- Specialist Involvement
- Technical Process:
 - What is an Environmental Impact Assessment (EIA)
 - Technical Process
- Public Participation Process (PPP):
 - What is Public Participation (PP)
 - PP Process
- Contents of the Basic Assessment Report (BAR)
 - Impacts Identified to date
 - Way forward



Project Role Players

Client/ Proponent





Environmental Project Team

Aurecon provides world-class Environmental, engineering, management and specialist technical services to government and private sector clients. With more than 6,000 staff and over 80 offices worldwide, Aurecon has a presence in Africa, Australia, New Zealand, Southeast Asia, China, and the Middle East.



Background

Due to the torrential rainfall experienced within the eastern areas of Mpumalanga and Limpopo province during January and February 2012, the MalaMala West St Bridge, which was constructed during mid-1997, was recently damaged.

The bridge was constructed over the Sand River, which is one of the primary watercourses within the Game Reserve, to ensure access into the traversing areas on the western fringes of the Kruger National Park. Being a premier commercial game lodge, access into this game rich area is critical for the economic viability of the business.



Project Details and Information

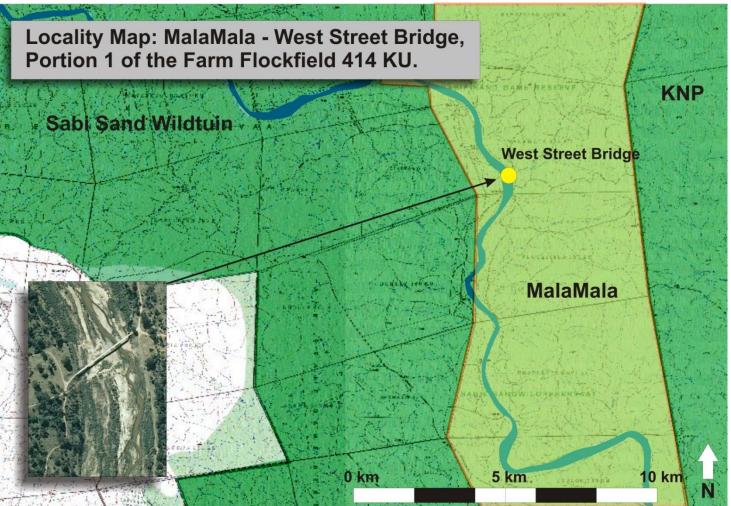
The project site is situated on the farm Flockfield 414KU on the eastern portion of the Game Reserve, adjacent to the Kruger National Park. The co-ordinates of the Bridge are S 24 49' 34.1" E 31 33'27.4" please refer to locality plan attached).

This project includes the following activities which will be investigated through the EIA process:

- Reconstruction of the bridge on the same footprint;
- Possibly raising of the bridge by approximately 2m
- The extension of the bridge stays and approaches.



Locality Map







Specialist Involvement

Specialty	Company name	Contact Person
WULA	WFA Water Recourses (Pty) Ltd	Paul Odendaal



Legal Requirements

The proposed project triggers activities listed in GN 544 and therefore environmental authorisation from the relevant government department, i.e. the Mpumalanga Department, Economic Development, Environment & Tourism (MDEDET) is required as per sections 21 to 25 of GN 543.

The following activities (and a description of each) in GN R544 will be triggered by the proposed project:

Activity 18

The infilling or moving of materials exceeding 5 cubic meters within a watercourse.

Activity 39

Expansion of the eastern stay to ensure that the approaches to the bridge are not impacted on by flood waters in future.

Accordingly, the proposed project will require the submission of a Basic Assessment Report (BAR) as outlined in sections 21 to 25 of Regulations 543.



EIA Technical Process

What is an EIA?

- EIA Regulations under the NEMA (Act 107 of 1998) as amended 2012
- An EIA is required where an activity is likely to have significant impacts
 due nature or extent, of the activities or activities are associated with high
 levels of environmental degradation, or the impacts cannot be easily
 predicted.



EIA – Basic Assessment Process

Public Participation Phase Issues identified to focus BAR

Draft BAR Phase

Potential impacts (negative & positive) studied

Final BAR

Consolidate findings related to potential impacts

Decision Making Phase

Authorities use EIA as tool make a decision on the future of project



Technical Process & Time Frames

BASIC ASSESSMENT PROCESS – DRAFT PHASE

Submit Application form to CA

CA acknowledges and accepts application form within 14 days

Public participation process commences, which includes providing I&AP's 30 days to register

Submit draft Basic Assessment Report (BAR) to CA

Submit draft BAR to I&AP's and State Departments & provide 40 days for comment (30 for I&AP's)



Technical Process & Time Frames

BASIC ASSESSMENT PROCESS - FINAL PHASE

Compile final BAR after receipt of comments

Provide I&AP's and State Departments with 21 days to comment on final BAR

Submit final BAR with comments received to CA

CA acknowledges receipt of final BAR within 14 days

Within 30 days of acknowledging receipt of BAR, CA to accept or reject the report, or request additional information

Within 30 days of accepting the BAR, CA to grant or refuse authorisation

On reaching a decision, the CA must, within 2 days notify the applicant of the decision.

The applicant must, within 12 days of the date of the decision, notify I&AP's of the decision and publish a notice



Public Participation Process

What is Public Participation?

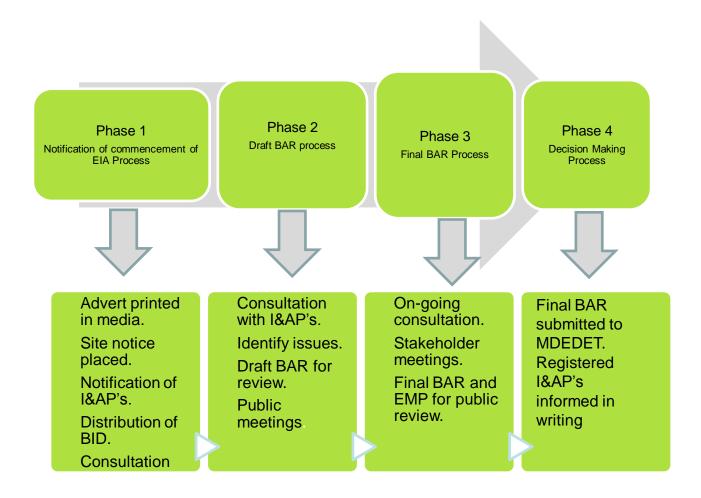
A process leading to a joint effort by

- stakeholders
- technical specialists
- the authorities
- the proponent

Who work together to produce better decisions than if they had acted independently



PPP- EIA Phase





Contents of the DSR

Identified Potential / Anticipated Impacts:

- Ecology (aquatic fauna, flora) during construction
- Impact on water course
- Socio-economic negative impact on the operation of MalaMala

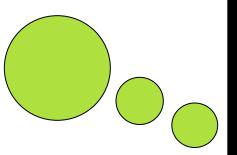


Way Forward

- Public Review of DBAR
- Incorporation into Issues and Response Report
- Compilation of the FBAR
- Submit to FBAR to I&AP's
- FBAR to DEDET for authorisation



Questions





Annexure G Public Meeting Register

	AURECON	Ž					
		MEE	MEETING ATTENDANCE REGISTER	E REGISTER			
Contract No: 108200	Contract description: The Reconstruction and Modification of the West St. Bridge on MalaMala Ranch	The Reconstruction	and Modification	of the West St. Brid	ge on MalaMala	Ranch	
Meeting No: 01	Venue: Nelspruit Public Library	c Library		Dat	Date: 04/05/2012	Time: 13:00 pm	
			PRESENT				
Name	Organisation	Tel No	Cell No	Fax No	m.	E-mail	Signature
A. GREER	WSS	0137355102	8818411880	0137355994	CEGOS	560518181810.0020	Molan
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Annexure H Departmental Meeting Registers



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MDEDET REF No: 17/2/3/E-136 **AURECON REF NO:108200**

Attendance register for the departmental meeting for the Proposed Reconstruction and modification of

the west St Bridge on MalaMala



Name & Surname	Organization	Contact Details	Signature
VICHAZ NYIRONDA	DEDET	Contact Details NELSPENIT FOR MYRRAY STREET	M
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PETER BOORSMA	GOBA QNIM	pulub Egifo. a	
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MDEDET REF No: 17/2/3/E-136 AURECON REF NO:108200

Attendance register for the departmental meeting for the

Proposed Reconstruction and modification of the west St Bridge on MalaMala



Name & Surname Organization Contact Details Signature So Myerry Street Thuir Thoryang DEDE: Therefore Arecon
Thui Thoman DEDET 11
5 Henry Arecon
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PETER BOORSMA GOVEA PONIN Prilate Cylo. C. Zo Ros

Annexure I List of Registered Interested and Affected Parties

Title	Initials	Surname	Organisation	Address	Postal code	Telephone	Fax	Mobile	Email
Mr	Α	Parker	Sabi-sands	P.O. Box 05 ,Skukuza	1350	013 735 5102		083 735 5994	ceo@sabisands.co.za
Ms	Т	Mthombeni	Ward Councillor	P.O.Box 518 ,Ximhungwe	1281			082 827 0393	
Ms	Т	Nkonyana	MDEDET	50 Murray Street, Nelspruit	1200	013 766 4800			
Mr	Α	Smith	Skukuza	P.O.Box 402,Skukuza	1350	013 735 4219		082 923 1959	
Mr	F	Bronkhorst	МТРА					072 227 7358	fbronkhorst@telkomsa.net
Mr	Р	Ntabeni	Department of Water Affairs(Water Resource Management)					079 510 7283	ntabenip@dwa.gov.za
Mr	S	Shabangu	Department of Water Affairs (Strategic Environmental Assessment)					082 857 4275	Shabangus2@dwa.gov.za
Ms	В	Mahlangu	Department of Water Affairs (Compliance Monitoring Enforcement)					082 803 7652	mahlangul@dwa.gov.za
Mr	Р	Oodendal	Water Resources						
Mr	W	Keyter	Dudley Farm (SSW)			012 470 2200	086 669 1890	082 857 6948	wilco.keyter@epiuse.org
Ms	Т	Petersen	Sanparks (Kruger National Park)	P.O.Box 394 Skukuza	1350	013 735 4271	013 735 4051	076 896 3399	tracy.petersen@sanparks.org

Annexure J Comments and Responses

ISSUE RAISED	COMMENTATOR/S	SOURCE	RESPONSE
1. Issues related to traffic and access			
The issue of vehicle movement and control thereof through the reserve. Concern was raised that vehicular movement (construction vehicles large and small, contractors etc) needs to be properly controlled. In this regards it was recommended that gate times, entrance protocol as well as general rules regarding vehicle weight, use of roads suited to heavy load transport and travel times be adhered to. Andrew under took to forward these requirements to the EAP. It was suggested that Shaw's Gate be used for entrance and that military road be used the link between the gate and MalaMala.	A. Parker	Aurecon	The access road from Shaws gate to Flockfield 414KU is a right of way and whilst MalaMala will respect the wishes of the SSW in the interests of good neighbourliness, MalaMala enjoys unencumbered access to its properties through Shaws GateSite access as well as the location of laydown and storage areas and additional work areas will be based on the following criteria: Avoiding unduly steep or rugged terrain. Minimising impacts on sensitive vegetation, erosion prone soils and watercourse crossings. May not be within 32 meters of a stream or water body. Avoiding significant riparian and natural vegetation. Existing roads and tracks will be used where practicable. Only designated access tracks will be used by construction vehicles, including personnel vehicles. Public and private access tracks will be reinstated to the pre-construction condition,. Damage to public and access roads, caused by any activities related to this project must be repaired without any inconvenience caused to other road users (guests, landowners and reserve staff). Repair work must be carried out when practically feasible and convenient. Workforce education, signage and boundary demarcation will be used to ensure vehicles remain on designated access tracks, within the construction area. Access via Shaws Gate would be investigated and treated as the preferred access point. All rules and regulations regarding acess to the Sabi Sand will be adhered to.
Reiterated that access of contractual staff into the reserve and proper control thereof is of the utmost importance. All staff movement should be controlled. Additional to this the issue of contract staff accommodation was raised. Andrew requested that the client inform all parties about details pertaining to temporary staff accommodation. It was highlighted that accommodation outside the reserve would be preferable.	A. Parker	lain Garratt (Aurecon)	This was noted. All staff movement will be controlled. Temporary staff accommodation will exist at the site of the bridge on the western bank of the Sand River at the site used in 1988.
Asked what recourse the Sabi Sand would have, should roads used to access MalaMala and the site be damaged by construction vehicles and transport? He requested that this be minuted. IG: Answered that this issue would be investigated further. Further to this lain added that "Normally as EIA consultants conducting the EIA process we design or develop standard mitigation strategies that ensures the security and assurance to the neighbors".	A. Parker	lain Garratt (Aurecon)	Public and private access tracks will be reinstated to the pre-construction condition,. Damage to public and access roads, caused by any activities related to this project must be repaired any inconvenience is caused o other raod users (guests, landowners and reserve staff) is incurred. Repair work must be carried out when practically feasible and convenient Given that it is expected that construction will commence on the bridge during the dry season it is expected that any heavy equipment will be placed on site at this time and therefore road damage will be minimal.
2. Issues related to waste control			
Wanted to know what would be done with building rubble, both left over from the bridge ruins as well as waste generated during and after completion of the new bridge? Would concrete sections too large to remove from site be re-used, if possible, for the re-construction? Such rubble as is possible to remove should be done so and disposed of at a registered waste facility. Again the EMP should inform the mitigation of this impact.	A. Parker	lain Garratt (Aurecon)	Removal of large concrete slabs washed downstream may be problematic. The possible negative impacts related to the removal of these concrete pieces from the river will have to be evaluated against the possible positive impacts that the removal will create. Where possible, all unused building rubble and generated waste will be removed from the site. Concrete sections too large to move will be, where possible be reused in the construction process.

3. General Issues			
Clarification on the current status of MalaMala and its being a part of the Sabi sands Association.		lain Garratt (Aurecon)	In the simplest terms, that MalaMala was no longer part of the Sabi Sands Association, but that they were still part of the formally protected area as gazetted.
4. Issues related to Natural Resourses			
Wanted to know where building materials for the bridge were going to be sourced. More specifically, was the applicant intending to source any materials within the reserve. Excavation of sand for construction was of concern and it would be preferred that all materials be sourced from external sources. Exception to this would be the reuse of concrete and material that could be salvaged from the old bridge.	A. Parker	lain Garratt (Aurecon)	River sand will be sourced from the Sand River
5. Issues related to the public participation process			
Asked about the reaction of the people within the Sabi-Sands and the surrounding areas to this proposed project? Furthermore IG asked AP to let the community and the Sabi Sand Association members know that they are very welcome to assist with any relevant information they might have and that could assist with the compilation of a meaningful EIA report. Should anyone require that they have input into the EIA process and would like it to be included; they should forward correspondence to the EAP. A request to be registered as an I&AP should also be forward to the EAP. Contact details are made available on the BID as circulated.		lain Garratt	The Sabi Sand Wildtuin people are in general enthusiastic about the project and would prefer that the project commence during the dry season as the wet seasons could really impact on the construction process. The commencement of construction through the wet season could lead to unnecessary damage to roads and other infrastructure. is therefore noted that there are no objections from people within the SSW to the proposed reconstruction.
7. Basic Assessment report			
Wanted to know how long or how many months it would be before commencement of construction would take place?	A. Parker	lain Garratt (Aurecon)	The EIA (Basic Assessment) process would take about 4 months to complete. Thereafter construction could commence. Again time frames were indicated in the slide presentation.
Who had the right to comment on the EIA documentation and process.	A. Parker	Iain Garratt & Steven Henwood	EIA legislation "states interested, affected parties (surrounding landowners, residents within a 100 m radius of the proposed activity as well as appropriate stake holders, which may be organs of state) are allowed to comment
Approximately how long would the construction period last?	A. Parker	lain Garratt (Aurecon)	Estimated that it may last approximately seven months.

Appendix E; Annexure K Proof of submission and distribution of Draft Basic Assessment

From: Microsoft Outlook

Sent: 13 August 2012 10:13 AM

To: Leandri Joubert

Subject: Relayed: MalaMala West St Bridge reconstruction EIA

Delivery to these recipients or groups is complete, but no delivery notification was

sent by the destination server:

nickm@lionsands.com (nickm@lionsands.com)

Subject: MalaMala West St Bridge reconstruction EIA

No virus found in this message.

Checked by AVG - www.avg.com

Version: 2012.0.2197 / Virus Database: 2437/5210 - Release Date: 08/19/12

From: Leandri Joubert

Sent: 13 August 2012 10:13 AM

To: nickm@lionsands.com

Subject: MalaMala West St Bridge reconstruction EIA

Mr. N. More

MalaMala West St Bridge reconstruction EIA has reference.

MDEDET Ref# 17/2/3/E-136

Aurecon Ref# 108200

As per Section 56 (5) of GN 544, we would like to inform you that the 30 day review of the draft report ends today and we have received no further comments or issues from yourselves and/or other registered I&AP's regarding the draft BA report.

In the event that the close of the 30 day review has been overlooked, please can you forward us any recommendations and or suggestions regarding the identified impacts and proposed mitigations so that we can evaluate the submissions and incorporate any feasible options into the final report?

We would like to distribute the final report for review on Tuesday 14th August and would need your inputs by COB Monday the 13th.

Kind Regards,

Leandri Joubert

Environmental Practitioner | Aurecon

T +27 13 752 7055 | F +27 86 573 4066 | M +27 83 253 9162

E Leandri.Joubert@aurecongroup.com
25 Rood Street, Nelspruit I South Africa
aurecongroup.com

From: Hilton Loon [mailto:hloon@sabisabi.com]

Sent: 13 August 2012 02:16 PM

To: Leandri Joubert

Subject: Read: MalaMala West St Bridge reconstruction EIA

Your message

To:

Subject: MalaMala West St Bridge reconstruction EIA

Sent: Monday, August 13, 2012 2:16:43 PM (UTC+02:00) Harare, Pretoria

was read on Monday, August 13, 2012 2:16:15 PM (UTC+02:00) Harare, Pretoria.

No virus found in this message.

Checked by AVG - www.avg.com

Version: 2012.0.2197 / Virus Database: 2437/5210 - Release Date: 08/19/12

From: Leandri Joubert

Sent: 13 August 2012 10:15 AM

To: 'Hloon@sabisabi.com'

Subject: MalaMala West St Bridge reconstruction EIA

Hi Hilton

MalaMala West St Bridge reconstruction EIA has reference.

MDEDET Ref# 17/2/3/E-136

Aurecon Ref# 108200

As per Section 56 (5) of GN 544, we would like to inform you that the 30 day review of the draft report ends today and we have received no further comments or issues from yourselves and/or other registered I&AP's regarding the draft BA report.

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Kind Regards,

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25 Rood Street, Nelspruit I South Africa

aurecongroup.com

DISCLAIMER

From: Leandri Joubert

Sent: 13 August 2012 10:15 AM

To: 'Hloon@sabisabi.com'

Subject: MalaMala West St Bridge reconstruction EIA

Hi Hilton

MalaMala West St Bridge reconstruction EIA has reference.

MDEDET Ref# 17/2/3/E-136

Aurecon Ref# 108200

As per Section 56 (5) of GN 544, we would like to inform you that the 30 day review of the draft report ends today and we have received no further comments or issues from yourselves and/or other registered I&AP's regarding the draft BA report.

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We would like to distribute the final report for review on Tuesday 14th August and would need your inputs by COB Monday the 13th.

Kind Regards,

Appendix E; Annexure K Proof of additional request for comment from I&AP's

From: Iain Garratt

Sent: 10 August 2012 01:36 PM To: 'Andrew Parker' Subject: MalaMala Bridge rebuild EIA Importance: High
Hi Andrew
MalaMala West St Bridge reconstruction EIA has reference.
MDEDET Ref# 17/2/3/E-136
Aurecon Ref# 108200
As per Section 56 (5) of GN 544, we would like to inform you that the 30 day review of the draft report ends today and we have received no further comments or issues from yourselves and/or other registered I&AP's regarding the draft BA report.
In the event that the close of the 30 day review has been overlooked, please can you forward us any recommendations and or suggestions regarding the identified impacts and proposed mitigations so that we can evaluate the submissions and incorporate any feasible options into the final report?
We would like to distribute the final report for review on Tuesday 14 th August and would need your inputs by COB Monday the 13 th .
Kind regards
lain Garratt EAP, M Environmental Management, BTech Nature Conservation Associate Principal Environmental Practitioner Aurecon
Associate I i ilitolpai Etivitotiitietitai Fiactitiotiet I Autecott

T +27 13 752 7055 **I M** +27 84 514 9169

E <u>lain.Garratt@aurecongroup.com</u>
25 Rood Street, Nelspruit I South Africa
<u>aurecongroup.com</u>

From: Andrew Parker [mailto:ceo@sabisand.co.za]

Sent: 10 August 2012 02:14 PM

To: Iain Garratt

Subject: Re: MalaMala Bridge rebuild EIA

Thanks Iain I did get your message but things have been crazy over the full moon period and we have been working flat out to deflect ongoing attempts by poachers.

Sent from my iPhone

CONSTRUCTION OF WEST ST BRIDGE - MALAMALA

DRAFT ENVIRONMENTAL MANAGEMENT PROGRAMME

June 2012



LEAD CONSULTANT

Aurecon (Pty) Ltd. Po Box 3135 Nelspruit 1200

Tel: (013) 752 7055 Fax: (013) 753 2116

Email: lain.Garratt@aurecongroup.com



PROPONENT

MalaMala Ranch (Pty) Ltd Pvt Bag X284 Hillcrest 3650

Tel: (031) 716 3555 Fax: (013 753 2116) Email: <u>dne@iafrica.com</u>

PROJECT DETAILS

PROJECT NUMBER:	108200			
TITLE:	Proposed Construction of the West St Bridge, MalaMala Private Game Reserve - Draft Environmental Management Programme.			
AUTHORS:	Iain Garratt Steven Henwood			
CLIENT:	MalaMala Ranch (Pty) Ltd David Evans Tel: 031 716 3555 E-mail: dne@iafrica.com			
PROJECT NAME:	Proposed Construction of the West St Bridge, MalaMala Private Game Reserve			
REPORT STATUS:	Draft			
REPORT NUMBER:				
SUBMISSION DATE:	June 2012			
IAIN GARRATT		STEVEN HENWOOD		
Associate: Principal Environi Practitioner	mental	Environmental Practitioner		
(EAPSA Certified, M. Environm Management, BTech Nature Co		(Nat. Dip. Nature Conservation)		
APPROVED BY:				
GEORGE FULLARD				
TECHNICAL DIRECTOR				

This report is to be referred to in bibliographies as: Aurecon (2011). MalaMala West Street Bridge Construction: Draft Environmental Management Programme.

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PART A: INTRODUCTION

1 BACKGROUND

Due to the torrential rainfall experienced within the eastern areas of Mpumalanga and Limpopo province during January and February 2012, the MalaMala West St Bridge, which was constructed during mid-1997, was recently destroyed.

The bridge was constructed over the Sand River, which is one of the primary watercourses within the Game Reserve, to ensure access into the traversing areas on the western fringes of the Kruger National Park. Being a premier commercial game lodge, access into this game rich area is critical for the economic viability of the business.

The proposed EMP requires authorisation from the competent environmental authority in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA), as amended, before the construction of the bridge can commence. The NEMA states under Section 28(1) that: "Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonable be avoided or stopped, to minimise and rectify such pollution or degradation of the environment".

Furthermore, the EIA Regulations of 2010 stipulate that the purpose of the Regulations is to ensure that environmental degradation should be avoided, however; where these impacts cannot be avoided, mitigation, and management measures of acceptable levels, or which encourage positive environmental impacts, should be implemented. The legal requirements are discussed in more detail below.

PURPOSE OF THIS DOCUMENT

The main purpose of an Environmental Management Programme (EMP) is to ensure the sustainable management of the environment, whilst avoiding and/or minimising any environmental damage, during the entire lifespan of the project, in this case this restricted exclusively to the maintenance of the MalaMala West Street Bridge. This EMP must be viewed as a legally binding document to which all parties involved in the maintenance of the bridge must be compliant.

Thus the aim of the EMP is to:

- Provide background information on the project, and thus the fundamentals on which the EMP is based:
- ~ Ensure that the construction/maintenance staff are familiar with the environmental procedures to be followed and comply with all the recommendations made within it;
- Ensure that a directory of environmental persons involved in the project is given to the construction/maintenance staff;
- Ensure that a monitoring schedule is established and maintained, in order to proactively identify and manage any potential negative environmental impacts;

- Provide systems to ensure that the mitigation measures are implemented to avoid and/or minimise the identified negative environmental impacts and to enhance the positive impacts of the project on the environment;
- Ensure that a monitoring programme is in place that monitors the implementation of the identified mitigation measures; and
- Provide a system that ensures non-compliances are identified and addressed or mitigated to reduce the potential severity of the resulting environmental impact.

3 STRUCTURE OF THIS DOCUMENT

This Environmental Management Plan (EMP) has been divided into four parts, each addressing a different aspect of the EMP:

- Part A provides a brief introduction and overview of the purpose and structure of this guideline document;
- Part B sets the context for the EMP by providing an overview of the project, summarising the objectives of the Environmental Management Programme, highlighting the scope of the Environmental Management Programme and briefly emphasising MalaMala's environmental commitments;
- ~ Part C is the Construction/maintenance Environmental Management Programme
- ~ Part D is the conclusion of the entire EMP.

INFORMATION PROVIDED IN TERMS OF NEMA (GN 544, EXCLUSION (I) OF ACTIVITY 18)

This EMP has been compiled in accordance with GN 544, exclusion (i) of activity 18 of the National Environmental Management Act (Act 107 of 1998), as amended by the National Environmental Management Amendment Act (Act 62 of 2008). The following details are furnished in compliance with the Act.

4.1 AUTHOR'S CREDENTIALS

lain Garratt, as an Associate Environmental Practitioner in Nelspruit, has a Masters Degree in Environmental Management. He has over 10 years' experience as an environmental practitioner, consultant, ecologist, project manager and administrator. He has also acted as project manager for interdisciplinary projects throughout Southern Africa.

He has gained experience in managing of protected areas, initiating environmental management policies for reserves, setting up an environmental educational programme and community liaison. Iain is presently the Mpumalanga Branch Chair for South African Affiliate for the International Association for Impact Assessment.

Steven Henwood, has been involved in the Environmental Field for approximately 16 years. After completing his National Diploma in Nature Conservation at the then Pretoria Technikon, he spent the ensuing years working in the Kruger National Park and various private reserves in Southern Africa. He has managed numerous environmental applications (Basic Assessments and full EIA's). His skill set includes Global Information Systems - including Visual impact Analysis, Environmental Management Planning, Conservation Planning and Tourism Planning.

Leandri Joubert, an Environmental Practitioner is based in Nelspruit. Leandri has a Bachelors Education degree majoring in Geography with Honors in Geography and Environmental Sciences. She has assisted

with environmental applications (Basic Assessments and thorough Environmental Impact Assessments) for various environmental related projects and Environmental Management Plans relating to mining operations. She also gained experience in full public participation and Geographic Information Systems.

4.2 RESPONSIBLE PARTIES

The following parties are responsible for the implementation of the Environmental Management Programme:

PHASE	RESPONSIBLE PARTY	REPRESENTATIVES
Construction	MalaMala Ranch (Pty) Ltd David Evans Tel: 031 716 3555 E-mail: dne@iafrica.com	Environmental Control Officer: To be Appointed Contact: Tel: E-mail: Primary Contractor I: To be appointed Contact: Tel: E-mail:

PART B: SETTING THE CONTEXT

5 PROJECT DESCRIPTION

The project comprises the construction related to the repairs of the MalaMala West Street Bridge, situated on the farm Flockfield 414KU. The co-ordinates of the Bridge are S 24 49' 34.1" E 31 33'27.4". In order for the bridge to function optimally again, the existing structure would need to be repaired, a like on like rebuilding on the same footprint. See photograph below indicating the bridge both pre and post flood damage.



MalaMala West Street Bridge prior to flooding in 2012



MalaMala West Street Bridge post flooding in 2012

The following points have been established with regard to the maintenance that is to take place on the existing West Street Bridge:"

- River sand will be sourced from the Sand River¹.
- Where possible, all material from the present bridge will be used as well. It is proposed that all demolished concrete be placed in the fill behind the NE Abutment within the erosion cavity caused by the flooding. All other material will be sourced from normal commercial sources.
- Where possible, all unused building rubble and generated waste will be removed from the site. The damaged steel beams from the three span that were washed away should be cut up and removed off site and sold as scrap for re-cycle. The building rubble will be placed and mixed into the new fill behind the NE Abutment as above.
- The substructure should be completed before the end of September including placing the beams. It is estimated that the contract period will be 7 to 8 months in duration.

¹ See section 7.3 for further detail regarding, where, why, the amount to be sourced, and time frame for sourcing

PART C: MAINTENANCE/CONSTRUCTION EMP

⁶ INTRODUCTION

It is imperative that, prior to the maintenance/construction of the West Street Bridge, that a comprehensive set of mitigatory and remedial requirements be identified and through the EMP (this document) be properly and effectively implemented. Thus this Environmental Management Programme (EMP), is to be seen as a working document, and will have a key role to play in the proper and successful maintenance of the West Street Bridge.

An EMP is defined as "an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented and / or minimised and / or mitigated, and that the positive benefits of the projects are enhanced"2. As the name suggests, the Maintenance/Construction Environmental Management Programme provides specific environmental quidance maintenance/construction of the MalaMala West Street Bridge project, and is intended to manage and mitigate construction activities so that unnecessary or avoidable environmental impacts do not result. These impacts range from those incurred during mobilisation (site establishment of the construction camp, mobilisation of the workforce, etc.) through to those incurred during the construction activities themselves (erosion, pollution of watercourses, noise, dust, etc.). The Maintenance/Construction Environmental Management Programme also addresses construction demobilisation phase, as it relates to requirements for the site exit and remediation by the contractor (soil stabilisation, re-vegetation, clean-up, etc.). Specifically, the objectives of the Maintenance/Construction Environmental Management Programme can be articulated as follows:

- To give effect to the environmental and social commitments that the client (MalaMala) has, with regard to maintaining the ecological status of the property;
- To ensure that these requirements or commitments are expressed in a manner that is accessible to all parties and is binding upon those responsible for project implementation;
- To ensure that adequate financial and human resources are allocated to the project in order to give effect to such requirements or commitments, and to ensure that the scale of EMP-related interventions is consistent with the significance of identified impacts;
- To provide a coherent and pragmatic framework for the implementation of the requirements, especially through highlighting the roles and responsibilities of the key project role-players with regard to the auditing and reporting of compliance; and
- To ensure that the maintenance/construction of the project does not result in undue or reasonably avoidable adverse environmental or social impacts, and that any potentially beneficial impacts are enhanced.

The scope of the Maintenance/Construction Environmental Management Programme is to ensure that the objectives outlined above are addressed. The following potentially significant,

² Lochner (2005) *Guideline for Environmental Management Plans*. CSIR Report No ENV-S-C 2005-053 H. Republic of South Africa, Provincial Government Western Cape, Department of Environmental Affairs and Development Planning, Cape Town.

construction-related activities and related environmental impacts necessitating management interventions are as follows:

- ~ Access;
- ~ Clearing and grading;
- ~ Earthworks:
- ~ Terrestrial Flora and Fauna Management;
- ~ Aquatic Flora and Flora;
- ~ Water Management;
- ~ Land Contamination;
- ~ Waste Management;
- ~ Chemical and Dangerous Goods Management;
- ~ Noise and Vibration;
- ~ Air Quality;
- ~ Transport Management;
- ~ Emergency Response;
- ~ Fire Management and
- ~ Incidents and Complaints.

None of the maintenance/construction impacts are expected to have a highly significant impact on the receiving environment, given their relatively short duration and localised extent. Many of the impacts may however, be of medium significance and require specific mitigation interventions in order to avoid and minimise the impact on the local biophysical and social environment.

This Maintenance/Construction Environmental Management Programme has been written in a form and language that is consistent with the documentation used for engineering contracts, to allow for the integration into the civil and mechanical contract specifications. It is essential that the Environmental Management Programme be released as part of the tender information for the following reasons:

- The Contractor is made aware of the Maintenance/Construction Environmental Management Programme and obligations at tender stage already (including environmental requirements beyond the technical scope of work, such as site exit and rehabilitation);
- The Contractor is able to cost and source necessary resources to ensure compliance with the Maintenance/Construction Environmental Management Programme; and
- Inclusion of the Maintenance/Construction Environmental Management Programme within the contract ensures that the Employer's legal obligations become contractually binding on the Contractor.

The applicant has an obligation to ensure compliance by various parties with a suite of environmental requirements related to the maintenance/construction phase. The compilation of the Maintenance/Construction Environmental Management Programme, its integration into the tender documentation along with any conditions of authorisation, serves as part of meeting this obligation.

To ensure that these obligations continue to be fulfilled during the construction process, it behoves the Employer (Applicant) to ensure that the appointed Contractor/s possess the requisite environmental management experience and expertise, and have made provisions for meeting compliance with the Construction Environmental Management Programme. Accordingly, it would be prudent for the Employer to ensure that environmental considerations form part of the tender adjudication process. Key considerations in this regard would be as follows:

- To request, as part of the tender process, that the Contractor provide his environmental policy and indicate how this will influence the way the construction process is approached and managed on site:
- ~ To request a list of the Contractor's previous experience in terms of the onsite implementation and management of environmental requirements;
- To request an indication of the proposed organisational structure for the Contract, and specifically for the Contractor to indicate which staff would be acting in the capacity of Environmental Officer, providing a CV indicating relevant expertise, and which senior staff member would have overall responsibility for ensuring compliance by the Contractor with the specified environmental requirements; and
- To confirm, upon receipt of the Tender, that the Contractor has made sufficient allowance in his Tender Price for meeting the various environmental requirements outlined in the Maintenance/construction Environmental Management Programme, including the final site rehabilitation requirements that may continue to a number of years following completion of the maintenance/construction phase.

During the tender adjudication process for each Contract, each Contractor should be scored in terms of the aforementioned considerations and allocated an environmental competency score. This score should form a key consideration in the final decision-making regarding the award of the various contracts.

REVIEW, DEVELOPMENT, AND AMENDMENT OF THE MAINTENANCE/CONSTRUCTION ENVIRONMENTAL MANAGEMENT PROGRAMME

The Maintenance/construction Environmental Management Programme in its current form serves as a minimum requirement. It is inconceivable that all scenarios and construction activities can be adequately identified and addressed at this stage. Attempts to create an all-inclusive and rigid Maintenance/construction Environmental Management Programme can result in contractual challenges and disputes during the implementation phase, which in turn can indirectly result in additional environmental impacts. The approach should therefore be adopted of ensuring that a hierarchy of suitably qualified and experienced environmental staff is employed within the various organisations (i.e. Employer, Project Manager, Contractor and the Environmental Control Officer) that are able to identify and respond to environmental challenges arising out of the construction activities, and who can collaborate and further refine the Maintenance/construction Environmental Management Programme and develop work procedures where required in the spirit of environmental best practice.

The Environmental Control Officer, in consultation with the Employer, Project Manager, and Contractor, shall identify where substantive Maintenance/construction Environmental Management Programme amendments and additions are required, through routine auditing. Such amendments and additions shall be submitted in writing to the MDEDET for approval.

Where amendments and additions are not deemed substantive by the Environmental Control Officer, such amendments will be issued to the Contractor in the form of a Site instruction.

6.2 LEGAL REQUIREMENTS

All construction activities shall be executed in accordance with all statutory requirements in terms the prevailing environmental legislation and in so doing shall be undertaken in a manner that will minimise the impacts on the surrounding environment, the public and adjoining landowners.

The Contractor shall implement all necessary environmental protection measures in each area or associated with specific activities before any construction work may proceed. The Environmental Control Officer, Employer and / or Project Manager may suspend the Works at any time in terms the Conditions of Contract should the Contractor, in the Environmental Control Officer, Employer or Project Manager's opinion, fail to implement, operate or maintain any environmental protection measures adequately. All costs and damages arising from such work stoppage associated with non-compliance and any remedial actions shall be for the Contractor's account.

Apart from the requirements of the EMP, the Employer and its Contractors will be required to comply with the full suite of South African Legislation concerning the natural environment, pollution and the built environment. This legislation includes but is not limited to:

- Conservation of Agricultural Resources Act (No 43 of 1983) and the regulations dealing with declared weeds and invader plants as amended from time to time;
- Environment Conservation Act (No 73 of 1989), including the noise regulations and litter controls promulgated thereunder;
- Hazardous Substances Act (No 15 of 1973);
- Health Act (No 63 of 1977);
- Minerals and Petroleum Resources Development Act (No 28 of 2002);
- National Building Regulations and Building Standards Act (No 103 of 1977);
- ~ National Environmental Management Act (No 107 of 1998);
- National Environmental Management: Air Quality Act (No 57 of 2003);
- ~ National Environmental Management: Biodiversity Act (No 10 of 2004);
- National Environmental Management: Protected Areas Act (No 10 of 2004);
- National Forest Act (No 84 of 1998);
- National Heritage Resources Act (No 25 of 1999);
- National Veld and Forest Fire Act (No 101 of 1998);
- National Water Act (No 36 of 1998);
- Occupational Health and Safety Act (No 85 of 1993), including the Major Hazard Installation Regulations and Construction Regulations promulgated thereunder; and
- ~ Fertilizer, Farm feeds, Agricultural Remedies and Stock Remedies Act (No 36 of 1947).

6.3 THE AUTHORITIES

As the competent environmental authority, MDEDET has the responsibility to ensure that the proponent, *viz.* Employer, complies with the conditions of authorisation as well as the requirements in terms of the broader environmental legislation, specifically the National Environmental Management Act. Compliance would be confirmed via the following mechanisms:

- Receipt and review of the monthly environmental compliance reporting compiled by the ECO; and
- Ad hoc and planned site inspections by the Compliance and Enforcement section of MDEDET.

6.4 THE EMPLOYER

As the Proponent, the Employer must ensure that the implementation of the project complies with the requirements of NEMA, as well as any obligations emanating from other relevant environmental legislation. Although part of this obligation is being met by the development of the Maintenance/construction Environmental Management Programme, and its integration into the tender documentation, as well as the appointment of the Environmental Control Officer, the Employer cannot delegate or defer these obligations. Accordingly, the Employer must retain an oversight role and retain some key roles and responsibilities as it relates to environmental management during the maintenance/construction of the West Street Bridge. These are outlined below.

The Employer, as an organisation must ensure that adequate funding is made available for the implementation and monitoring of the environmental controls.

The responsibilities of the Employer include the following:

- Identify and appoint a suitably qualified independent environmental control officer (ECO) and issue a clear terms of reference;
- Be fully conversant with the EMP for the project, the conditions therein and all relevant environmental legislation;
- Ensure that all the Maintenance/construction Environmental Management Programme, legal constraints and Employer standards and procedures pertaining to the project, specifically with regards to environmental management, are highlighted to the Project Manager and Contractor(s) so that they are aware of these;
- Ensure that the Maintenance/construction Environmental Management Programme is correctly implemented throughout the project by means of site inspections and monthly site meetings;
- The Employer, in consultation with the Department of Environmental Affairs, shall provide the Environmental Monitoring Committee with a clear Terms of Reference once the Environmental Monitoring Committee has been constituted, the draft Terms of Reference would be distributed to the Environmental Monitoring Committee members for review and ratification;
- Make financial provisions for the inclusion of an Environmental Monitor as part of the Project Manager's Contract, inclusive of all staff and equipment resources needed to execute their functions; and
- Issue ad hoc instructions, corrective action requests, or initiate punitive proceedings where non-compliances are not adequately addressed.

THE ENVIRONMENTAL CONTROL OFFICER

The Employer must appoint a suitably qualified and independent Environmental Control Officer to monitor compliance with the requirements of the Maintenance/construction Environmental Management Programme and the environmental legislation on a monthly basis on behalf of the Employer. To fulfil these requirements, the Environmental Control Officer would need to have relevant on site experience and would need to be based relatively close to the site for the duration of the construction/maintenance phase. The Environmental Control Officer could be an Employer employee, as long as they had the requisite environmental training and experience.

The Environmental Control Officer will be responsible for monitoring, reviewing, and verifying compliance by the Contractor with the Maintenance/construction Environmental Management Programme. Accordingly, the Environmental Control Officer would be required to:

- Be fully knowledgeable of the contents of the Maintenance/construction Environmental Management Programme, specifically as articulated in the Maintenance/construction Environmental Management Programme attached to each Contract;
- Be fully knowledgeable of the contents of all relevant environmental legislation and Employer environmental policies and procedures, and ensure compliance with these;
- Ensure that compliance with the Maintenance/construction Environmental Management Programme are monitored and verified through regular and comprehensive inspections of the site and surrounding areas, and that the results of these inspections are captured in writing;
- Ensure that if the Maintenance/construction Environmental Management Programme is not followed, appropriate measures are undertaken to address this; and
- Report to the Employer and MDEDET every month regarding compliance with the requirements of the Maintenance/construction Environmental Management Programme, and environmental legislation.

In meeting the aforementioned obligations, the Environmental Control Officer's specific duties would include the following:

- Assisting the Project Manager in ensuring necessary environmental authorisations and permits have been obtained;
- ~ Confirming that activities on Site comply with legislation;
- Monitoring and verifying that the conditions of the Maintenance/construction Environmental Management Programme are adhered to at all times and requiring the Contractor to take action if these are not followed;
- Monitoring and verifying that environmental impacts are kept to a minimum;
- Giving a report back on the environmental issues at the monthly site meetings and other meetings that may be called regarding environmental matters;
- Inspecting the Site and surrounding areas regularly with regard to compliance with the Maintenance/construction Environmental Management Programme;
- Ensuring that a register of complaints is kept by the Contractor and that all complaints are appropriately recorded and addressed;
- Ensuring that the requisite environmental induction occurs for all new personnel coming onto site;
- Recommending the issuing of penalties for contraventions of the Maintenance/construction Environmental Management Programme;
- Advising on the removal of person(s) and/or equipment, not complying with the Maintenance/construction Environmental Management Programme, from site;
- Completing the requisite environmental reporting including a monthly environmental compliance report and incident reports for submission to the Employer and MDEDET;
- Keeping a photographic record of progress on Site from an environmental perspective;
 and
- Attending the site meetings to report on construction/maintenance phase monitoring program compliance.

6.6 THE PROJECT MANAGER

The Project Manager (often referred to as the Engineer or Consultant) is responsible for the following:

- Issuing all instructions to the Contractor;
- Providing adequate resources for the implementation of the EMP (could include financial and human resources)
- Administering all contractual issues, including any penalties or punitive measures initiated as result of non-compliances; and
- ~ Ensure that issues pertaining to environmental management are handled and resolved.

6.7 THE CONTRACTOR

By virtue of the environmental obligations delegated to the Contractor through the Contract Document, all staff (including subcontractors and staff), suppliers, and service providers appointed for the project would be responsible for:

- Ensuring adherence by providing adequate staff and provisions to meet the requirements of the Maintenance/construction Phase Environmental Management Programme;
- Ensuring that any instructions issued by the Project Manager, on the advice of the Proponent or Environmental Control Officer, are adhered to;
- Ensuring the representation of a report at each site meeting, documenting all incidents that have occurred during the period before the site meeting;
- Ensuring that a register of all the transgressions issued by the Environmental Control Officer is kept in the site office;
- ~ Ensuring that a register of all public complaints is maintained; and
- Ensure that all employees, including those of sub-contractors receive training before the commencement of construction in order that they can constructively contribute towards the successful implementation of the environmental requirements of the Contract.

⁷ ENVIRONMENTAL MONITORING PROGRAMME

The environmental monitoring programme is to be administered by the Environmental Control Officer

The Environmental Control Officer shall undertake inspections of all construction and Contractors' areas on a monthly basis, assessing environmental aspects as presented in this Maintenance/Construction Environmental Management Programme.

Should there be any incident on site affecting the environment, irrespective of whether it is the result of non-compliance or not, the following lines of communication should be implemented:

- All incidents must to be reported to the relevant authority, MalaMala Management and the contractor immediately;
- All issues of non-compliance must be reflected in the environmental reporting, and an incident report must be completed for all environmental incidents (i.e. any environmental degradation resulting from the construction activities, irrespective of whether it is the result of non-compliance or not); and
- Environmental Incident reports must address the following aspects:
 - Description of the incident,
 - Remedial action required, including the deadline for such action,
 - Relevant/ supporting documentation, i.e. providing evidence of the incident and the cause of the incident,
 - Relevant diagrams to support the description of the incident and/ or the remedial action to be taken.

Element/Issue	Access
Operational Policy or Management Objective	To utilise, as far as possible, existing cleared areas and access tracks/roads so as to: • Minimise impacts to flora and fauna, both land and aquatic. • Minimise impacts to soil and water quality. • Reduce the likelihood of the spread of weeds and pests. • Minimise the number of access tracks/roads and diversions. • Minimise disruption to third parties, especially neighbours (game drive vehicles and their exclusivity is of importance). • Manage road and track usage, and achieve satisfactory road and site rehabilitation. • Minimise damage to existing road networks.
Performance Criteria	 Access tracks/roads and work areas/sites are readily manageable and able to be rehabilitated using standard techniques. No unacceptable environmental impacts. Compliance with relevant environmental authority conditions.
Implementation Strategy	 Site access as well as the location of laydown and storage areas and additional work areas will be based on the following criteria: Avoiding unduly steep or rugged terrain. Minimising impacts on sensitive vegetation, erosion prone soils and watercourse crossings. May not be within 32 meters of a stream or water body. Avoiding significant riparian and natural vegetation. Existing roads and tracks will be used where practicable. Only designated access tracks will be used by construction vehicles, including personnel vehicles. Public and private access tracks will be reinstated to the pre-construction condition,. Damage to public and access roads, caused by any activities related to this project must be repaired any inconvenience is caused o other raod users (guests, landowners and reserve staff) is incurred. Repair work must be carried out when practically feasible and convenient. Workforce education, signage and boundary demarcation will be used to ensure vehicles remain on designated access tracks, within the construction area.
Monitoring and Auditing	Construction areas and associated work areas will be regularly inspected to assess the effectiveness of protection measures with particular attention to erosion and siltation control, topsoil management and waste management.



Reporting and Corrective Action

Reporting of environmental performance data will be conducted in accordance with Section 6.2 and 6.5.

Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required.

The following represent an incident or failure to comply:

- Management controls not implemented.
- Off-site environmental impacts occur.

Should an incident or failure to comply occur, a selection of the following actions will be taken:

- An investigation will be undertaken into why directives are not being carried out.
- Employees will be re-educated on desired practices.
- Work policies and procedures will be reviewed and modified to improve the situation.



7.2 CLEARING AND GRADING

Element/Issue	Clearing and Grading
Operational Policy or Management Objective	To manage the impact of site clearing and disturbance such that: Impacts on both terrestrial and aquatic vegetation, fauna and ecological communities are minimised. Cleared material is stored appropriately and able to be effectively used during restoration activities. The rehabilitation success of the disturbed areas is optimised.
Performance criteria	 No unplanned or unapproved damage to terrestrial and aquatic flora and fauna. Environmental impacts are within authorised limits. Installation and maintenance of erosion control measures. No accelerated erosion to river banks and downstream areas. Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction/maintenance. Prompt reinstatement of disturbed areas.
Implementation Strategy	 No clearing of protected vegetation will occur until appropriate permits have been obtained. All clearing boundaries will be illustrated on construction drawings and clearly marked in the field. Clearing will be limited to the minimum area practicable. The following are examples
Operational Policy or Management Objective	To manage the impact of site clearing and disturbance such that: Impacts on both terrestrial and aquatic vegetation and ecological communities are minimised. Cleared material is stored appropriately and able to be effectively used during restoration activities. The rehabilitation success of the disturbed areas is optimised.



Performance criteria	 No unplanned or unapproved damage to terrestrial and aquatic flora and fauna. Environmental impacts are within authorised limits. Installation and maintenance of erosion control measures. No accelerated erosion to river banks and downstream areas. Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction. Prompt reinstatement of disturbed areas.
Implementation Strategy	 No clearing of protected vegetation will occur until appropriate permits have been obtained. No unnecessary clearing of vegetation may occur, i.e. The current development footprint may not be exceeded. Mechanical clearing to be implemented (rather than chemical). All clearing boundaries will be illustrated on construction drawings and clearly marked in the field. Clearing will be limited to the minimum area practicable. The following are examples of how this can be achieved: Having defined limits on the clearing plan; Delineation of disturbance areas and "no go" areas; and Implementing access control.



- Clearing in riparian vegetation will be kept to a minimum required to safely gain access to those sections of the bridge that need to be maintained and access road to meet other environmental requirements (e.g. erosion control, spoil storage).
- It is understood that foundations are to be used as is. However, where sections of the bridge to be maintained occur within flowing wet watercourses, containment dams will be constructed to isolate work areas.
- Blade clearing of trees will occur to retain the root mass.
- Cleared vegetation will be removed as merchantable logs, stockpiled onsite or chipped and stored for use as mulch during site landscaping
 and rehabilitation works and/or in surrounding vegetated areas susceptible to erosion to the greatest extent practicable. Some hollow logs
 will be stockpiled for use during rehabilitation.
- Where practicable, vegetation and soil stockpiles will be located outside watercourses behind the flood line, and away from undisturbed trees or fence lines.
- Vegetation and soil stockpiles will be protected against soil loss through wind or water erosion.
- Water trucks will be used (particularly in hot and windy conditions) on access roads and on the site to reduce dust generation.
- Vehicle speeds will be restricted on unsealed areas.

Soil and Erosion Management

- Install, maintain and monitor erosion and sediment control devices (e.g. berms, silt fences, jute matting) so that ground is stable and vegetation cover is maintained.
- Ensure that runoff control devices (e.g. berms) are maintained to prevent erosion.
- Carry out excavation works in accordance with the provisions of the construction/maintenance EMP.
- Install sediment fencing around active erosion adjacent to watercourses as needed to keep areas stable.
- Remove and stockpile topsoil where excavation or subsidence remediation is to occur.
- Replace topsoil as soon as practicable after works have finished.
- Sediment control devices will be used to preserve stockpiled soils to prevent siltation of any land surface water or blockage of any existing drainage channels.
- Where erosion management structures are impacted they will be reinstated as quickly as practicable or alternative structures erected to retain an adequate level of erosion control.

Monitoring and Auditing

Monitoring and auditing will be conducted in accordance with Section 6.2 and 6.5.

The construction/maintenance site will be regularly inspected to assess the effectiveness of protection measures with particular attention to areas such as clearing demarcation, topsoil and vegetation storage and erosion, siltation and sediment control measures.



Reporting of environmental performance data will be conducted in accordance with Section 6.2 and 6.5.

Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required.

The following represent an incident or failure to comply:

- Vegetation clearing permits not obtained.
- · Management controls not implemented.
- Off-site environmental impacts occur.

Should an incident or failure to comply occur, a selection of the following actions will be taken:

- The relevant authority shall be advised if a breach of legislation has occurred.
- Clearing permits will be sought.
- An investigation will be undertaken into why directives are not being carried out.
- Employees will be re-educated on desired practices.
- Work policies and procedures will be reviewed and modified to improve the situation. Any third party complaints will be recorded in the complaints register and appropriate corrective actions will be implemented and closed out by the ECO.



7.3 EARTHWORKS

Element/Issue	Earthworks
Operational Policy or Management Objective	To manage the impacts of earthworks activities such that:
Performance criteria	 Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction. Access for authorised third parties maintained. Installation and maintenance of erosion and siltation control and soil containment devices.



Implementation Strategy

- Excavated spoil (sub soils) will be stockpiled separately to topsoil and vegetation.
- Excavated material will be stockpiled outside watercourses, and/or behind containment structures so as to prevent siltation of any land or surface water or blockage of any existing drainage channels.
- Regular gaps and spaces in the topsoil, subsoil and vegetation stockpile will be provided for fauna movement.
- The distances between gaps in stockpiles will be reduced at approaches to stream crossing.
- Any excavations will be left open for the minimum time practicable.
- Ramps will be installed in the terrestrial excavations to allow the easy egress of fauna.
- River sand used for maintenance purposes may only be sourced by means of "Bar Skimming"
 - o Sand/gravel should be removed only during low flows and from above the low-flow water level
 - o The final grading of the gravel bar should not significantly alter the flow characteristics of the river during periods of high flow.
 - Bar skimming operations need to be monitored to ensure that they are not adversely affecting gravel recruitment downstream or stream morphology either upstream or downstream of the site.
 - o If the stream or river has recent history of rapidly eroding bars or streambed lowering, bar skimming should not be allowed.
- Sand used for construction and maintenance may only be removed from the river where there is an excess of surface sedimentation deposit.
- These excess sand deposits should only be removed where access in and out of the river is suitable (river banks should facilitate easy
 egress/ingress).
- A maximum of 150 cubic meters of sand may be removed and utilised for reparation purposes.
- Pooled water in excavations will be monitored and managed to reduce the potential for wall instability, biting insect breeding areas and contamination.
- Quantities should be strictly limited so that gravel recruitment and accumulation rates are sufficient to avoid extended impacts on channel morphology and instream habitat.

³ Bar skimming or scalping requires scraping off the top layer from a gravel bar without excavating below the summer water level. Preliminary Guidence Document on the Impacts of Sand Mining on In stream and Riparian Habitat. L.Hill & C.j. Kleynhans IWQS March 1999.



	In areas of high fauna density, additional ramps, branches, hessian sacks or similar devices to enable small fauna to exit the trench may be used. Temporary sediment, siltation and erosion control devices will be reinstated when no longer required. Excavations will be constructed to an approved standard to minimise the potential for wall collapse or subsidence. Catchment areas to excavations will be managed to minimise the pooling of water.
Monitoring and Auditing	Construction sites will be regularly inspected to assess the effectiveness of protection measures, with particular attention to areas such as soils segregation, and erosion and siltation control devices.
Reporting and Corrective Action	Reporting of environmental performance data will be conducted in accordance with Section 6.2 and 6.5. Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required The following represent an incident or failure to comply: Management controls not implemented. Third party infrastructure is damaged. Off-site environmental impacts occur from earthworks operations. Should an incident or failure to comply occur, a selection of the following actions will be taken: An investigation will be undertaken into why directives are not being carried out. Employees will be re-educated on desired practices. Work policies and procedures will be reviewed and modified to improve the situation.



Element/Issue	Terrestrial Flora and Fauna Management
Operational Policy or Management Objective	To minimise and manage impacts to the ecological values of the construction/maintenance site and to rehabilitate disturbed areas to as close as practical to the pre-construction condition.
Performance Criteria	 Minimal disturbance of flora and fauna during construction activities. No unplanned or unapproved disturbance to flora and fauna. Restoration of available disturbed areas to equivalent to surrounding area after construction. Relevant permit is in place before removing any protected species.
Implementation Strategy	All works will be conducted in accordance with the National Environmental Management: Protected Areas Act (No 10 of 2004); National Forest Act (No 84 of 1998) and National Water Act (No 36 of 1998); including obtaining the necessary permits to remove, destroy or damage any fauna or flora. Strategies outlined below will be implemented to minimise potential impacts on flora and fauna: Planning A pre-construction/maintenance vegetation survey will be completed by qualified ecologist in targeted areas of the site to identify for flagging individual significant species and trees that must be avoided during construction. Appropriate permits for the clearing of vegetation, including any aquatic vegetation, will be obtained prior to the commencement of construction if relevant. The location of vegetation to be retained will be clearly indicated on all construction drawings. Flagging of clearing boundaries will be completed prior to any clearing activity. Construction Disturbance will generally be restricted to designated work areas. Physical barriers will be installed around significant vegetation areas in order to restrict unauthorised access and avoid disturbance. Removal of vegetation is only acceptable if access to infrastructure is impeded. Maintenance work must endeavour to not remove vegetation which is obstructive but does not prevent or inhibit access to the existing infrastructure. When clearing and excavations left open. Clearing and disturbance in riverine and wetland/water body areas will be minimised so as to meet environmental requirements.



7.4

Bush and habitat surrounding construction areas will be managed to prohibit any unauthorised disturbance so as to maintain the area's habitat values as much as possible. Where practicable, dead trees, stumps and hollow branches will be salvaged from the terrestrial areas to be cleared and relocated to the surrounding undisturbed areas to create compensatory shelter. Where practicable, the timing of clearing operations will be selected to minimise impacts on breeding species and watercourse functionality. Hollow bearing trees will be felled in a manner which reduces potential for fauna mortality. Felled trees will be inspected after felling and fauna (if identified and readily accessible) will be removed and relocated or rendered assistance if injured. After felling, hollow bearing trees will remain unmoved over-night to allow animals to move of their own accord. A landscape plan which covers all areas disturbed during construction but not covered by built structures will be prepared and implemented Rehabilitate any disturbance to riverbanks to pre-pipeline/bridge conditions. Monitoring and auditing will be conducted in accordance with Section 6.2 and 6.5. Monitoring and Auditing Ongoing monitoring will be undertaken to assess the success and integrity of construction/maintenance and ensure appropriate follow-up rehabilitation measures are implemented. Routine inspections of undisturbed areas by the ECO to identify any evidence of habitat disturbance or feral pest presence. The ECO will monitor site clearing to ensure that: Areas to be cleared are clearly defined. There is no unauthorised disturbance of the surrounding habitat area. Compensatory shelter is established where necessary. Where necessary, an animal and plant retrieval program is implemented. Reporting and Reporting of environmental performance data will be conducted in accordance with Section Corrective Action 6.2 and 6.5. Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, noncompliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required



The following represent an incident or failure to comply: The pre-construction vegetation survey not undertaken. Vegetation clearing permits not obtained if needed. Management controls not implemented. Unapproved disturbance or impact to flora or fauna.
 Should an incident or failure to comply occur, a selection of the following actions will be taken: The relevant authority shall be advised if a breach of legislation has occurred. Surveys will be undertaken or permits sought. An investigation will be undertaken into why directives are not being carried out. Employees will be re-educated on desired practices. Work policies and procedures will be reviewed and modified to improve the situation.

AQUATIC FLORA AND FAUNA MANAGEMENT

Element/Issue	Aquatic Flora and Fauna Management
Operational Policy or Management Objective	To limit impacts to the aquatic flora and fauna as a result of the West Street Bridge maintenance activities to those areas directly affected.
Performance criteria	 No unplanned or unapproved damage to aquatic flora and fauna. Restoration of disturbed areas to equivalent of surrounding area after construction.
Implementation Strategy	Strategies outlined below will be implemented to meet the proposed performance criteria for aquatic flora and fauna: • Vehicles used and related to works carried out for the maintenance of the West Street Bridge will abide by the Sabi Sands Wildtuin speed restrictions and reserve rules. • Maintain a lookout for fauna both aquatic and land based that may be affected by maintenance activities. • Provide training for staff regarding the sensitivity of the surrounding wetland, riverine and bush ecosystems.



7.5

Monitoring and Auditing	Monitoring and auditing will be conducted in accordance with Section 6.2 and 6.5. Inspections of the site for compliance will occur on a monthly basis. Audits will be conducted throughout the project to monitor against this EMP and other licence conditions.
Reporting and Corrective Action	Reporting of environmental performance data will be conducted in accordance with Section 6.2 and 6.5. Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, noncompliance events and third party complaints) will be managed through the IMS and reported to the appropriate authority as required. • Reporting will occur on an incident, weekly and monthly basis to the appropriate ECO • Non-compliances, environmental incidents and their corrective actions will be managed through the Environmental Issues Register. • Any third party complaints will be recorded in the complaints register and appropriate corrective actions will be implemented and closed out by the ECO.



Element/Issue	Water Management
Operational Policy or Management Objective	 To minimise the potential impacts associated with erosion and to prevent the release of contaminants that may adversely affect downstream surface water quality. To protect the existing water quality values of the Sabi Sand Wildtuin.
Performance Criteria	 No direct or indirect release of contaminants resulting from construction operations to surface waters. Minimal accelerated erosion as a result of construction activities.
Implementation Strategy	The following strategies will be implemented to minimise potential impacts on receiving surface waters: • To minimise potential impacts on receiving surface waters, preparation and implementation of a site-specific construction erosion and sediment control plan in accordance with engineering best practice guidelines. These may include the following: • Stabilising cleared areas not used for construction activities with vegetation or appropriate surface treatments as soon as practicable following earthworks, to minimise erosion. • Provision of appropriate bunded storage areas for fuels and dangerous goods in accordance with SABS standards. • Ensuring that relevant construction personnel are trained in appropriate handling of fuels and dangerous goods and spill prevention. • Refuelling will occur only within bunded areas or off site. • All transfers of fuels and chemicals will be controlled and managed to prevent spillage outside bunded areas. • Restricting vegetation clearance to the smallest area necessary. • Stripping and stockpiling of topsoil from disturbed areas. Diversion channels will be constructed around the topsoil stockpiles to prevent erosion and loss of topsoil. The topsoil will be respread prior to revegetation of areas to be rehabilitated at completion of construction. • Topsoil stockpiles will be located in areas outside drainage lines and will be protected from erosion. Prior to the re-spreading of topsoil, the ground surface will be ripped to assist with binding of the soil layers, water penetration, and revegetation.
Monitoring and Auditing	Monitoring requirements for erosion and sediment control will include routine visual inspections, including following all significant storm events, by the ECO. Inspections will include the integrity of diversion bunds, drains and storage facilities as well as housekeeping to ensure stormwater runoff does not contain rubbish or contaminants.



The ECO will report regularly to the MDEDET and the client on the following:

- Contractor's compliance with approved erosion and sediment control plan.
- Incidents of erosion or surface water contamination.
- Results of routine inspections.

The following is to be classified as an incident or failure to comply in relation to surface water management:

- Erosion and sediment control plan not prepared and/or implemented.
- Drainage from construction areas not contained and managed according to the erosion and sediment control plan.
- · Breach in integrity of bunds.
- Any temporary sediment basins demonstrating significant reduced available volume.
- Insufficient housekeeping to prevent general rubbish and contaminants entering the stormwater runoff from the site.

In the event of an incident or failure to comply, investigations will be undertaken into the cause of the incident or failure to comply and the appropriate corrective actions taken to overcome the problem and prevent recurrence.

Should an incident or failure to comply occur in relation to stormwater management, a selection of the following corrective actions will be considered where relevant:

- The cause of any non-compliance with environmental authority limits will be investigated and the problem rectified.
- Any breaches in bund integrity will be repaired.
- Construction activities will be modified as necessary to ensure that the drainage and ponding system of each catchment performs as designed.
- Prepare and/or implement erosion and sediment control plan.
- Repair stormwater controls.
- Contain and remediate or dispose of contaminated material/contaminants.
- Treat or dispose of contaminated stormwater.
- Improve level of housekeeping.
- Any breaches of approval will be reported to the relevant authority within 72 hours.



Element/Issue	Land Contamination
Operational Policy or Management Objective	To manage potential soil contamination during the construction/maintenance of the bridge and access road.
Performance Criteria	No contamination of soil.
Implementation Strategy	Sources Prevention of land contamination will be a high priority. Land resources can be affected by contamination which may potentially arise from any of the following: • Spillage or leakage of fuels or hazardous materials. • Disposal of waste from construction activities. Prevention Strategies for the prevention of potential land contamination adopted by the construction contractor will include: • Avoid the disturbance of any known areas of contamination. If avoidance is not possible, the contaminated material will be excavated and with remediated or disposed of at an approved facility. • Construction of appropriate spill containment facilities for all fuel storage areas. • Establishing and maintaining hazardous materials register detailing the location and quantities of hazardous substances including the storage, use and disposal. • Induction and training of personnel and implementation of safe work practices for minimising the risk of spillage. Containment • If an area of contamination is reported, the cause will be identified and the area of contamination contained. The impact may be contained by isolating the source or implementing controls around the affected site. Remediation • Remediation of contaminated land will use the most appropriate available method to achieve required commercial/industrial guideline validation results. • Validation sampling of any remediated area will be used to establish the site as "clean".



Monitoring and Auditing	Monitoring and auditing will be conducted in accordance with Section 6.
	The integrity of storage facilities for hazardous materials and wastes and bunded areas will be routinely inspected.
Reporting and Corrective Action	Reporting of environmental performance data will be conducted in accordance with Section 6.
	The following will be classified as an incident or failure to comply in relation to soil contamination management: • Breach in integrity of chemicals storage areas.
	Should an incident or failure to comply occur in relation to soil contamination management, a selection of the following corrective actions will be considered where relevant:
	Rectify storage/handling non-compliance.
	Contain and remediate or dispose of contaminated material/contaminants.
	Investigate and implement measures to prevent recurrence.

7.8 WASTE MANAGEMENT

Element/Issue	Waste Management
Operational Policy or Management Objective	To manage wastes from construction in such a way that any potential impacts on the environment are minimised or avoided by incorporating the waste management hierarchy.
Performance Criteria	Prevent adverse environmental impacts from wastes during the construction. Adhere to waste minimisation principles by: Minimising waste generation. Maximising water and materials reuse and recycling. Safely treating and disposing of all non-reusable and non-recyclable materials.



Implementation Strategy

General

- Waste management plan for specific waste streams will be developed by the construction contractor prior to construction commencing.
- General waste will be collected and transported generally to local council approved disposal sites.
- Food wastes will be collected, where practicable, considering health and hygiene issues, for disposal off-site.
- Refuse containers will be located at each worksite.
- Where practical, wastes will be segregated and reused / recycled (e.g. scrap metal).
- All personnel will be instructed in project waste management practices and procedures as a component of the environmental induction process.
- Suppliers will be requested to minimise packaging where practicable.
- A high emphasis will be placed on housekeeping and all work areas will be maintained in a neat and orderly manner.
- All equipment and facilities will be maintained in a clean and safe condition.

Hazardous Waste

- Chemical wastes will be collected in 200 litre drums (or similar sealed container), appropriately labelled, for safe transport to an approved chemical waste depot or collection by a liquid waste treatment service.
- Storage, transport and handling of all chemicals will be conducted in accordance with all legislative requirements.



	 Containment bunds and/or sumps will be drained periodically to prevent overflow and subsequent pollution of the surrounding land and/or water body.
	 All hazardous wastes will be appropriately stored in bunded areas away from watercourses and in accordance with legislative requirements.
	 Hazardous wastes, such as solvents, rust proofing agents and primer will be managed in accordance with the requirements of relevant legislation and industry standards.
	A hazardous materials inventory for the construction period will be prepared.
	Material Safety Data Sheets (MSDS) for hazardous materials will be available on-site during construction.
	 Hydrocarbon wastes, including lube oils, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations.
	 All regulated waste will be removed from site by a person who holds a current authority to transport such waste and sent to a facility licensed to accept such waste.
	 If a hazardous contaminant is released to waters or land the following steps will be taken:
	 Take immediate action to stop any further release;
	 Take immediate action to contain the hazardous contaminant to the affected area, taking particular care to protect environmentally sensitive areas;
	 Restore or rehabilitate the environment to its condition before the release occurred; and
	 Take necessary action to prevent a recurrence of the release.
Monitoring and Auditing	Monitoring and auditing will be conducted in accordance with Section 6. Housekeeping checks to ensure waste is being stored correctly and that no littering is occurring.
	Construction areas will be inspected after completion to ensure that no waste material remains.



Reporting and	Reporting of environmental performance data will be conducted in accordance with Section 6.
Corrective Action	Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required
	The following represent an incident or failure to comply:
	Waste management plan not implemented.
	Management controls not implemented.
	Off-site environmental impacts occur from waste management activities.
	Should an incident or failure to comply occur, a selection of the following actions will be taken:
	Waste management plan will be prepared.
	An investigation will be undertaken into why management controls are not being carried out.
	Employees will be re-educated on desired practices.
	Work policies and procedures will be reviewed and modified to improve the situation.

7.9 CHEMICAL AND DANGEROUS GOODS MANAGEMENT

Element/Issue	Chemical and Dangerous Goods Management
Operational Policy or Management Objective	To ensure that storage and handling of chemicals and dangerous goods on-site does not cause environmental harm or harm to persons.
Performance criteria	 No hazardous goods contamination of the environment. Compliance with OHS Act



Implementation Strategy	 Spill control procedures will be prepared and personnel trained. Dangerous goods will be stored and handled as per the requirements of relevant OHS Standards. Dangerous goods will be stored in bunded areas away from watercourses. Provision of appropriate bunded storage areas for fuels and dangerous goods in accordance with relevant standards. Ensuring that relevant construction personnel are trained in appropriate handling of fuels and dangerous goods and spill prevention. Refuelling will occur only within bunded areas. MSDSs for chemicals and dangerous goods will be available on-site. Waste dangerous goods, which cannot be recycled, will be transported to a designated disposal site as approved by local council. Spills of dangerous goods will be rendered harmless and collected for treatment and disposal at a designated site, including cleaning materials, absorbents and contaminated soils. Absorbent and containment material (e.g. absorbent matting) will be available where hazardous materials are used and stored and personnel trained in the correct use. Protective clothing, appropriate to the materials in use, will be provided. Relevant permits will be held and conditions of permits met.
Monitoring and Auditing	Regular inspections to ensure that chemical storage facilities continue to meet South African Standards. Audits will include inspection of dangerous goods storage areas.



Reporting of environmental performance data will be conducted in accordance with Section6.

Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required.

The following represent an incident or failure to comply:

- Chemicals or dangerous goods not managed in accordance with South African Standards.
- Spill of chemical or dangerous goods occurs.
- Off-site environmental impacts occur from management of chemicals or dangerous goods.

Should an incident or failure to comply occur, a selection of the following actions will be taken:

- An investigation will be undertaken into why management controls are not being carried out.
- Employees will be re-educated on desired practices.
- Work policies and procedures will be reviewed and modified to improve the situation.



7.10 NOISE AND VIBRATION

Element/Issue	Noise and Vibration
Operational Policy or Management Objective	To prevent excessive noise emissions from construction.
Performance Criteria	All activities will be conducted in accordance with this EMP.
Implementation Strategy	 Construction work during evening and night-time periods (6.30 pm to 6.30 am) and on Sundays/Public Holidays will be undertaken in accordance with "best practice" noise management. Construction work may not take place during game drive times. Use of the quietest plant and equipment that can practically and reasonably undertake the work wherever possible. Maintain equipment in order to keep it in good working order. Adjacent landholders will be notified prior to any atypical noise events outside of daylight hours. Operators of construction equipment will be made aware of the potential noise problems and of techniques to minimise noise emission through a continuous process of operator education. Best available work practices will be employed on-site to minimise occupational noise levels. High efficiency mufflers will be fitted to appropriate construction equipment. Reversing alarms within construction areas cannot be avoided for safety reasons. Large rocks and concrete blocks will be placed in dump trucks not dropped. To prevent a startle response from fauna at the start of impact piling (if required), observations will be made of an area (350 m radius initially and 150 m after first day) around the pile before commencement of impact piling on any day or after an extended time when piling has stopped. If large fauna is observed within the area then commencement of impact piling will be delayed until they clear the area. Alternatively, a soft start to piling will be considered.
Monitoring and Auditing	Construction equipment will be inspected regularly to maintain optimal working conditions. Throughout construction, the ECO will undertake regular environmental audits.



Reporting of environmental performance data will be conducted in accordance with Section 6.

Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required

Non-compliance and incident reports will be closed out by ECO

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The following represents an incident or failure to comply in regard to noise management:

- Noise complaint received.
- Noise management strategies not implemented.

Should a complaint be received, one or more of the following steps will be taken:

- Activities will be investigated to determine the cause of the problem.
- Current procedures and control measures will be reviewed to prevent recurrences and, where necessary, additional control and mitigation measures will be investigated and adopted.



7.11 TRANSPORT AND TRAFFIC MANAGEMENT

Element/Issue	Traffic Management
Operational Policy or Management Objective	To minimise any potential impacts associated with traffic generated by the project's construction traffic.
Performance Criteria	Traffic-related complaints and incidents investigated within 2 days of receipt.
Implementation Strategy	 The following strategies will be implemented to minimise potential impacts from construction related traffic: All heavy vehicles travelling to and from the site will follow dedicated heavy vehicle routes to avoid roads that are not suited to these vehicles. Heavy vehicles will not be permitted to travel along these roads after more than 20 mm of rain and until the roads have dried satisfactorily. Where practicable, truck deliveries will be restricted to daytime working hours and the gate times of the Sabi Sans Wildtuin. If possible, the transport of oversize loads will be restricted to non-peak periods to minimise traffic disruptions and will be provided with appropriate escorts and approvals from both the Main Roads Department and the Police. Clear traffic signs and signals will be installed on-site to provide for safe traffic movement. An on-site speed limit will be enforced.
Monitoring and Auditing	Any incidents or complaints received in relation to project traffic will be managed through the auditing process and reported to the appropriate authority as required.
Reporting and Corrective Action	Reporting of environmental performance data will be conducted in accordance with Section 6. Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required Non-compliance and incident reports will be closed out by senior management. Any third party complaints will be recorded in the complaints register and appropriate corrective actions will be implemented and closed out by the Environmental Control Officer.



7.12 CULTURAL HERITAGE

Element/Issue	Cultural Heritage
Operational Policy or Management Objective	To protect the cultural heritage values of the site.
Performance Criteria	Compliance with the requirements of the National Heritage Resources Act (No 25 of 1999)
Implementation Strategy	Include cultural heritage issues in the project induction program for staff and contractors.
Monitoring and Auditing	Auditing of compliance with the EMP.
Reporting and Corrective Action	Any signs of disturbance of artefacts will be reported to the ECO and SAHRA. Any of the following will constitute an incident or failure to comply: • Unauthorised disturbance of any artefacts. In the event of an incident or failure to comply, the commitment that has not been undertaken will be reviewed and modifications implemented as appropriate.



7.13 EMERGENCY RESPONSE

Element/Issue	Emergency Response
Operational Policy or Management Objective	To ensure that project personnel can respond effectively and efficiently in the event of an emergency associated with construction.
Performance Criteria	 Emergency response plans are developed and in place. Compliance with the relevant requirements of: Hazardous Substances Act (No 15 of 1973); Health Act (No 63 of 1977); Occupational Health and Safety Act (No 85 of 1993), including the Major Hazard Installation Regulations and Construction Regulations promulgated thereunder.
Implementation Strategy	The contractor will prepare a detailed emergency response plan prior to work commencing. The plan will include consideration of the following: Information identifying the obligations under the relevant legislation. Development of a response, investigation, command, control and recovery for both natural disasters and other disasters/emergencies and incidents. Response procedures in the event of a fire, chemical release, spill, accident, explosion, equipment failure, bomb threat, natural disaster (including severe storm, bushfire and flood events) or any other likely emergency. Communication arrangements and contact details. Roles and responsibilities of responsible personnel. Emergency controls and alarms. Evacuation procedures. Emergency response equipment. Training requirements. Site access and security.
Monitoring and Auditing	The effectiveness of the emergency response plan will be regularly tested and audited.



Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the auditing process and reported to the appropriate authority as required

Non-compliance and incident reports will be closed out by the ECO. The following constitute incidents or failure to comply:

- Emergency response plan is not prepared or implemented.
- · Emergency response equipment is not provided.
- Emergency response training is not undertaken.
- Emergency response procedures not followed in the event of an incident.

In the event of an incident or failure to comply, one or more of the following actions will be undertaken as appropriate:

- Prepare or implement the emergency response plan.
- Provide the necessary equipment or training.
- Investigate why the emergency response procedures were not followed and implement mitigating measures.



7.14 FIRE MANAGEMENT

Element/Issue	Fire Management
Operational Policy or Management Objective	To prevent the initiation of bushfires as a result of the West Street Bridge maintenance Project related activities.
	To protect personnel and the Sabi Sands Wildtuin from bushfire and fire impacts.
Performance Criteria	 Develop and implement emergency response plans that include fire management. No unplanned or uncontrolled fires caused by GLNG Project relative activities. Emergency plans for construction developed and in place prior to activities commencing. All personnel familiar with emergency procedures and their role in the event of emergency, and drills undertaken.
Implementation	Minimise fire risk through evaluation processes and management of those risks.
Strategy	Restrict high-risk activities in accordance with local fire bans or in times of high fire danger.
	 Maintain a plan for rapid and co-ordinated response to the outbreak of fire through an established fire response plan in conjunction with the local reserve and rural fire brigades.
	Develop evacuation procedures and hazard reduction.
	Undertake fire safety awareness training as part of site inductions.
	Conduct fire safety awareness training as part of site inductions.
	Conduct regular fire drills and record exercises as actions generated.
	Conduct periodic fire equipment audits.
	Consult with all relevant fire management authorities.
Monitoring and Auditing	The effectiveness of the fire management component of the emergency response plan will be regularly tested and audited.



Reporting and Corrective Action	 Extinguish fire if safe to do so. Report all fire events to the Health and Safety Manager. Notify reserve manager, fire brigade and implement evacuation procedure if appropriate. Review fire management plans following fire events. The Health and Safety Manager will be responsible for compiling the results of testing and auditing programs.
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7.15 INCIDENTS AND COMPLAINTS

Element/Issue	Incidents and Complaints
Operational Policy or Management Objective	To manage and respond to any environmental or social incidents and complaints from the community regarding the construction project.
Performance Criteria	Incidents and complaints regarding environmental and social issues will be minimised and mitigation measures implemented to reduce the incidence of complaints.
	Incident and complaints register established and maintained.
Implementation Strategy	All incidents and complaints will be managed through the auditing process and reported to the appropriate authority as required.
	All incidents and complaints will be documented in an incidents/complaints register. The complaints form will document at least the following information:
	Time, date and nature of complaint.
	Type of communication (telephone, letter, email, visit).
	Name, contact address and contact number (if provided).
	Response and investigation undertaken as a result of the complaint.
	Action taken and signature of person investigating complaint.
	Each complaint will be investigated as soon as practicable and, where appropriate, corrective action taken to remedy the cause of the complaint.



Monitoring and Auditing	The ECO will maintain the complaints register and ensure all complaints are resolved. The complaint form will be checked within two weeks of complaint receipt to ensure follow-up action has been taken to resolve the issue.
Reporting and Corrective Action	All complaints and incidents are to be reported to the client and ECO. The complainant will be advised of what action, if any, has been taken as a result of the complaint.
	Should further incidents occur or complaints be received in relation to previous occurrences, an appropriate selection of the following corrective actions will be undertaken: - Additional environmental awareness training of the workforce with respect to the procedures to be followed for environmental incidents or complaints. - Investigation into why the incident/complaint was not addressed within the specified time frame. - Incident/complaint follow-up according to the results of the investigation. - Where required, work place practices will be reviewed.



7.15.1 Making good on environmental damage

The requirement to make good any environmental damage stems from the following provisions:

- By entering into a Contract with Employer, the Contractor agrees to comply with the various obligations attached to that Contract, which include the environmental responsibilities specified herein; and
- The Contractor shall take all reasonable steps to protect the environment (both on and off Site) and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations.

In light of these considerations, the Contractor is expected to meet their environmental commitments, failing which it is reasonable to expect them to make good on any environmental degradation, at their own cost.

7.15.2 Removal from site and suspension of works

The ECO has the power to remove from site, any person who is guilty of misconduct, or is incompetent, negligent or constitutes an undesirable presence on Site. Failure to comply with the requirements of the environmental Maintenance/Construction Environmental Management Programme could suffice in this regard. All Plant should be in good working order, and accordingly the ECO could order any Plant that does not meet this requirement to be removed from Site.

If the ECO deems the Contractor to be in breach of any of the requirements of the Contract, he may order the Contractor to suspend the progress of the Works or any part thereof. Failure to comply with the requirements of the Maintenance/Construction Environmental Management Programme would constitute such a breach.



PART F: CONCLUSION

The implementation of the EMP serves to minimise possible negative impacts during the maintenance of the MalaMala West Street Bridge and assigns responsibility for environmental controls.

Environmental management requires the ability to respond to changing requirements in a dynamic and multifaceted environment. Whilst the provision of management controls and mitigation measures are seen as important, the establishment of a system and provision of staff with the appropriate technical knowledge required to respond to changing requirements is of greater importance. MalaMala and all Contractors, throughout the maintenance of the bridge are therefore encouraged to recruit environmental personnel of adequate calibre and provided with ample authority and resources required to ensure the effective implementation of the environmental management programme.

