



AFCAP/MOZ/054/B

**USE OF ROAD WORKS TO ENHANCE COMMUNITY
WATER SUPPLIES IN MOZAMBIQUE**

FINAL DESIGN REPORT

April 2013

This project was funded by the Africa Community Access Programme (AFCAP) which promotes safe and sustainable access to markets, healthcare, education, employment and social and political networks for rural communities in Africa.

Launched in June 2008 and managed by Crown Agents, the five year-long, UK government (DFID) funded project, supports research and knowledge sharing between participating countries to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources.

The programme is currently active in Ethiopia, Kenya, Ghana, Malawi, Mozambique, Tanzania, Zambia, South Africa, Democratic Republic of Congo and South Sudan and is developing relationships with a number of other countries and regional organisations across Africa.

THE PROJECT

Many rural communities in Mozambique have poor access to water, particularly in the dry season. The task of walking long distances to collect water is often left to women and children. Experience in Mozambique has shown that road works can be used to enhance community water supplies.

The purpose of the overall project is to undertake research on using road works to enhance community water supplies on a larger scale in Mozambique.

This phase of the project is aimed at establishing a pilot project through the identification of suitable sites for

- a) the construction of structures for research and demonstration purposes, preparation of engineering designs and tender documents,
- b) the identification of suitable borrow pit sites where water may be stored with appropriate design for harvesting the water, and;
- c) establishing participatory, representative community road pond committees at each of the sites

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LIST OF ABBREVIATIONS

AfCap	Africa Community Access Programme
ANE	Administração Nacional de Estradas
ARA-Sul	Administração Regional de Águas do Sul
CRA	Water Regulatory Council / Conselho de Regulação do Abastecimento de Água
DNA	National Directorate for Water Affairs / Direcção Nacional de Águas
DPOPH	Provincial Department of Public Works / Direcção Provincial das Obras Públicas e Habitação
FIPAG	Water Supply Investment and Asset Fund / Fundo de Investimento e Património do Abastecimento de Água
FRL	Finished Road Level
FSL	Full Supply Level
HDPE	High Density Polyethylene (sheeting)
IL	Invert Level
MOPH	Ministry of Public Works and Housing / Ministério das Obras Públicas e Habitação
MIPAR	Rural Water Project Implementation Manual / Manual de Implementação de Projectos de Água Rural
PI	Plasticity Index
PVC	Polyvinylchloride (pipes)
MZN	Mozambique Meticals
SDAE	District Services for Economic Activities/ Serviço Distrital de Atividades Económicas
SDPI	District Service for Planning and Infrastructure / Serviço Distrital de Planeamento e Infraestrutura
ToR	Terms of Reference
USD	United States Dollar

UNITS OF MEASUREMENT

m	metre
mm	millimeter
m ³	cubic metre
km	kilometer
km ²	square kilometer
ha	hectare
mamsl	metres above mean sea level

1 INTRODUCTION

Following a competitive bidding process, Stange Consult GmbH were appointed as Consultant in a Contract dated 13th July 2012 for *Use of Road Works to Enhance Community Water Supplies and Climate Resilience in Mozambique (Phase 2a – Design of Water Pilots)*, Contract Reference AFCAP/MOZ/054.

The assignment is to take 6 months commencing 11th October 2012. A Pre-Inception Report and Inception Report were submitted on 10th November and 10th December 2012 respectively. Other reporting is as follows:-

- Draft Design Report – 10th March 2013;
- Final Project Report – 10th April 2013.

This report is the Draft Design Report covering the following activities carried out by the Consultant in the period 11th December 2012 to 10th March 2013:-

- Co-ordination with the project steering committee and other stakeholders;
- Preparation of detailed technical designs and specifications for the selected pilot road pond structures;
- Preparation of draft tender documents in collaboration with ANE and the Provincial Maintenance Consultant;
- Undertaking of a participatory sociological survey at each site to establish community road pond committees.

2 EXECUTIVE SUMMARY

The *Draft Design Report* was presented at a Stakeholder Workshop held in Inhambane over two days from 17th – 18th April 2013. Comments from the Workshop together with the Consultant's findings and recommendations are incorporated in this Executive Summary as part of the *Final Project Report*.

The Workshop comprised a presentation of the project, an explanation of the selection and design criteria used for the pilot project sites, followed by presentation of the socio-economic data.

The workshop was attended by 24 persons from various organisations. .

Table 1: Workshop Participants

	NAME	ORGANISATION		NAME	ORGANISATION
1	F. Dado	ANE Inhambane	12	Filipe Mandava	DPOPH Manica
2	Enesto Siva Marrovisa	ANE Inhambane	13	Armando Gunebo	DPCA Manica
3	Nkululeko Leta	AFCAP	14	Luis Fernandos	ANE Maputo
4	Susana Chamusso	ARA - Sul	15	Arlindo Sambo	ANE Inhambane
5	Roberto N. Tope	DPCA Inhambane	16	Edwin maruza	Stange Consult
6	Adriano Joaquim	DPCA Inhambane	17	Domingo Vozac	Stange Consult
7	Alson Jaime	DPOHI	18	N. Kuzipa	Stange Consult
8	Leonel da Silva	ANE Maputo	19	Quimesse	ARA - Sul
9	Goncalves A	ANE Manica	20	A. Mupamba	Stange Consult
10	Freitas E	ANE Manica	21	Carla Jozi	ANE Inhambane
11	Adamo Ali	ANE Manica	22	Paul Wiggins	Stange Consult
			23	Wolfgang Stange	Stange Consult

The workshop programme is shown below:

Table 2: Workshop Programme

Time	Activities	Presenter
Wednesday 17 April		
08:30 – 09:00	Opening	DPOPH
09:00 – 09:20	Introduction/Explanation of AFCAP	AFCAP/ STANGE
09:20 – 09:30	Introduction to Pond Project	STANGE
09:30- 09:50	Explanation of Techniques for Road Pond and Dam Selection and Design	STANGE
09:50- 10:30	Explanation of Inhambane Selection and Designs	STANGE
10:30 – 10:45	Discussions	ALL
10:45 – 11:00	Coffee Break	..
11:00 – 12:30	Explanation Manica Selection and Designs	STANGE
12:30 – 13:00	Discussions	ALL
13:00 – 14:00	Lunch	.
14:00 – 14:30	Socio Economic Survey	STANGE
14:30 – 15:00	Discussions	ALL
15:00 – 15:30	Coffee Break	.
15:30 – 16:00	Wrap up of Day 1 – Programme for Day 2	Facilitator.
Thursday 18 April		
08:30 – 09:30	Responsibilities and requirements for implementing Ponds Projects	STANGE
09:30 – 10:00	Discussions	ALL
10:00 – 10:30	Tea	
10:30 – 12:30	Rounding up of Matters Arising from Workshop and discussions	STANGE
12:30 – 13:00	Closing	ANE Delegate
13:00 – 14:00	Lunch	

1.1. BACKGROUND TO PROJECT

Stange Consult GmbH was appointed as Consultant for *Use of Road Works to Enhance Community Water Supplies and Climate Resilience in Mozambique (Phase 2a – Design of Water Pilots)*, Contract Reference AFCAP/MOZ/054. This was a 6 month assignment commencing 11th October 2012.

The assignment included the following activities:-

- Co-ordination/liaison with relevant authorities;
- Selection of 8 suitable pilot project sites in Manica and Inhambane Provinces
- Preparation of detailed technical designs and specifications for the sites;
- Preparation of draft tender documents;
- Undertaking of a participatory sociological survey at the sites.

1.2. PROJECT COORDINATION

A number of meetings were held with the Project Steering Committee which included representatives from Roads, Water, Health, Environment, Local Government, and District Services Ministries and Authorities.

At the meetings the Project was presented and explained and the general approach for implementing the project mapped out with any specialized inputs from the various authorities.

Following this a number of site visits were done to - locate potential sites, - carry out physical surveys to establish design data, - carry out socio-economic related data collection and to introduce and explain the project to communities in the selected site influence areas.

1.3. SITE SELECTION AND DETAILED TECHNICAL DESIGN

3.1.1. GENERAL PRINCIPLES FOR DESIGN OF PILOT PROJECTS

Where road structures, or related works in the form of borrow pits can assist in enhancing community water supplies, the essential philosophy has been to design simple cost-effective road pond schemes.

It was acknowledged in the *Phase 1 Feasibility Study* that water supply from road ponds would be for domestic (other than drinking) and agricultural purposes. The main social and technical guidelines for the selection are therefore as follows:-

General Guidelines

- Beneficiaries are resident nearby;
- There is a separate potable water supply nearby (preferably in the form of a borehole fitted with a handpump);

Guidelines for Improved Borrow Pits

- The borrow pit should retain water all year;
- The borrow pit should no longer be in use;
- The borrow pit should preferably have a regular shape and depth and it should have been rehabilitated to a reasonable standard in accordance with ANE requirements, although it was acknowledged that the requirement to re-establish vegetation was not necessary;
- The borrow pit should have the potential for road side drains to be diverted into it.

Guidelines for Road Dams

Guidelines for the selection of suitable sites for road dams includes a consideration of physical and hydrological characteristics as follows:-

- A clearly defined watercourse crossing the road, which is identifiable on the 1:50,000 mapping;
- The watercourse should be seasonal – damming the perennial streams in the dune fields of southern Inhambane Province is not recommended because this would have a detrimental effect on other downstream users;
- The road should preferably be on an embankment but it is acknowledged that this is unlikely on tertiary and vicinal roads;
- The watercourse should be in its upper reaches so that the catchment area does not generate unmanageable floods;
- The crossing has appropriately steep gradients in order to minimise embankment length and to maximise basin depth and capacity;

- Local availability of suitable construction materials;

Hydrology: Estimation of Design Floods – The most critical hydrological aspect of road dams is their ability to pass the design flood without overtopping which would cause damage. As the catchment areas are of small or moderate size, a modified Rational Formula has been used.

Selection of Sites: In Inhambane Province it was difficult to locate suitable sites where, due to the sandy nature of the natural ground, there is little capacity to retain water and, in addition, due to the very flat nature of the Province it is also difficult to find suitable dam sites which fulfill conditions of short embankments on steep approaches.

Manica Province offered better possibilities for potential sites having less porous materials and the terrain being more hilly allowing better characteristics for dam structures.

8 sites were selected 2 borrow pit improvements and 2 dam sites for each Province.

Table 3: Inhambane Province: Project Information Summary Table

No.	Name Road District Province	Proposed Pilot Project Design Works	Catchment / Basin Areas	Max. Depth / Storage Capacity	Potential Population Served	Proposed Uses of Water
INH/1	Nhamboica N1 Massinga Inhambane	Improved borrow pit. Experimental sealing of the base of a rehabilitated sand borrow pit with bentonite and, if successful:- • Diversion of a lined drain from the N1 into the pit to increase inflow; • Fencing of the borrow pit	Borrow pit area 1.34ha	2.5m 9,252m ³	24,00	• Livestock watering • Cultivation
INH/2	Tambajane Unclassified Morrumbene Inhambane	Road dam. Raising an existing low embankment by 1.2m over a length of 180m and construction of a 30 x 3m reinforced concrete drop-inlet spillway discharging through the existing pipe culverts.	Catchment 39 km ² Basin 3.98ha	2m 23,116m ³	14,000	• Livestock watering • Cultivation
INH/3	Inhamussua R482 Homoine Inhambane	Road dam. Utilisation of an existing 4m high embankment without raising. Construction of an 8.5 x 4.25m reinforced concrete drop-inlet spillway discharging through the existing box culvert. Ancillary works include:- • Guardrail for road safety	Catchment 5.8km ² Basin 2.11ha	2.6m 19,995m ³	12,000	• Livestock watering • Cultivation
INH/4	Pambarra N1 Vilankulo Inhambane	Improved borrow pit. Protection of a perennial water source within Pambarra calcrete quarry by:- • Fencing; • Construction of a collector well complete with handpump; • Construction of a livestock drinking trough	Borrow pit area 2.19ha	2.5m 2,344m ³	1500	• Potable water • Laundry • Livestock watering

Table 4:: Manica Province: Project Information Summary Table

No.	Name Road District Province	Proposed Pilot Project Design Works	Catchment / Basin Areas	Max. Depth / Storage Capacity	Potential Population Served	Proposed Uses of Water
MAN/1	Saibera N261 Macossa Manica	Improved borrow pit. Protection of a perennial water source retained within a borrow pit by:- <ul style="list-style-type: none"> • Fencing; • Construction of a collector well complete with handpump; • Construction of a livestock drinking trough 	Borrow pit area 0.55ha	2m 5,610m ³	240	<ul style="list-style-type: none"> • Laundry • Livestock watering • Cultivation
MAN/2	Dunda N261 Macossa Manica	Road dam. Construction of a new 5m high embankment over a length of 309m and a 9 x 2m reinforced concrete drop-inlet spillway discharging through the existing double pipe culvert. Ancillary works include:- <ul style="list-style-type: none"> • Guardrail for road safety 	Catchment 1.4km ² Basin 1.64ha	4m 30,187m ³	800	<ul style="list-style-type: none"> • Livestock watering • Cultivation
MAN/3	Magaro N260 Sussendenga Manica	Improved borrow pit. Protection of a perennial water source retained within a borrow pit by:- <ul style="list-style-type: none"> • Fencing; • Construction of a collector well complete with handpump; • Construction of a livestock drinking trough 	Borrow pit area 3.2ha	3.5m 9,328m ³	1,000	<ul style="list-style-type: none"> • Laundry • Livestock watering • Cultivation
MAN/4	Guezanhe R521 Machaze Manica	Road dam. Construction of a new 5m high embankment over a length of 168m and an 8 x 2m reinforced concrete drop-inlet spillway discharging through the existing triple pipe culvert. Ancillary works include:- <ul style="list-style-type: none"> • Guardrail for road safety 	Catchment 4.4km ² Basin 1.76ha	4m 28,245m ³	17,000	<ul style="list-style-type: none"> • Livestock watering • Cultivation

1.4. TENDER DOCUMENTS

4.1.1. INSTRUCTION TO TENDERERS / CONDITIONS OF CONTRACT

The Instructions to Tenderers, which incorporate the General and Special Conditions of Contract, are based on those used for the Provincial Maintenance Contracts with a view to attracting small to medium sized contractors with relevant experience in earthworks, concrete works, pipe works and fencing.

Contract duration is envisaged to be from 3 to 6 months, inclusive of one month for mobilization, depending on the complexity and magnitude of the works.

Sample documents have been prepared, which include the following specific items,

- **The General Specification** covers general construction requirements. The General Specification has been derived from the SANS 1200 series of Standardised Specifications for Civil Engineering Construction and the SATCC Standard Specification for Road and Bridge Works, both of which are used extensively in Mozambique
- **The Project Specification** covers the scope of works and the site specific conditions and requirements at each Site
- A **Bill of Quantities** has been prepared for each project follows the format established in the General Specification
- An allowance for the **Training of Water Management Personnel** at the Community level is included into the contract.

1.5. SOCIOLOGICAL SURVEY

Socio economic information was collected for each of the sites for the project planning provision of guidelines for stakeholder participation and as base data for base line studies.

The specific objectives included:

- Coordination and liaison with relevant interested authorities and agencies
- Ensuring participative involvement of committee members
- Informing communities about the project aims and objectives
- Collection of socio economic information (water availability and requirements, population numbers and distribution, economic activities) each site for the planning, design and base-line surveys,

- Identification of the relevant stakeholders at the sites and establishing structure, responsibilities and functions of community management committees

Approach and Methodology: The project's used a participative approach involving all the inhabitants living within the influence area of the road pond sites. An explicit gender approach was formulated to ensure the active participation of women in the discussions and formulations.

Stakeholders to be involved in the process were identified at ponds steering committee meetings. Particular attention was given to ensuring involvement of Government Local Authorities and Traditional Community Leaders.

Stakeholders Opinions: The stakeholders at all the sites welcomed the project and its proposed improvements since both any improvements in water availability and/or water quality are very important to their livelihood needs.

Road Pond Management Committees: the responsibilities for maintenance and management of the road pond was discussed and agreed. The project team asked the group to organise a road ponds management committee composed of men and women.

1.6. DISCUSSIONS ARISING FROM WORKSHOP

Various issues which were raised during the presentations were formulated and discussed in further detail during the 2nd day in order to clarify and finalise these items.

- 1) PRIORITY LISTING OF PONDS/ROAD DAMS FOR IMPLEMENTATION
- 2) MODIFICATION OF TENDER DOCUMENTS
- 3) PROCESS FOR SELECTION, DESIGN AND IMPLEMENTATION OF PONDS
- 4) SELECTION/LOCATION OF PONDS
- 5) DESIGN OF PONDS/ROAD DAMS AND INFRASTRUCTURE
- 4) PROJECT IMPLEMENTATION

6.1.1. PRIORITY LISTING OF PONDS/ROAD DAMS FOR IMPLEMENTATION

It was requested that projects should be prioritised for construction sequence. The agreed prioritised list is as follows.

Table 5: : Priority Ordered Project List

Priority	ID	Pilot Project	Est. Cost [USD]	Comments
Inhambane Province				
1	INH/3	Inhamussua Road Dam	58,641	Very visible and accessible, simple construction, utilises an existing embankment.
2	INH/4	Pambarra Improved Borrow Pit	55,263	Immediate improvement to source used for potable water.
3	INH/2	Tambajane Road Dam	155,282	Could be included as part of necessary road rehabilitation works from Morrumbene.
4	INH/1	Nhambuica Improved Borrow Pit	171,123	Investigate the option of first doing a smaller trial area.
Manica Province				
1	MAN/1	Saibrera Improved Borrow Pit	64,187	Arid area, lowest cost
2	MAN/4	Guezanhe Road Dam	241,032	Arid area, lowest cost. Previous attempt to store water at this site failed
3	MAN/3	Magoro Improved Borrow Pit	76,568	Other surface water sources (e.g. Rio Lucite) are available.
4	MAN/2	Dunda Road Dam	348,292	Expensive. Previous attempt to store water at this site failed.

6.1.2. MODIFICATION OF TENDER DOCUMENTS

During general discussions with the various participants it was indicated that ARA-Sul had experience in training community committee members in maintenance and operation of the infrastructure. It was decided that a training component should be included into the contract document for the training of the community water management personnel. The ARA-sul agreed to supply the training materials if the training course was included into the works contract for the ponds.

The following will be included into the tender documentation for Training of Community Water Management Committess

“On completion of construction and installation of facilities the Contractor will arrange for a short training course for the water management committee personnel in the operation, maintenance and basic repair of the supplied facilities such as – fences, wells, pumps, water pipes, water channels and troughs etc.:

The Training manual will provided.

The Training will take place at the project site and will be practical on-the-job training.

The training will be specific to the facilities being provided for the pond or dam e.g. fencing, pumps, wells dams, borrow pits. Training will be for the following items
(Specifying items to receive training)

The Contractor will provide a suitably qualified trainer with relevant job experience to carry out the specified training.

The training will be done over days. The number of persons attending the course will be about (No days and No persons to be specified for each tender)

A lump sum amount will be calculated to cover the cost of the training”

6.1.3. PROCESS FOR SELECTION, DESIGN AND IMPLEMENTATION OF PONDS

SELECTION/LOCATION OF PONDS

The provision of Ponds and /or dams requires a multi-sectorial approach as a number of different ministries and authorities need to be involved in the process. The main organisations include Water, Health, Environment and Local Government.

The main issue with the design is liaison and cooperation with the other ministries, authorities and organisations.

It was agreed that environmental and health requirements will follow normal practice using already established procedures planning small community based projects. The Communities activities are to follow the National Water Policy Rules.

Taking account of the fact that ANE is a Road Authority and should not be expected to manage water issues it was agreed that:

- ANE would Design and Construct the Ponds/Dams and water extraction infrastructure with the assistance of the various responsible authorities for any specialist inputs (Health, Environment, Water, Agriculture and Local Government).
- The Construction would be tendered and carried out by Contract.
- ANE would arrange for the Contractor carrying out the Pond/Dam Work to carry out a Traing Course for the Water Management Committee Personnel. The ARA responsible for the area will supply necessary manuals and training materials.
- On completion the responsible ARA for the region will take over the Ponds/Dams and make arrangements for the final handover of the Ponds/Dams to the community and provide any further support or inputs which may be needed to maintain the ponds and dams.
- ANE would remain responsible for any items which affect the road such as
 - Drains and Channels taking water from the road to a pond or dam
 - Embankments being used as dams which are part of the Road Carriageway,
 - Drainage Structures used to take water from of the Pond/Dam across the road

6.1.4. SUITABILITY OF BENTONITE

The use of bentonite for lining ponds was raised in regard to possible health risk and also if it would be possible to clean the pond surface of the bentonite without damaging it.

In response it was explained that the Bentonite will be mixed with the in situ material to form a 300 mm deep layer. It is not anticipated that this should be damaged in normal usage. The fencing of the pit will prevent access by animals which would be the main threat to the surface layer.

As the ponds are mainly rain fed it is not expected to have excessive amounts of debris or silt. Where this does occur, the pond should be allowed to dry and the debris or silt removed taking care not to disturb the bentonite layer.

There is no indication that the bentonite, which will be mixed into the sand, would present

6.1.5. PROJECT IMPLEMENTATION

The current implementation phases of the project are:

- PHASE 1 - FEASIBILITY STUDY OF POSSIBLE INTERVENTIONS
- PHASE 2A – DESIGN OF PILOT WATER STRUCTURES
- PHASE 2B - CONSTRUCTION AND TECHNICAL MONITORING OVER 2-YEAR PERIOD
- PHASE 3 – PRODUCTION OF MANUALS FOR THE DESIGN, CONSTRUCTION AND UTILISATION OF ROAD PONDS, AND DISSEMINATION OF FINDINGS

ANE indicated to the AfCap representative that they would like to proceed with the projects as soon as possible and asked AFCAP whether they would be in a position to support the project with supervision inputs if the projects started soon.

AFCAP informed the meeting that they could expedite the supervision phase if the projects are to be started soon. The extent of the supervision in terms of inputs would be dependent on the number of projects and specific supervisor requirements. This would be assessed when projects are finalised and the time schedule is known.

It was suggested that Guidelines for the planning, design and implementation of the ponds be prepared first and that the Manuals should only be produced later after the guidelines ponds/dams have been tried and tested and proved i.e. after a number of years.

3 PROJECT STEERING COMMITTEE

During the assignment to date, meetings have been held with the project steering committee and other stakeholders as indicated in **Table 6** below.

Table 6: Schedule of Meetings with Steering Committee and Other Stakeholders

Date	Venue	Meeting	Participants
17-9-2012	ANE, Maxixe	Inaugural Steering Committee	Steering Committee
22-10-2012	ANE, Maxixe	Second Steering Committee	Mr. Dias Constantino (ARA-Sul) Mr. André Chongo (DPOPH-I)
29-10-2012	ANE, Chimoio	Briefing with ANE representative	Mr. Freitas Edreth
29-10-2012	ANE, Chimoio	Briefing with ANE advisor	Mr. Kuda Machibaya
29-10-2012	ANE, Chimoio	Courtesy call on Scott Wilson (maintenance engineers for Manica)	Mr. Luis Mulingawiza Mr. Taurai Mutangiro
22-11-2012	ANE, Maxixe	Briefing with ANE Delegate	Eng. Fernando Dabo
26-11-2012	ANE, Chimoio	Briefing with ANE Delegate	Eng. Adam Ali Mr. Freitas Edreth
26-11-2012	ANE, Chimoio	Briefing with ANE advisor	Mr. Kuda Machibaya
26-11-2012	ANE, Chimoio	Courtesy call on Scott Wilson	
9-1-2013	ANE, Maxixe	Third Steering Committee	Steering Committee chaired by Eng. Dabo.

A schedule of separate meetings held solely in connection with the sociological survey is include in **Section 7**.

4 PILOT PROJECT SITES

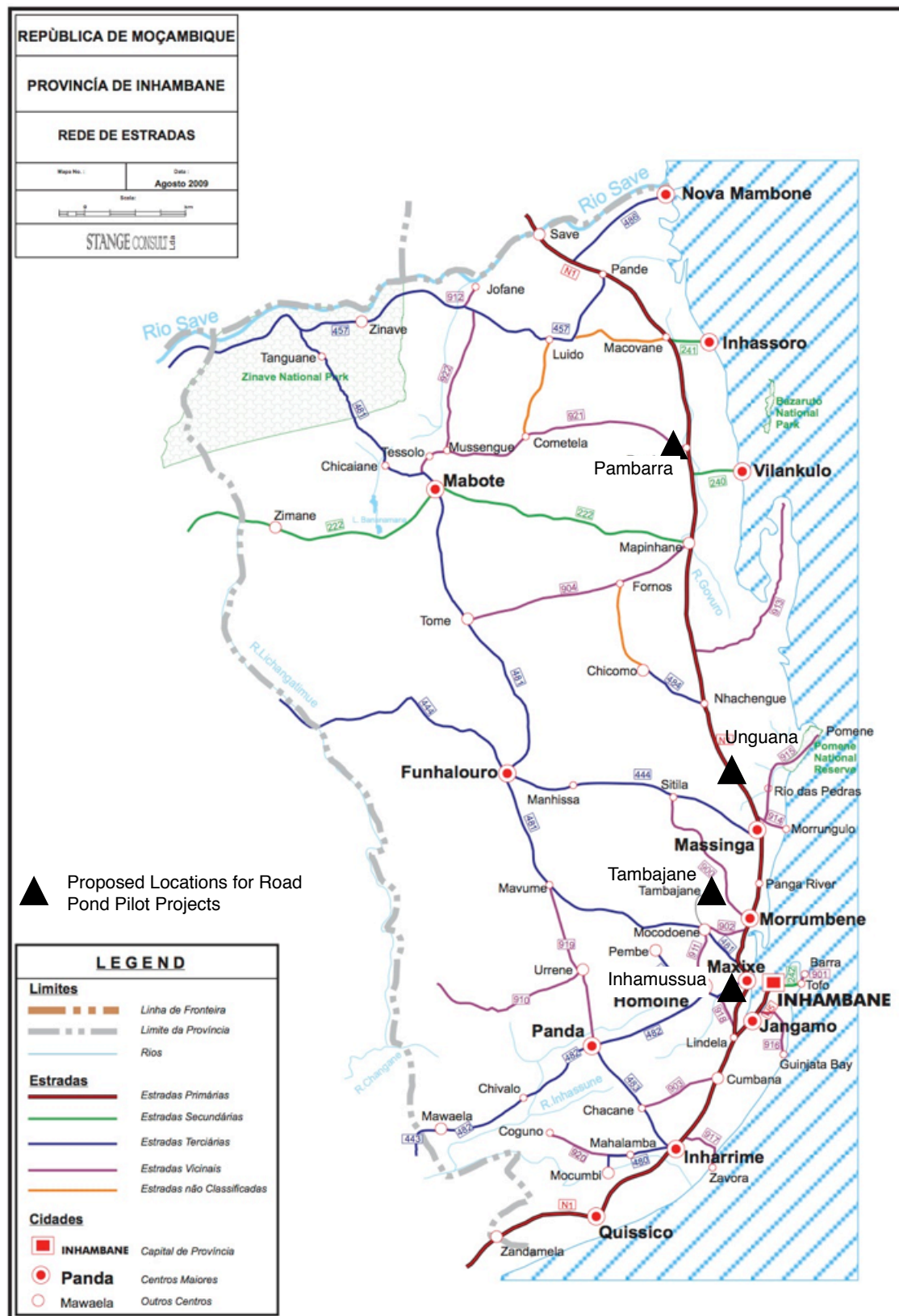
4.1 INHAMBANE PROVINCE

The selected pilot project sites are listed in **Tables 6 & 7** with their location shown on **Figure 1 & 2**.

Table 7::: Inhambane Province: List of Selected Pilot Project Sites

No.	Name	District	Road	Location	1:50,000 Map No.	Proposed Pilot Project Works	Comments
INH/1	Nhambuica	Massinga	N1	9kms north of Ungwana	1061	Improved borrow pit. Experimental sealing of the base with bentonite and, if successful, diversion of a lined drain from the N1 into pit.	The borrow pit has been rehabilitated.
INH/2	Tambajane	Morrumbene	U/C Morrumbene – Tambajane	Tambajane	1093	Road dam. Raising existing low embankment and construction of a drop-inlet spillway discharging into existing culverts.	
INH/3	Inhamussua	Homoine	R482 Maxixe – Homoine	11.2kms from Maxixe	1109 1110	Road dam. Utilisation of the existing high em- bankment without raising. Construc- tion of a drop-inlet spillway dis- charging into the existing box culvert.	
INH/4	Pambarra	Vilankulo	N1 Pambarra Calcrete Quarry	5.7kms from N1	973	Improved borrow pit. Protection of the potable water source with a collector well.	Water is retained in part of the quarry and is being used by transient villagers and livestock.

Figure 1: Inhambane Province showing location of selected road pond pilot projects



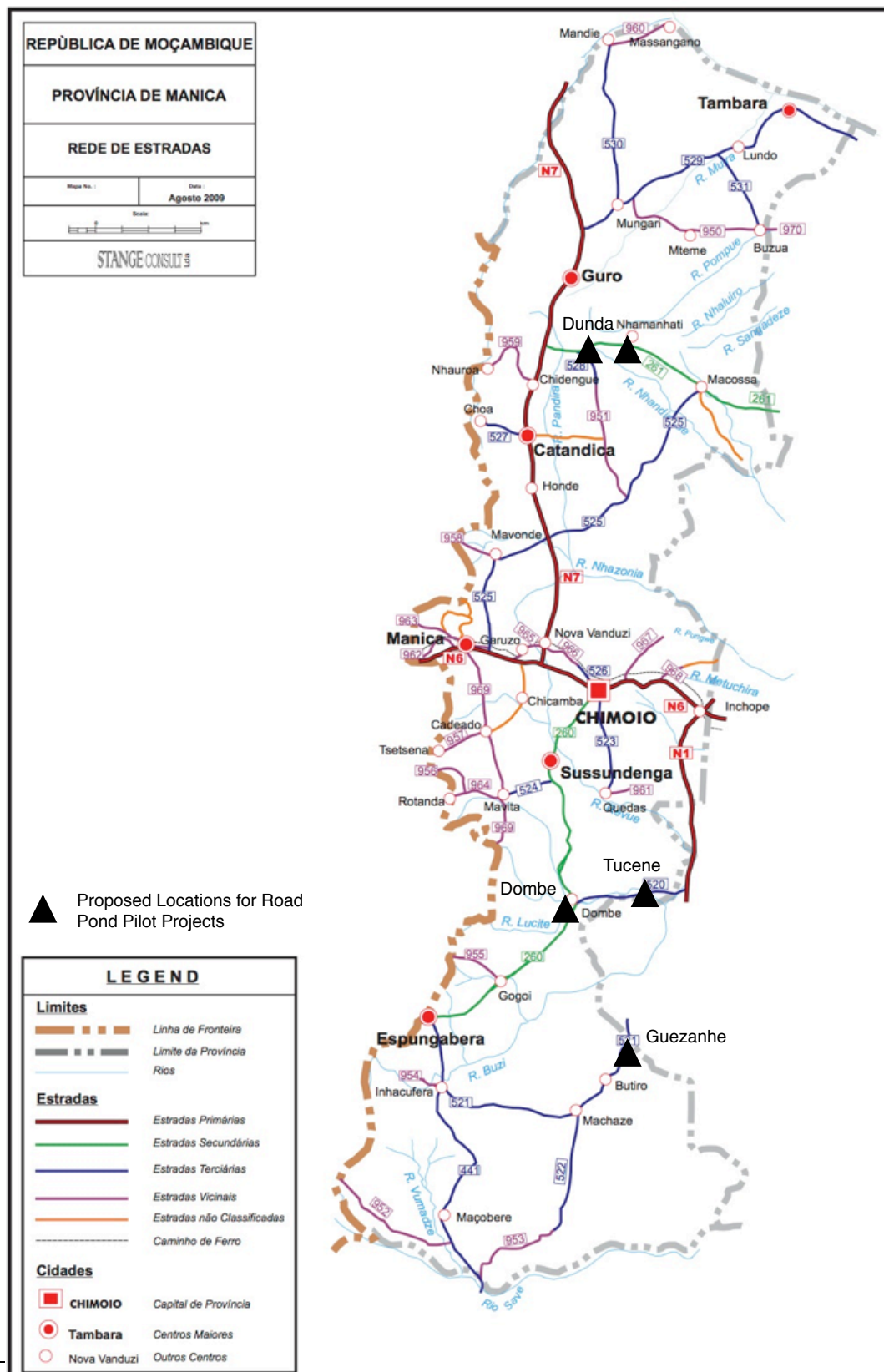
4.2 MANICA PROVINCE

Table 8::: Manica Province: List of Selected Pilot Project Sites

No.	Name	District	Road	Location	1:50,000 Map No.	Proposed Pilot Project Works	Comments
MAN/1	Saiberra ¹	Macossa	N261 Cruz. N7 – Macossa	29kms from Cruz. N7	733	Improved borrow pit. Erection of fencing and installation of a collector well.	The borrow pit retains water all year.
MAN/2	Dunda	Macossa	N261 Cruz. N7 – Macossa	1.5kms west of Dunda	733	Road dam Construction of an embankment and a drop-inlet spillway discharging into the existing culvert.	There has been a previous, failed, attempt to store water at this site.
MAN/3	Magaro	Sussendenga	N260 Chimoio – Espungabera	4kms west of Dombe	873	Improved borrow pit. Erection of fencing and installation of a collector well.	The borrow pit retains water all year.
MAN/4	Guezanhe	Machaze	R521 Muxungue – Machaze	3.3kms west of Guezanhe	904	Road dam Construction of an embankment and a drop-inlet spillway discharging into the existing culvert.	There has been a previous, failed, attempt to store water at this site.

¹ Formerly referred to by the name of "Gravel".

Figure 2: Manica Province showing location of selected road pond pilot projects



5 DETAILED TECHNICAL DESIGN

5.1 GENERAL PRINCIPLES FOR DESIGN OF PILOT PROJECTS

Where road works, or related works in the form of borrow pits, can assist in enhancing community water supplies the essential philosophy has been to design simple cost-effective road pond¹ schemes. It was acknowledged in the *Phase 1 Feasibility Study* that water supply from road ponds would be for domestic (other than drinking) and agricultural purposes.

Observation during the design phase of the project indicate that the use of borrow pits for community water supply is largely opportunistic – if the pit holds water it is likely to be utilised. Water from borrow pits and by extension from road ponds would be used for bathing and laundry, occasionally for recreation, without exception for livestock watering but seldom for agricultural purposes (garden watering). In extreme circumstances it would be used for potable supply.

Water supply from road ponds is by nature unsafe for potable use and, in the event of such use, there is an increasing risk of gastric illnesses or from other waterborne diseases. By creating open bodies of water, road ponds can also exacerbate other health risks in respect of malaria and bilharzia. It is apparent boreholes for potable supply should be considered complementary to the use of road ponds to enhance community water supplies.

In designing the eight pilot projects, four road dams and four improved borrow pits, for the former the main objective has been to provide a more assured supply from surface water sources for uses other than potable, and for the latter the main objective has been to improve the quality of water retained in borrow pits.

The ANE cost estimate of \$40,000 per site in the *Feasibility Study* has been used as a guide to the size and scope of works for the pilot projects. The emphasis has been on using road works to enhance community water supplies rather than on designing works that are otherwise not strictly necessary. For example, in respect of road dams, other than where the opportunity exists, no special dam works have been designed, e.g. in the form of impervious cut-offs or cores.

The pilot projects are essentially experimental. Subsequent monitoring of these eight projects during future phases should allow designs to be modified and refined.

¹ The term “road pond” is used in a generic sense and includes road dams and improved borrow pits.

5.2 ROAD DAMS

5.2.1 GUIDELINES

Design criteria for selecting sites for road dams are related to physical and hydrological characteristics of the site. Physical guidelines for the selection of suitable sites for road dams, which also takes into account social criteria, are as follows:-

- Beneficiaries are resident nearby;
- There is a separate potable water supply nearby (preferably in the form of a borehole fitted with a handpump);
- A clearly defined watercourse should cross the road in culvert or over a drift with the road preferably on an embankment that can be raised;
- The watercourse should be in its upper reaches so that the catchment area is not of a size that generates an unmanageable flood;
- Good approach gradients, i.e. at appropriately steep gradients in order to minimise embankment length and maximise basin capacity and depth thereby reducing cost and losses through evaporation respectively;
- Local availability of suitable construction materials;

There is little point in constructing a road dam if there are no beneficiaries in the vicinity and, since road dams are not for potable water use, there should be a separate potable water supply available to the resident community.

Generally the low traffic densities on tertiary and vicinal roads do not warrant high level crossings of seasonal watercourses because in the event of a flood the traffic merely waits for the flood to subside. Consequently, raising the road on an embankment to form a road dam is not strictly necessary for road functionality. The pilot projects at Dunda and Guezanhe in Manica Province fall into this category.

However, on secondary roads with higher traffic densities it is generally accepted that roads should not be susceptible to flooding and the vertical alignment in sags should be consistent with higher design speeds. Consequently, in crossing watercourses secondary roads are generally on embankments, which may be utilised to form a road dam. The pilot projects at Inhamussua and Tambajane in Inhambane Province fall into this category although the latter is on an unclassified road and the existing embankment requires a nominal raising to optimise storage capacity.

That the watercourse is defined both physically on the ground and on the 1:50,000 mapping suggests there is an identifiable flow during the rains. However, the road should cross the

watercourse in the upper reaches so that the catchment is in the range of 2 – 40 km² with less steep catchments tending to be towards the higher end of this range.

The maximum recommended longitudinal grade for tertiary and vicinal roads is 8% (or 1 in 12.5). With this grade on both approaches a 5m high embankment would be 125m long. With approach gradients of 5% (or 1 in 20) a 5m high embankment would be 200m long.

Basin capacity is directly related to embankment height and it is apparent a compromise must be struck between the cost of the embankment, which increases exponentially with height, and capacity. The 30,000m³ capacity of the ARA-Sul excavated reservoirs has been used as a guide in this regard.

Under current road maintenance programmes borrow pits are at fairly frequent intervals and it should therefore be feasible to locate a pit with suitable construction materials in close proximity to the proposed road dam.

From a road safety perspective, guardrails have been specified for road dam embankments in excess of 4m height.

5.2.2 HYDROLOGY: ESTIMATION OF DESIGN FLOODS

The most critical hydrological aspect of road dams is their ability to pass the design flood without overtopping which, through scour action, could result in damage or failure of the dam and road. In the absence of specific site data the estimation of design floods for the road pond spillways is a subjective exercise. As the catchment areas concerned are of small or moderate size, a modified Rational Formula has been used.

Assuming a triangular hydrograph, with time to peak (t_p) equal to the time of concentration (t_c) of the flood, and a recession time of three times t_p , the applicable formula is :-

- $Q = 0.14CAI$, where Q = peak flood (m³/sec),
 C = coefficient of runoff,
 A = catchment area (km²), and
 I = rainfall intensity (mm/hour)

For each catchment,

C is estimated from considerations of slope, soil type and vegetation,

A is measured from 1:50,000 scale mapping,

I is estimated from intensity / duration curves, based on t_c assessed from catchment slope and velocity of flow, with consideration of the rainfall zone (mean annual precipitation).

Floods have been estimated for a return period of 20 years; floods for a return period of 10 years are derived by applying a factor of 0.625 to the former. The assessed parameters and the estimated design floods are given in **Table 9**.

Table 9: Estimated Design Floods for Road Dam Pilot Projects

ID	Name	A [km ²]	C	V [km/h]	t_c [min]	I [mm/ h]	Q_{20} [m ³ /s]	Q_{10} [m ³ /s]
INH/2	Tambajane	39.0	0.5	1.0	450	15	41.0	25.6
INH/3	Inhamussua	5.8	0.5	2.0	70	65	26.4	16.5
MAN/2	Dunda	1.4	0.6	3.0	30	115	13.5	8.4
MAN/4	Guezanhe	4.4	0.5	1.5	140	35	16.8	10.5

For all the pilot projects a simple and cost-effective drop-inlet spillway has been adopted, which discharges through the existing culverts as shown in **Figure 3**.

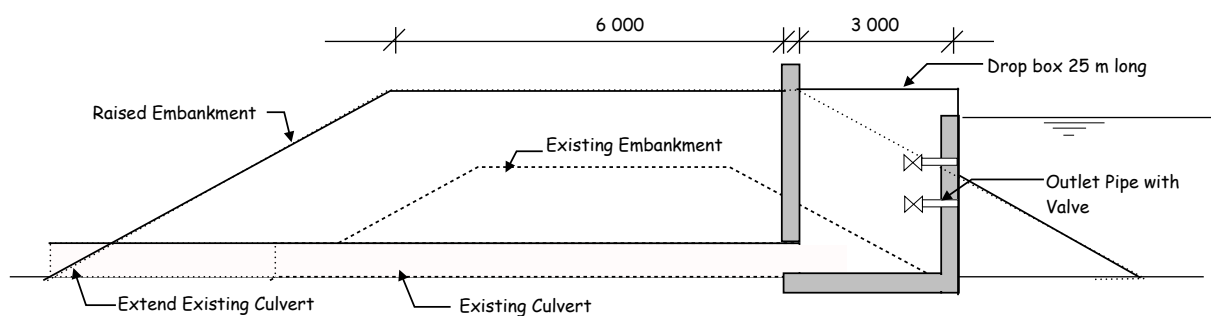


Figure 3: Cross-section of embankment showing Drop-inlet Spillway arrangement

The values of the design floods computed in **Table 9** can be compared with the discharge capacity of the existing culvert systems, which are shown in **Table 10**.

Table 10: Design Flood in Relation to Culvert Capacity

ID	Name	Existing Culvert Details	Design Flood Q_{10} [m ³ /s]	Culvert Capacity [m ³ /s]	Surcharged Culvert Capacity [m ³ /s]	Spillway Length [m]
INH/2	Tambajane ²	2x900Ø + 3x900Ø pipes	25.6	12.0	20.0	30
INH/3	Inhamussua ³	3.0m wide x 2.7m high box	16.5	14.0	14.0	17
MAN/2	Dunda	2 x 800Ø pipes	8.4	2.8	7.7	9
MAN/4	Guezanhe	3 x 800Ø pipes	10.5	4.2	11.6	7

It is apparent that, with the exception of INH/3 (Inhamussua with the large box culvert), the existing culverts are under-designed when compared with the derived flood estimates. However, when the road embankments are raised as part of the pilot projects, the culverts will be surcharged by a greater head of water spilling from the drop-inlet and the discharge capacities will be correspondingly increased as shown in **Table 10**.

Within the limits of estimation, these values are close to the design flood figures for a 10 year return period. It is therefore not considered necessary or advisable to alter the existing culverts, apart from the lengthening required to fit the raised embankments. In any case, the raised embankments will be as safe, or safer, against flooding than in the present state.

5.2.3 SPILLWAY DESIGN

The spillways for the road dams will comprise drop-inlet boxes constructed immediately upstream of the existing culverts. Flood waters overflowing the cill of the boxes will discharge through the existing culverts. At large flows, the boxes will fill with water giving increased head and discharge through the culverts.

The embankments are designed with 1.0m total freeboard. The spillway cills will operate on a maximum depth of flow of 0.75m, leaving a 0.25m dry freeboard. With a coefficient of discharge (C_d) of 1.6, the flow will be 1.0m³/sec per metre of length. In extreme conditions, (no dry freeboard), the flow will be 1.6m³/sec per metre of length. The ratio of these flows equates to the

² At Tambajane a 1 x 900Ø pipe does not form part of the spillway and is to be blocked.

³ In the case of Inhamussua, the large box culvert is over-sized in height and will not flow full.

assessed ration between 10 – year and 20 – year return period floods. Accordingly, spillway cill lengths are set as shown in the last column of 10.

5.3 IMPROVED BORROW PITS

5.3.1 GUIDELINES

Social and technical guidelines for the selection of borrow pits that may be improved are as follows:-

- Beneficiaries are resident nearby;
- There is a separate potable water supply nearby (preferably in the form of a borehole fitted with a handpump);
- The borrow pit should retain water all year;
- The borrow pit should no longer be in use;
- The borrow pit should have been rehabilitated to a reasonable standard in accordance with ANE requirements;
- The borrow pit should preferably have a regular shape and consistent depth;
- Ideally, the borrow pit should have the potential for road side drains to be diverted into it.

As with road dams, there is little point in improving a borrow pit if there are no beneficiaries in the vicinity and, since improved borrow pits are not for potable water use, there should be a separate potable water supply available to the resident community.

A borrow pit retaining water throughout the year will be of considerable value to the local community especially during the months September to November immediately prior to the rains. Preferably a borrow pit should retain water all year. However, towards the end of the dry season, as the volume of stored water diminishes it may become putrid and unusable.

It is readily apparent why the borrow pit should no longer be in use and, consequently, rehabilitation should have been carried out to an acceptable standard, which together with a regular shape and depth should eliminate local humps and hollows, the latter being potential breeding grounds for mosquitoes.

As part of the improvement works, mosquito and snail breeding can be reduced by clearing the vegetation from between the high and low water marks. Ultimately this clearing should be an activity carried out by the community.

Fencing borrow pits will also reduce contact between humans and the water's edge where bilharzias snail have a tendency to breed.

The diverting of road side drains into a borrow pit is an assured method of increasing inflow into the pit. This is a relatively straightforward exercise on paved roads with lined drains of considerable length if the borrow pit is not too distant and there is sufficient fall between the road side and pit. On gravel roads however, short lengths of side drain are usually led away from the road side in mitre drains spaced at regular intervals. It is not practicable to run appreciable lengths of side drain alongside gravel roads without increasing the erosion risk, which may seriously damage the road carriageway.

5.3.2 DESIGN CONSIDERATIONS

Observations indicate that water retained in borrow pits is used by the community for a variety of activities including bathing, laundry, recreation (swimming), occasionally for cultivation (garden watering) and, almost without exception, for livestock watering. All these uses, to varying degrees, pollute the body of water. Livestock in particular pollute the water through urine and faeces, which is unpleasant and an obvious health hazard for the community reliant on the borrow pit for other uses. During the dry season, through evaporation and possibly seepage, the volume of water retained in the borrow pit gradually diminishes. Human activities, viz. bathing, laundry and recreation, abstract only small amounts of water; in effect the body of water is continually re-used for these activities. As a consequence, until the water is replenished and refreshed from the rains, the pollution load rapidly increases especially from laundry and livestock watering activities.

The objective in improving borrow pits is to separate the various uses so as to minimise pollution especially from laundry and livestock watering activities. This can be achieved by fencing the borrow pit to keep livestock at bay and by the installation of a piped draw-off to a collector well fitted with a handpump from which water can be carried away for bathing, laundry and garden watering purposes or diverted into a drinking trough for livestock, in arrangements similar to those already in existence at boreholes. The collector well, livestock drinking trough and washing slab would be sited so that waste water does not drain back into the borrow pit. Alternatively, if necessary, waste water could be directed to a soak-a-way pit.

Since water is now physically abstracted through the draw-off arrangement rather than continually re-used within the borrow pit itself, it follows that in addition to evaporation and seepage, the body of water will be depleted more quickly.

5.4 INHAMBANE PROVINCE

5.4.1 SITE INH/1: NHAMBUICA: IMPROVED BORROW PIT

With the important exception of not retaining water, this borrow pit, 9kms north of Unguana on the east side of the N1, satisfies all the guidelines established in section 5.3.1, viz:-

- There are beneficiaries (villagers with livestock) in the immediate vicinity;
- The borrow pit is no longer in use;
- The borrow pit has been rehabilitated to a reasonable standard;
- The borrow pit has a regular shape and covers a relatively large area of 1.34ha;
- The borrow pit has a uniform depth of 4 – 4.5m;
- A 400m length of lined side drain from the N1 can be diverted into the borrow pit.

Photo 1 and **Figure A1 in Annex 1** show the extent of the borrow pit.



Photo 1: Nhambuica Borrow Pit

It is fact that borrow pits do not retain rainwater in the deep sandy relatively flat terrain of Inhambane Province since it immediately soaks into the ground. Consequently, as an experiment, the pilot project proposes to attempt to seal the pit by mixing approximately 4% bentonite into the top 300mm layer, that is at an application rate of 20kg/m². Bentonite is available locally from the MIMOC Mafuiane Quarry near Maputo and for this pilot project a quantity of 270 tonnes will be required. It is proposed to use this in the pilot project to see if it will be effective in sealing the pits. If the bentonite proves to work then investigations can be made to find out if there are other deposits which can be utilised.

For this type of application, milled bentonite from the quarry has previously been used to seal basins, for example Barragem Nkurumani at Moamba. Milled bentonite is however, expensive at Mtn7,000 per tonne (approximately \$250 per tonne or the same price as cement). At this price we do not believe sealing the pond will be cost effective. Consequently the proposal is to use screened bentonite from the quarry at a price of Mtn1,450 per tonne (approximately \$50 per tonne or 20% of the price of milled bentonite).

Should sealing the pit with bentonite prove successful, based on the area of the pit below the 92m contour and with diversion of the N1 side drain into the pit, it is estimated 7,500m³ of water could be stored, with a maximum depth of approximately 2.5m, during an average rainy season.

It is apparent the N1 side drain should only be diverted into the pit if the sealing is successful. Similarly, fencing of the borrow pit, as requested by the local community, is also dependent on the success of the sealing experiment.

5.4.2 SITE INH/2: TAMBAJANE: ROAD DAM

The site, which is on an unclassified road from Morrumbene, satisfies the guidelines established in **Section 5.2.1**, viz:-

- There are beneficiaries (villagers with livestock) in the immediate vicinity of Tambajane village;
- There are at least two boreholes with handpumps in Tambajane village;
- The Rio Tendele drainage line crosses the road in a series of three concrete pipe culverts (i.e. with 1 x single, 1 x double and 1 x triple 900mm dia. concrete pipes) set in a low embankment;
- At 39km² the catchment area is relatively large. However, it is also relatively flat with a hydraulic gradient of approximately 0.4% so consequently the design flood is manageable;
- The approach gradient from the east is relatively flat but it still allows a 1.0m embankment raising over a reasonable length of 180m;

- Construction materials are available within the basin and also from borrow pits within 2kms of the site.

Photo 2 and **Figure A2** in **Annex 1** show the site and extent of the proposed road dam.



*Photo 2: Tambajane: Site of Proposed Road Dam:
Existing embankment, incorporating three culverts,
across the Rio Tendele drainage line*

The principal technical features of the proposed road dam are:-

- Catchment area – 39km²
- Full Supply level (FSL) – 107.0mamsl
- Storage capacity – 23,116m³
- Length of embankment to be raised – 180m
- Finish Road Level (FRL) of embankment – 108.0mamsl
- Invert Level (IL) of existing [lowest] culvert – 105.16mamsl
- Freeboard – 1.0m

- Maximum water depth – 1.8m
- Maximum height of embankment – 2.8m
- Volume of earthworks in the embankment – 1,393 m³
- Drop-inlet spillway with a 30m cill discharging into the twin and triple existing pipe culverts (the single pipe culvert is to be sealed-off).

This site is attractive because Tambajane has good agricultural potential and, to date, the unclassified road from Morrumbene has not been fully rehabilitated. In the event that the road is rehabilitated, the opportunity exists to construct the road dam cost-effectively as part of the road works.

5.4.3 SITE INH/3: INHAMUSSUA: ROAD DAM

The site, 11.2kms along the recently paved R482 tertiary road from Maxixe to Homoine, makes use of an existing high embankment incorporating a large box culvert. **Photo 3** and **Figure A3** in **Annex 1** show the box culvert and extent of the proposed road dam.

As such the site satisfies relevant guidelines established in **Section 5.2.1**, viz:-

- There are beneficiaries (villagers with livestock) adjacent to and immediately downstream of the basin;
- There is a motorised borehole nearby (although in January 2013 it was not working due to the motor having been stolen);
- The unnamed tributary of the Rio Inhanombe crosses the road in a 3.0m wide x 2.7m high reinforced concrete box culvert;
- At 5.8km² the catchment area is of moderate size. However, it is apparent that the box culvert is over-sized for this catchment area.



*Photo 3: Inhamussua: Site of Proposed Road Dam
An existing box culvert in high embankment
can form a road dam without raising*

Since no earthworks are required, the road dam can be formed simply by blocking the box culvert with a drop-inlet spillway of reinforced concrete construction.

The principal technical features of the proposed road dam are:-

- Catchment area – 5.8km²
- Full Supply level (FSL) – 11.0mamsl
- Storage capacity – 20,000m³
- Length of embankment to be raised – Nil
- Finish Road Level (FRL) of embankment over the box culvert – 12.3mamsl
- Invert Level (IL) of existing box culvert – 8.39mamsl
- Freeboard – 1.3m
- Maximum water depth – 2.6m
- Maximum height of embankment – 3.9mm

- Drop-inlet spillway 8.5m x 4.25m in plan, with the overflow cill on three sides to give an effective length of 17m discharging into the existing box culvert.

During the dry season the flow in the tributary disappears beneath the surface to reappear a short distance downstream before discharging into Rio Inhanombe. Of concern to the local community is that the dam may restrict this downstream underground flow and also that seepage through the basin floor may result in the dam not holding water for any appreciable length of time. Any seepage will, of course, increase the underground flow and should excessive seepage occur it may be feasible to seal the basin with bentonite should the experiment at Nhambuica prove successful.

5.4.4 SITE INH/4: PAMBARRA CALCRETE QUARRY: IMPROVED BORROW PIT

Perennial ponds have formed in one corner of Pambarra calcrete quarry, which suggests that at a depth of 11 – 12m the water table has been reached and that the ponds are effectively spring fed and supplemented by rainfall. The high water mark indicates that up to 2,344m³ of water may be stored in the ponds. **Photo 4** and **Figure A4** in **Annex 1** show the extent of the quarry.

Villagers resident in the area and working as transient stone-breakers and charcoal makers, use the water for drinking, bathing and livestock watering. The nearest borehole (with handpump) is 5.4kms away near the N1. Consequently, there is a reliance on the quarry for potable water and, in this regard, separate wells have been opened up to one side of the ponds, which are badly polluted by livestock, in an attempt to prevent contamination.

Protection of the potable water wells is a priority and consequently it is proposed to sink a collector well, fitted with a handpump, at least one metre into the calcrete stratum and, for access to the well, to construct a causeway above the high water mark.

The resident villagers have expressed a desire for the water to be pumped to the lip of the quarry from where it could also be carried or channelled for garden watering. However, a lift of 11 – 12m is not feasible with handpumps. The alternative would be a solar powered pump delivering water to a tank on the lip of the quarry. Of necessity, because the calcrete is extremely hard and difficult to trench, the pipework from the pump to the water tank would have to be galvanised steel laid above ground. However, at the present time, it is apparent that the community is not sufficiently well established to manage and protect such an installation from theft. It has, however, been included as a provisional item in the pilot project scope of works.



*Photo 4: Pambarra Calcrete Quarry
The far face is approximately 9m in height*

5.5 MANICA PROVINCE

5.5.1 SITE MAN/1: SAIBRERA: IMPROVED BORROW PIT

The borrow pit, in an arid area 29kms from Cruz N7 on the N261 Macossa road, satisfies the guidelines established in **Section 5.3.1**, viz:-

- There are beneficiaries (villagers with livestock) resident nearby;
- There is a borehole fitted with a handpump within 150m
- The borrow pit retains water all year although at the end of the 2012 dry season very little water remained;
- The borrow pit is no longer in use;

- The borrow pit has been partially rehabilitated, on the east and south sides however, there is a ridge of overburden;
- The borrow pit is broadly rectangular in shape covering an area of 0.55 ha and it is 1.5 – 2.0m deep, at 1.5m depth the pit holds 5,610m³;
- Mitre drains divert short lengths of road side drain into the pit.

Photo 5 and **Figure A5** in **Annex 1** show the extent of the borrow pit.



Photo 5: Saibrera Borrow Pit

To relieve pressure on the nearby borehole, water in the borrow pit is used for laundry, garden watering and livestock drinking activities (mainly by goats). It is apparent laundry and livestock watering activities are polluting the water that remains in the pit. Consequently, as discussed in **Section 5.3.2** above, separation of the various uses is desirable and this can be achieved by improvements to fence the pit and the installation of a draw-off pipe leading to a collector well and livestock drinking trough on the south side so that waste water drains away from the pit. The local community are appreciative of the project and the suggested improvements to enhance the quality of water.

The local community have also made a suggestion to deepen the pit thereby allowing a greater volume of water to be stored. There is some merit in this suggestion; the base of the pit could be graded from a shallow west end to a deeper east end. However, prior to any deepening, trial pits should be excavated to ensure that the impervious base of the pit is not compromised. Consequently, a provision for such deepening has been allowed in the project documentation.

5.5.2 SITE MAN/2: DUNDA: ROAD DAM

The site, which is 17kms from Cruz N7 on the N261 secondary road to Macossa and 1.5kms west of Dunda village, satisfies the guidelines established in **Section 5.2.1**, viz:-

- There are beneficiaries (villagers with livestock) in the immediate vicinity;
- There is a borehole fitted with a handpump within 150m;
- A distinct drainage line crosses the road in a twin 800mm diameter cgi culvert;
- At 1.4km² the catchment area is relatively small but it includes the south-east face of Dunda mountain, which rises to 860mamsl to produce an overall hydraulic gradient of approximately 9% which will contribute significantly to run-off;
- The east and west approach gradients are approximately 4% and 5% respectively, which results in the 5m high embankment having a length of 308m;
- Construction materials are available from an abandoned borrow pit within 1km of the site.

Photo 6 and **Figure A6** in **Annex 1** show the site and extent of the proposed road dam.



*Photo 6: Dunda: Site of Proposed Road Dam
View looking west with Dunda Mountain top right.*

The principal technical features of the proposed road dam are:-

- Catchment area – 1.4km²
- Full Supply level (FSL) – 729.0mamsl
- Storage capacity – 30,187m³
- Length of embankment – 308.9m
- Finish Road Level (FRL) of embankment – 730.0mamsl
- Invert Level (IL) of existing twin 800mm dia. culvert – 724.0mamsl
- Freeboard – 1.0m
- Maximum water depth (above culvert invert) – 5.0m
- Maximum height of embankment (above existing road level) – 5.0m
- Volume of earthworks in the embankment – 17,133m³;
- Drop-inlet spillway with a 9m cill discharging into the existing twin 800mm dia. cgi culvert.

The local community are appreciative of the project, especially in view of the previous failed attempt by Caritas to store water at this site, since it will relieve pressure on the nearby borehole.

5.5.3 SITE MAN/3: MAGORO: IMPROVED BORROW PIT

The borrow pit, which is 4kms west of Dombe on the N260 secondary road to Espungabera, satisfies the guidelines established in **Section 5.3.1**, viz:-

- There are beneficiaries (villagers with livestock) resident nearby;
- There is a borehole fitted with a handpump in Magoro village within 500m;
- The borrow pit retains water all year although it is reported putrefaction occurs towards the end of the dry season;
- The borrow pit is no longer in use;
- The borrow pit has been rehabilitated with gentle side slopes although two islands remain within the water body;
- The borrow pit is broadly rectangular in shape covering an area of approximately 3.2ha with a maximum depth of approximately 4m below the level of the adjacent N260 road;

It is estimated that in an average rainy season the borrow pit fills to a depth of approximately 3 – 3.5m, which represents a water volume of approximately 9,300m³.

Photo 7 and **Figure A7** in **Annex 1** show the extent of the borrow pit.



*Photo 7: Magaro (Dombe) Borrow Pit
During the rains the water level rises to submerge the two islands.*

The borrow pit is frequented by villagers for bathing, laundry and livestock watering purposes and, notwithstanding the presence of at least two small crocodiles, children use it for recreation. The community is aware that their activities contribute to increasing pollution towards the end of the dry season. However, alternative water sources include the Mussapa and Lucite rivers where there is an ever present danger from crocodiles.

Consequently, as discussed in **Section 5.3.2** above, separation of the various uses is desirable and this can be achieved by improvements to fence the pit and the installation of a draw-off pipe leading to a collector well and livestock drinking trough on the north side so that waste water drains away from the pit. The local community are appreciative of the project and the suggested improvements to enhance the quality of water.

5.5.4 SITE MAN/4: GUEZANHE: ROAD DAM

The site, which is 3.3kms west of Guezanhe village on the R521 tertiary road from Muxungue (Cruz N1) to Machaze, satisfies the guidelines established in **Section 5.2.1**, viz:-

- There are beneficiaries (villagers with livestock) in the immediate vicinity;
- The nearest borehole, which is motorised, is at the Ministry of Agriculture establishment in Guezanhe, 3.3kms distant;
- The headwaters of Rio Tomere cross the road in a triple 800mm diameter cgi culvert;
- At 4.4km² the catchment area is of optimal size;
- The approach gradients are very good at approximately 7% and 6% from the east and west respectively, which results in the 5m high embankment having a length of 168m;
- Construction materials are available from an abandoned borrow pit within 4km of the site.

Photo 8 and **Figure A8** in **Annex 1** show the site and extent of the proposed road dam.



*Photo 8: Guezanhe: Site of Proposed Road Dam
View is looking south towards Machaze.*

The principal technical features of the proposed road dam are:-

- Catchment area – 4.4km²
- Full Supply level (FSL) – 272.0mamsl
- Storage capacity – 28,245m³
- Length of embankment – 168m
- Finish Road Level (FRL) of embankment – 273.0mamsl
- Invert Level (IL) of existing triple 800mm dia. culvert – 266.8mamsl
- Freeboard – 1.0m
- Maximum water depth (above culvert invert) – 5.2m
- Maximum height of embankment (above existing road level) – 5.0m
- Volume of earthworks in the embankment – 6,952 m²
- Drop-inlet spillway with an 8m cill discharging into the existing triple 800mm dia. cgi culvert.

The local community of Chitendeua are appreciative of the project, especially in view of the previous failed attempt to store water 200m downstream of the site. It will provide water from a source nearer than the Ministry of Agriculture borehole at Guezanhe and also relieve pressure on this borehole.

5.6 PROJECT SUMMARY INFORMATION TABLES

General information regarding the projects, type of storage, capacity and potential populations served are presented in the table following.

Table 11:: Project Information Summary Table

No.	Name Road District Province	Proposed Pilot Project Design Works	Catchment / Basin Areas	Max. Depth / Storage Capacity	Potential Population Served	Proposed Uses of Water
INH/1	Nhambuica N1 Masinga Inhambane	Improved borrow pit. Experimental sealing of the base of a rehabilitated sand borrow pit with bentonite and, if successful:- • Diversion of a lined drain from the N1 into the pit to increase inflow; • Fencing of the borrow pit	Borrow pit area 1.34ha	2.5m 9,252m ³	24,00	• Livestock watering • Cultivation
INH/2	Tambajane Unclassified Morrumbene Inhambane	Road dam. Raising an existing low embankment by 1.2m over a length of 180m and construction of a 30 x 3m reinforced concrete drop-inlet spillway discharging through the existing pipe culverts.	Catchment 39 km ² Basin 3.98ha	2m 23,116m ³	14,000	• Livestock watering • Cultivation
INH/3	Inhamussua R482 Homoine Inhambane	Road dam. Utilisation of an existing 4m high embankment without raising. Construction of an 8.5 x 4.25m reinforced concrete drop-inlet spillway discharging through the existing box culvert. Ancillary works include:- • Guardrail for road safety	Catchment 5.8km ² Basin 2.11ha	2.6m 19,995m ³	12,000	• Livestock watering • Cultivation
INH/4	Pambarra N1 Vilankulo Inhambane	Improved borrow pit. Protection of a perennial water source within Pambarra calcrete quarry by:- • Fencing; • Construction of a collector well complete with handpump; • Construction of a livestock drinking trough	Borrow pit area 2.19ha	2.5m 2,344m ³	1500	• Potable water • Laundry • Livestock watering

No.	Name Road District Province	Proposed Pilot Project Design Works	Catchment / Basin Areas	Max. Depth / Storage Capacity	Potential Population Served	Proposed Uses of Water
MAN/1	Saibera N261 Macossa Manica	Improved borrow pit. Protection of a perennial water source retained within a borrow pit by:- • Fencing; • Construction of a collector well complete with handpump; • Construction of a livestock drinking trough	Borrow pit area 0.55ha	2m 5,610m ³	240	<ul style="list-style-type: none"> • Laundry • Livestock watering • Cultivation
MAN/2	Dunda N261 Macossa Manica	Road dam. Construction of a new 5m high embankment over a length of 309m and a 9 x 2m reinforced concrete drop-inlet spillway discharging through the existing double pipe culvert. Ancillary works include:- • Guardrail for road safety	Catchment 1.4km ² Basin 1.64ha	4m 30,187m ³	800	<ul style="list-style-type: none"> • Livestock watering • Cultivation
MAN/3	Magaro N260 Sussendenga Manica	Improved borrow pit. Protection of a perennial water source retained within a borrow pit by:- • Fencing; • Construction of a collector well complete with handpump; • Construction of a livestock drinking trough	Borrow pit area 3.2ha	3.5m 9,328m ³	1,000	<ul style="list-style-type: none"> • Laundry • Livestock watering • Cultivation
MAN/4	Guezanhe R521 Machaze Manica	Road dam. Construction of a new 5m high embankment over a length of 168m and an 8 x 2m reinforced concrete drop-inlet spillway discharging through the existing triple pipe culvert. Ancillary works include:- • Guardrail for road safety	Catchment 4.4km ² Basin 1.76ha	4m 28,245m ³	17,000	<ul style="list-style-type: none"> • Livestock watering • Cultivation

6 TENDER DOCUMENTS

6.1 INSTRUCTION TO TENDERERS / CONDITIONS OF CONTRACT

The Instructions to Tenderers, which incorporate the General and Special Conditions of Contract, are based on those for the Provincial Maintenance Contracts. Sample documents are presented in **Annex 2 App 1**

6.2 GENERAL SPECIFICATION

The General Specification covers general construction requirements in respect of:-

- Preliminary and General
- Site Clearance
- Earthworks
- Concrete (Small Works)
- Pipe Work
- Ancillary Works
 - Guardrails;
 - Handrails;
 - Fencing;
 - Blockwork;
 - Collector Well;
 - Livestock Drinking Trough, and
 - Washing Slab.

The General Specification has been derived from the SANS 1200 series of Standardised Specifications for Civil Engineering Construction and the SATCC Standard Specification for Road and Bridge Works, both of which are used extensively in Mozambique. The referenced SANS 1200 specifications are:-

- SANS 1200 AA – General (Small Works)
- SANS 1200 AD – General (Small Dams)
- SANS 1200 C – Site Clearance
- SANS 1200 DA – Earthworks (Small Works)
- SANS 1200 DB – Earthworks (Pipe Trenches)

- SANS 1200 DE – Small Earth Dams
- SANS 1200 GA – Concrete (Small Works)
- SANS 1200 HA – Structural Steel Work (Sundry Items)
- SANS 1200 L – Medium-Pressure Pipelines
- SANS 1200 LB – Bedding (Pipes)
- SANS 1200 LE – Stormwater Drainage
- SANS 1200 MM – Ancillary Roadworks

(See Annex 2 App. 2)

The General Specification includes the following standard drawings:-

- STD/1 – Contract Signboard
- STD/2 – Guardrail Details
- STD/3 – Handrail Details
- STD/4 – Fencing Details
- STD/5 – Collector Well
- STD/6 – Livestock Drinking Trough
- STD/7 – Washing Slab
- STD/8 – Culvert Headwall and Trench Details

6.3 PROJECT SPECIFICATION

The Project Specification covers the scope of works and the site specific conditions and requirements at each Site. The requirements of the Project Specification are in addition to and, where necessary, take precedence over the requirements of the General Specification. Clauses in the Project Specification cover the following:-

- General description of the contract;
- Description of the site and access;
- Details of the contract including:-
 - The scope and nature of the works
 - Construction drawings
 - Survey
- The nature of the ground and borrow material;
- The construction programme;
- Site facilities
 - Availability of utility services
 - Location of the contractor's camp

- Facilities required for the Engineer
- Any features that require special attention

The project specifications are standalone documents so that each pilot project can be put out to tender separately. The project specifications are presented in **Annex 2 App. 3**.

6.4 BILL OF QUANTITIES

The Bill of Quantities for each project follows the format established in the General Specification with separate sections for each type of work plus a section for dayworks. Each section is scheduled as follows:-

Item	Payment Ref	Description	Unit	Quantity	Rate [Mtn]	Amount [Mtn]
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The bills of quantities, together with the project specifications, are standalone documents so that each pilot project can be put out to tender separately. The Bills of Quantities are presented in **Annex 2 App. 4**.

6.5 CONSTRUCTION DRAWINGS

Construction drawings have been prepared at appropriate scales to show site layouts, longitudinal profiles, cross-sections, structures and reinforcement details. All construction drawings are A3 size.

7 SOCIOLOGICAL SURVEY

7.1 INTRODUCTION

This section forms part of the project's draft design plan, providing socio economic information for each of the project sites for planning, and to provide guidelines for of stakeholders participation in the project and for the users taking over the responsibility management of the road ponds.

Furthermore, based on experiences of the pilot project so far and on the relevant institutional stakeholders, recommendations for the operation of future road pond activities by ANE are suggested. The specific objectives are:

- To provide relevant socio economic information about each project site and to present the suggestions of local stakeholders to be taken into account at the final design ,
- To suggest additional socio economic criteria to be built into any future site selection processes of road pond
- To identify stakeholders at the sites and document recommendations for their involvement at the different stages of the project
- To establish the necessary structure, responsibilities and functions of community road pond management committees and to identify strategies and actions for strengthening their effective functioning
- To offer a guideline for the implementation of road pond by ANE

They are presented as follows:

- i) The process followed for reaching the objectives indicated above;*
- ii) Results obtained regarding socioeconomic characteristics for each of the sites and across sites; iii) Results of meetings and consultations to stakeholders about the project; iv) Main characteristics of stakeholders; v) Finally conclusions and recommendations related to the objectives indicated above.*

Annex 3 contains the appendices to this section. They comprise: **App. 1** - A list of participants of each of the meetings (including names and contact of district authorities, technicians and community leaders); **App. 2** - shows the lists of the members of the Community Road Pond Management Committees established at the sites;). **App. 3** is the Characteristics of the Inhambane and Manica Sites; **App. 4** - Stakeholders of a possible Road Pond Project in ANE; **App. 5** the Roles and Responsibilities of the Road Ponds Project Partners and Local Stakeholders. **App. 6** gives some Guidelines for Socio Economic Appraisals for Planning, Monitoring and Evaluation and **App. 7** indicates Sources of Secondary Information.

7.2 APPROACH AND METHODOLOGY

7.2.1 APPROACH

The project's approach regarding the communities is participative, seeking the participation of relevant stakeholders during all the stages of the project cycle; especially active involvement of the road ponds users, mainly the inhabitants living in the influence area of the eight project sites. Furthermore, the project formulates an explicit gender approach.

The type of local participation for the project is consultative, in the sense that the project has been conceived by AFCAP and afterwards was presented to the stakeholders, inviting them to contribute with their opinions and suggestions, which are to be taken into account. Local participation is required to ensure the project's successful implementation through i) provision of first hand information on local characteristics, potentials and needs; ii) building up relationships with and between relevant stakeholders and iii) creating a community organizations, willing and capable to cope with the project's successful implementation.

7.2.2 METHODOLOGICAL ASPECTS AND FIELDWORK PROCESSES

During the initial project site visits in November/December 2012 basic data regarding population, settlement patterns, water supply and agriculture activities was collected in order to provide information for the selection of potential project site. Following the identification of potential sites the detailed fieldwork was carried out in January and February 2013. The project team comprising sociologist, interpreter of local languages and support staff from ANE and available technical staff from province.

Initial tasks were to organize meetings with relevant stakeholders and then to facilitate active exchange of ideas between stakeholders and the project team. Stakeholders to be approached during the process were identified during meetings with the the road ponds steering committee⁴; namely the District Services for Planning and Infrastructure (SDPI) and the District Services for Economic Activities (SDAE) of each district. At community level particular attention was to be given to ensuring legitimacy of activities by involving both, the representative Government Local Authority as well as the Traditional Community Leader.

For legitimizing the access to the communities, the project team was provided with a credential provided by ANE, which was shown to, and stamped by each Director of the respective district services; afterwards the stamped credential was presented to community authorities (both, president and traditional leader of the community), who then organized the community meetings.

Table 1 below shows the stakeholders who have been approached during the fieldwork and the reasons for including each of them, as well as specific objectives of the meetings.

Each meeting at both district level and community level, had the same structure: i) presentations; ii) presentation of the objectives of the meeting; iii) very detailed explanation of the project and of the proposed works at the respective site; iv) discussion on specific aspects, observations and suggestions of stakeholders. If suitable, at the end of the meetings, some socioeconomic information was gathered.

⁴ Realized on 9.1.13 at ANE-Inhambane

The community meetings were held on site, with the number of participants varying from 12 participants at Inhamussa to 30 participants at Nhambuica. Names of the participants on each of the community meetings are presented at Annex I. Furthermore, at the community meetings particular attention was to be made to enhancing women's involvement in the project.

At the community meetings (authorities and community members), discussion focused on:

i) foreseen use of the road pond, ii) possible impacts on health; iii) opinions and suggestions regarding the proposed work, iv) responsibilities of community with regards to maintenance of the pond and installations.

With regards to the management of the road ponds once the details had been explained and any queries dealt with, the community members themselves then defined and agreed upon their responsibilities and tasks in regard to the maintenance and management of the road pond.

Following this, the group was requested to organize a pond management committee, to oversee the agreed maintenance and management functions once the project has been implemented.

One of the projects' key aspects, which was made very clear at every visit and meeting, was the fact that these ponds projects form a part of an overall road project, they are not primarily water projects. ANE is looking at ways in which some of the structures used for the roads might also be utilised for the benefit of the community by storing rain water.

Table 12: Participation of stakeholders at the process

Stakeholders and reasons for their inclusion	Purposes	Objectives of participation
ANE Provincial Delegate (both provinces) Reasons: <ul style="list-style-type: none"> • ANE will implement the project • As a governmental institution, ANE, is firmly established in the formal administrative system, and is able to facilitate official project activities at district level 	Support of fieldwork Enhance involvement on project	<ul style="list-style-type: none"> • To understand and support the project • To arrange official district instances and announce project team visits • To supply necessary credentials for authorizing any sitework • To provide technical support and to share opinions and suggestions about proposed project work
Technician of DPOPH-Inhambane (Provincial department of public works and housing) <ul style="list-style-type: none"> • Expert in hydraulic works • Member of project's steering committee 	Technical advice on sites at Inhambane Enhance participation of DPOPH on project	<ul style="list-style-type: none"> • To participate on visits and meetings on districts and communities • To discuss with district authorities and technicians about technical aspects of proposed works • To provide opinions and suggestions based on technical expertise
ANE Technicians <ul style="list-style-type: none"> • Facilitate/support site visits 	Technical advice at sites Enhance involvement of ANE on project	<ul style="list-style-type: none"> • To participate on visits to sites and at meetings • To facilitate communication between project team and local authorities • To inform ANE director on results of meetings
Directors of SDPI and SDAE <ul style="list-style-type: none"> • Lead district development planning and implementation • For the project's successful implementation it should be inserted on official district processes and programs • Knowledge of potentials and constraints, needs and priorities at district level 	Technical advice Participation at project	<ul style="list-style-type: none"> • To know the project and specifically proposed improvement on site(s) at district • To contribute opinions and suggestions on proposed project work • To participate at its implementation and monitoring
Technicians of SDPI and/or SDAE <ul style="list-style-type: none"> • Technical knowledge related to water supply • Knowledge of characteristics, potentials, constraints, needs, possibilities of communities 	Technical advice Supply of socio economic information	<ul style="list-style-type: none"> • To provide opinions and suggestions, based on technical expertise as well as on knowledge of local characteristics • To provide socio economic information
Director of administrative post at Dombe <ul style="list-style-type: none"> • Leads local development activities 	Participation on project	<ul style="list-style-type: none"> • To know the project and specifically on Magaro site • To share opinions and suggestions on proposed work • To provide socioeconomic information

Stakeholders and reasons for their inclusion	Purposes	Objectives of participation
Technician of administrative post of Dombé <ul style="list-style-type: none"> • Technical knowledge on fish production • Close contact to community 	Technical advice	<ul style="list-style-type: none"> • To know the project site and proposal at Magaro • To inform the director about community meeting • To provide recommendations on fish production
Community leaders <ul style="list-style-type: none"> • Official contact between community and official instances (political, administrative, community development programs) • Formal representatives of community needs, potentials, constraints • Local knowledge • Sources of information on socioeconomic characteristics of sites 	Sharing of knowledge Involvement on the process (leading)	<ul style="list-style-type: none"> • To know the project and specifically proposed improvement at their community • To share opinions and suggestions on proposed improvements • To provide socioeconomic information on the site
Community members (users, men and women) <ul style="list-style-type: none"> • Target group • Local knowledge • Information on socioeconomic characteristics of sites • In charge of maintenance of road pond at their community 	Involvement on the process Sharing of knowledge and information	<ul style="list-style-type: none"> • To know the project; specifically proposed improvement at their community • To share opinions and suggestions on proposed work • To provide socioeconomic information about the site

To ensure proper understanding of the proposals and to elicit useful opinions and suggestions from the participants, the community meetings were held at the actual project sites. Visual aids were also used; including pictures and diagrams of the proposed works taken from the inception report and drawings and concept maps on charts and on the ground to explain the proposals and for the discussions and observations. At the community meetings discussions were held using local languages with contributions immediately being simultaneously translated into Portuguese in order to ensure overall understanding of the discussions.

The community meetings were preceded by meetings with the community leaders. This was so that community leaders could be thoroughly informed on the project and they could then actively participate with and contribute to the project team's explanations.



Photo 9: Use of visual aids at Inhamussa Community Meeting

Women's participation has been explicitly emphasised, the project having been presented separately to men and to women. Idem, opinions and suggestions were requested separately.



Photo 10: Women and men attending project explanations at Dunda

To obtain necessary socioeconomic data, semi structured interviews were held with local residents, direct observations of situations made and participative concept mapping with communities was carried out. The concept mapping was a useful tool for sharing information with different groups.



Photo 11 Meeting with Community Leaders at Dunda and at Pambara

Interviews covered issues such as the population of project target groups and immediate surroundings, types and extent of economic activities in area, the main agricultural actions and livestock populations, existing water supply and management, water needs; health issues related to stored water, existing community programs and community organizations.

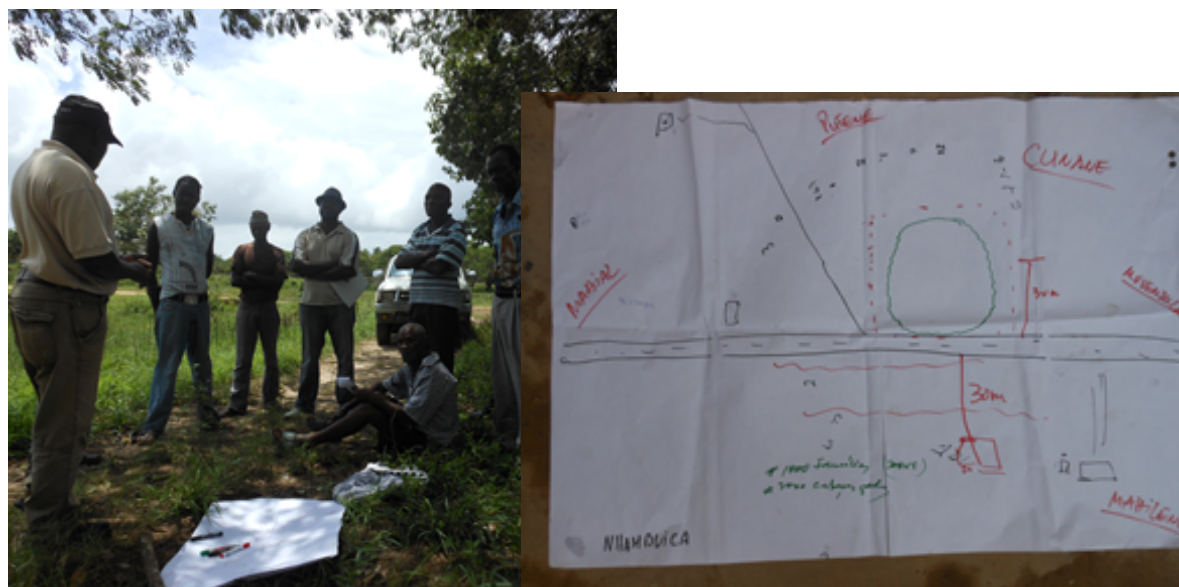


Photo 12: Example of Concept Map (surroundings of Nhamboica) and preparing for mapping at Tambajane

It was difficult to obtain sufficient reliable quantitative socio-economic data at district and community levels. Therefore primary information has been complemented with data obtained from respective district development plans, provided generously by GIZ-Inhambane and GIZ Manica. Secondary information also has been used for describing the political and institutional frame of rural water supply in Mozambique. The sources of information are listed in **Annex 3 App. 7**.



Photo 13: Community meetings at project sites in Magaro and Guezanhe

Annex 3 App 1 contains the participants at the meetings and visits and the respective lists of participants. A list of the elected management committee at each site members is shown at **Annex 3 App 2**.



*Photo 14: Community Meeting at Nhmbuica and
Project Team Members Community Tambajane*

7.3 SOCIOECONOMIC CHARACTERISTICS OF PROJECT SITES

Socioeconomic characteristics of each one of the sites is presented in **Annex 3 App. 3** following. Summaries of the characteristics are presented below..

7.3.1 PROJECT LOCATIONS

Four project sites are located within the Inhambane Province and four sites are located within the Manica Province. **Figures 1 & 2** show the specific location of each project sites.

Table 13: Location of Project Sites

Name of site Province	District Province	Location	Proposed Type
Inhamussa	Homoine Inhambane	On R 482, 11 km from Maxixe towards Homoine, on the limit between communities Inhamussa and Muduele	Road Dam
Tambajane	Morrumbene Inhambane	Unclassified road, 21 km from Morrumbene to Tambajane at sub community Mubule, 1 km before Tambajane	Road Dam
Nhambuica	Massinga Inhambane	On N1, at 9 km north of the locality of Unguana, at the community Nhambuica	Improved borrow pit, sealing of the base
Pambara	Vilankulo Inhambane	At 6 km west of N1, from community Pambara/sub community Mussunga	Improved calcrete borrow pit
Magaro	Sussundenga Manica	On N260, from Chimoio to Lucite at, 4 km west of the locality of Dombe.	Improved borrow pit
Guezanhe	Machaze Manica	On R 521, from Muxungue to Machaze, about 3 km west of Guezanhe	Road dam
Saibera (Gravel)	Macossa Manica	On R 261 to Macossa, at 29 km from N7 and 10 km after the community of Dunda.	Improved borrow pit
Dunda	Macossa Manica	On R 261, at 29 km from Cruz N1 to Macossa, 1,5km before Dunda.	Road dam

At following, relevant socio economic characteristics of sites will be compared, pointing out some similarities and differences between them.

7.3.2 POPULATION DISTRIBUTION FOR EACH OF THE SITES

The population distribution fro the proposed sites is summarised below.

Table 14. Population at each project sites.

Site	Approximate population of users ⁵		
	Nr. of families	Members / family	Total persons
Inhamussa	200	12	2.400
Tambajane	1000	14	14.000
Nhambuica	1000	12	12.000
Pambara	105	14 - 15	1.500 – Main users: 100
Magaro	28	2 to 20	240
Guezanhe	20 to 50	5 to 10	Guezanhe: 500 Near site: 300
Saibera	58	5 to 30; avg: 20	1.000
Dunda	700	20 to 30	17.500

Source: interviews with community leaders and residents

As shown in **Table 15** the potential number of users of the road ponds varies from about 28 families at Magaro and Guezanhe to as many as 1000 families at Tambajane and Nhambuica. The sites with the highest population are Tambajane, Nhambuica and Dunda, with over 700 families per site. The sites with less population are Magaro, Saibera and Guezanhe with fewer than 60 families. In total, the potential users of improved road ponds could be around 3 000 families.

7.3.3 AGRICULTURE AND LIVESTOCK PRODUCTION

Table 16 shows relevant characteristics of agriculture at each of the sites.

⁵ Numbers have been estimated by community members. Sometimes the totals do not correspond to inputs.

Table 15: Relevant characteristics of agriculture at project sites.

Site	Type	Area of Cultivation /family	Potential for agriculture	Main Constraints
Inhamussa	Mainly subsistence with some cashews for cash. Mainly rainfed. Irrigation from river basin	0,1 to 2,0 ha	High potential for diverse annual crops and cassava, mango, coconut, cashew nuts	No stored water - so water availability seasonal relying on rain fall
Tambajane	Subsistence rainfed agriculture	1 ha	Fertile soils	Dry area – low rainfall
Nhambuica	Subsistence rainfed agriculture	1 ha	Fertile soils	No stored water - so water availability seasonal relying on rain fall
Pambara	Subsistence agriculture with some commercial maize production Mainly rainfed	subsistence 1 ha, 3+ ha cash crops (17 farmers)	Fertile soils. Permanent water sources for possible irrigation	Dry area
Magaro	Subsistence and commercial production of maize, sesame and cotton	subsistence 1 ha; 2 - 4 ha cash crops	Fertile soils	No stored water - so water availability seasonal relying on rain fall
Guezanhe	Subsistence and cashew for cash.	1,5ha	Potential for cashew nuts	Dry area
Saibera	Subsistence and commercial maize, cotton sesame for cash	1,5 – 2 ha	Fertile soils	No stored water - so water availability seasonal relying on rain fall
Dunda	Subsistence and commercial maize, cotton sesame for cash	1,5 – 2 ha	Fertile soils	No stored water - so water availability seasonal relying on rain fall

Source: community members, SDAE technicians

Almost all the families living within the project influence rely on low input, diversified subsistence agriculture, each family cultivating about 1 hectare of basic food stuffs such as maize, beans, peanuts, cassava, banana, sweet potatoes, some vegetables and some fruits. Multiple cropping is used for subsistence production, allowing for the provision of different crops throughout the seasons and also, in the case of leguminous crops, serves to replenish soil fertility. Agriculture is mostly rainfed, but there are small amounts of irrigated crops where water sources are available,

Generally, family manual labour is used for the land preparation, and the whole family is involved in the farming activities, with exception to Guezanhe, where men are absent working as migrant labour outside the area and the farming is performed mostly by women.

When there is surplus produce this may be sold at nearby markets or on the road side to supplement cash income.

In the Inhambane province and at Guezanhe, cashew trees are dispersed around the area. These provide an important source of cash as they tend to do better in dry years and provide alternative income source.

In some areas livestock production also contributes towards subsistence. Cattle are held by most families (see details on table 17). Cattle function as savings and constitutes insurance for the families, especially during the hardship periods. Goats are present at all sites, providing cash for family needs. Other minor animals, such as chicken and turkeys provide protein for the family and are sold occasionally.

Commercial agriculture is practiced on a small scale at some of the sites, especially Magaro, Saibera and Dunda, which are fertile and traditional cotton production areas. Commercial livestock production in the form of small scale cattle production is practised at Inhamusa with the meat being sold in nearby towns.

At some of the sites, District Services for Economic Development (SDAE) promote commercial agriculture and livestock production at Magaro, Dunda, Saibera and Pambara (production of annual crops), at Inhamussa and Guezanhe (cashew nut production), and at Inhamussa, and Pambara (cattle production).

Although the soil fertility is good at most sites, the agriculture potential is severely constrained due to lack of water for farming activities. Crops are largely rainfed relying on the often erratic seasonal rainfall and there is little or no stored water in the areas. The same applies to livestock production, lack of water being the main constraint for its expansion. Populations are highly reliant on boreholes which tend to be in short supply and over utilised.

The number of cattle and goats at each site is shown below, as well as constraints and potential for cattle production

Table 16: Livestock production at project sites

Site	No. Cattle	No. Goats
Inhamussa	400	< 100
Tambajane	80	> 1000
Nhambuica	2000	> 5000
Pambara	2500	> 3000
Magaro	29	> 1000
Guezanhe	500	< 200
Saibera	nil	> 15.000
Dunda	20 - 30	200-300

Generally livestock production is constrained by lack of available water for livestock

Sources: community members, SDAE technicians

To lessen demand on boreholes by providing an alternative water source for livestock and also to increasing the potential for keeping livestock is a main reason given by the residents for having the road ponds.

7.3.4 SOURCES OF INCOME

The absence of significant local sources of income is something most sites have in common, most families living in area rely on subsisting farming. Lively hood strategy is based on diversification of produce to take advantage of any opportunity for income generation.

Table 17: Main sources of income at project sites

Site	Activities	Location	Comments
Inhamussa	Commerce of agriculture produce, mainly vegetables, cashew nuts and coconut (copra). Commerce of meat	Roadside markets or nearby town markets	All commerce is very small scale.
Tambajane	Small scale informal commerce of agriculture surplus and local products (mainly beverages)	local	Few income sources close to the community.
Nhambuica	Small scale commerce of agricultural surplus. Migrant labour working on mines	Roadside markets or nearby town markets	There are no major sources of income in Massinga District
Pambara	Some commercial agriculture, mainly maize. Some commerce in local products (beverages, food) Production of aggregate	Vilankulo and surrounding areas. Along N1	Commercial agriculture and cattle production is promoted by SDAE but so far this only involves a few farmers.
Magaro	Some Commercial Agriculture	Private purchasers	Commercial agriculture very small scale.
Guezanhe	Small scale commerce of cashew nuts Migrant labour working on mines	Commerce of cashew nuts through SDAE. South Africa.	Most men leave to work on SA mines during the whole year.
Saibera	Commercial Agriculture. Brick production	Private purchasers	Commercial agriculture very small scale.
Dunda	Commercial Agriculture. Brick production	Private purchasers	Commercial agriculture very small scale.

Sources: Community members, SDAE and SDPI technicians, direct observation

- In Dunda (Macossa district) and Magaro (Sussendengue district), commercial agriculture constitutes the main source of income. Crops are cultivated for private enterprises which provide the seed and pesticides and purchase the production.

- In the districts of Homoine, Massinga and Morrumbene, at Inhambane Province; and district of Machze at Manica Province, cashew production constitutes an important source of income.
- In Massinga and Morrumbene district, a main source of income is placed at South African mines.
- Other sources of income are livestock production and informal commerce in items such as beverage, household utensiles and food. In Saibera and Dunda for small scale commercial brick production provides additional income when water is available for brick molding.

7.3.5 WATER SUPPLY AND NEEDS

The main permanent source of safe water for rural population at general, and specifically at each of the project sites comes from bore holes. Boreholes have been installed at rural communities since the mid-nineties, through official programs, such as “Agua Rural” and by private organizations (e.g. CARE, WATER AID, CARITAS, CONCERN, GTZ etc).

Most of them were placed near public services, such as schools, health posts, agriculture nurseries etc; yet they can be found also at the house of community leaders. Boreholes are provided with a hand pump, mainly of the “Afridev” type. Some sites are equipped with a laundry slab and water trough.



Photo 15: Community pump at Pambara

Accordingly to the National Water Policy, each pump should serve 500 families. However more people are using each borehole than this because of population growth and break downs of

pumps⁶. Part of the reason for the break downs of pumps is attributed to intensive use and also to the pumps not being designed to operate at the depths need to reach the water table on some boreholes.⁷ At relatively densely populated areas, boreholes are placed at about every 5 km along roads. Nevertheless, in less densely populated areas, boreholes can be very far away from households.

Table 18: Permanent water sources and their use at project sites

Site	Use	Permanent sources	Problems and needs
Inhamussa	Mainly human	Community borehole, at 0.2 km from site	Break downs. Competition between human use and livestock
	Mainly livestock	Inhanombe River, at 1 km from site	Need for more water sources for extension of livestock production
	Mainly agriculture	Subterraneous stream, water table at cultivated area is one meter in January.	none
Tambajane	All usages	Two community boreholes at 200m and 1km from the site	Break downs. Competition between human use and livestock
Nhambuica	All usages	Two boreholes at nearby sub communities Malihab and Maguna, at 2 km and 3 km from site	Break downs. Competition between human use and livestock. Over demand causes delay at pump; women spending 3 – 5 hours at borehole
Pambara	Mainly human consumption and livestock.	Borehole on N1 at 6 km from the site.	High demand and competition between human use and livestock. Break downs.
	Mainly drinking	Wells and lagoon at calcrete borrow pond	Pollution, especially during dry season
Magaro	All usages	Nearby borehole	More water of good quality, at safe from crocodiles, for all kind of usages. (More boreholes)
	All usages	Lucite River, 3km distance	Crocodiles.

⁶ Accordingly to official sources, near 20% of boreholes installed at rural areas of Mozambique are not functioning

⁷ Accordingly to PDOPH-Inhambane

Site	Use	Permanent sources	Problems and needs
	All usages	Borrow pit	Two small crocodiles and heavy pollution and bad smell towards the end of dry season
Guezanhe	All usages	3 boreholes at 2km, 3 km and 9 km distances from site.	Heavy competition between people and livestock, especially during dry season
Saibera	All usages	Community pump, at 50 m from site	During dry season, strong competition between people and livestock. The most felt need is water for irrigation
	Mainly irrigation	Private 7 m deep well near the site	Private. The most felt need is more water for irrigation
Dunda	All usages	Two boreholes, at 50 m and 1,5km from site	During dry season, strong competition between people and livestock. The most felt need is water for irrigation

Source: Community members at project sites

Community boreholes are meant for human use, however, due to lack of alternative water sources, they are also used for livestock watering, and even for small scale gardening. Consequently demand on bore holds is high; competition between people and livestock being especially hefty during dry season. Competition between people is common also. For example, getting water at the nearby community pump at Nhamuica project site, takes 3 to 5 hours a day.

Additional water sources are rivers and natural wells. Some borrow pits, wells and river pools maintain water during the whole year but the quality of these sources deteriorates during dry spells due to uncontrolled livestock contamination as well as through human use (laundry, bathing). An important water sources for those without reasonable access to permanent water sources is rainwater. After a heavy rainfall, these people collect water from any natural depression that fill up.

Table 12 indicates that the main requirements of community members are more water for livestock and irrigated agriculture. With regards to livestock, alternative water supply would decrease the pressure on community boreholes. Furthermore, as at the case of Inhamussa and

Tambajane, livestock production could widen to areas which otherwise would not be exploited because of lack of water⁸.

7.4 WATER MANAGEMENT COMMITTEES

Accordingly to the Manual for Rural Water Projects (MIPAR), in Mozambique, the management body at the community level is the water committee, with the following duties:

- Collect and manage funds to be used on operation and maintenance, repair and replacement.
- Promote the cleaning of the water source.
- Undertake routine maintenance of the water source.
- Repair the hand pump.
- Ensure the correct use of the water source.
- Keep the district authorities regularly informed of the water supply situation⁹.

In Inhambane and Manica Provinces, community water management committees have been established for many communities during early 2000's, being part of water supply projects implemented mainly by NGOs. Most of the committees received training to realize their functions; and are still functioning, managing the respective community boreholes, collecting the water user's contributions and using that money for repairs when the pump breaks down.

Details on water management system of permanent water sources at each of the project sites are shown below.

Table 19: Water management at project sites

Site	Permanent water sources	Maintenance management
Inhamussa	Community borehole	In charge of Ministry of Agriculture, placed at cashew nursery
	Inhhanombe River,	None
	Up surging stream	None. Every farmer maintains his own irrigation canals
Tambajane	Two community boreholes	Community water management committee

⁸ Cattle don't move further than 5 – 8 km distance from water sources.

⁹ In: AMCOW/National Directorate of Water, Mozambique (2010) Country Status Overview on Water Supply and Sanitation for Mozambique

Site	Permanent water sources	Maintenance management
Nhambuica	Two community boreholes	Community water management committee in charge of maintenance of all pumps at Nhambuica
Pambara	Borehole	Located at the house of community leaders who collects user's contributions in case of break downs
	Well and lagoon at borrow pit	No maintenance
Magaro	Nearby borehole	Community pump attendant, yearly household contributions
	Lucite River	None
	Borrow pit	None
Guezanhe	3 boreholes.	In the event of the borehole breaking down, users contribute for spares and repair
Saibera	Community pump	Community leader is responsible for maintenance.
	Private well	Private
Dunda	Two boreholes	In the event of the borehole breaking down, users contribute for spares and repair

Source: Community members at the project sites

7.4.1 OPINIONS AND SUGGESTIONS OF STAKEHOLDERS

The stakeholders at all the sites, welcomed the project and its proposed improvements since both water availability and improvement of water quality are very important to their livelihood needs.

At the district and community meetings, many of the stakeholders discussed the proposed works in terms of their practicality and technical aspects, and offered suggestions based on local and knowledge and experiences. At some of the sites, men's concerns varied from women's concerns; the former being more concerned with availability and quantity, while women were also concerned with quality. At two sites (Inhamussa and Pambara), some of the stakeholders expressed concerns whether there would be a negative impact on the water availability downstream.

7.4.1.1 Water Usage

As can be seen in the table below livestock watering followed by vegetable gardens is viewed as the most important function of the road ponds..

Livestock, mainly cattle, consume a considerable amount of water per day. Alternative water supply for stock through road ponds will alleviate the heavy demand observed at all pumps. Additionally, incrementing and dispersing water sources for cattle permit them to exploit wider areas of forage. Lack of water was indicated as the main constraint for expanding cattle production in all district visited.

Irrigated vegetable production constitutes the second main use of the ponds. Food production, limited by lack of adequate water, is a huge concern of almost all families at project sites. Small plots of vegetables are grown near most of the community boreholes, in spite of the many difficulties in getting water from the borehole. Any additional water availability from the improved road ponds will certainly contribute to expansion of food production.

Table 20: Uses of Water from Road Ponds

Site	Main use	Additional
Inhamussa	Livestock	Laundry and Vegetable production bathing
Tambajane	Livestock, vegetable production	Not indicated
Nhambuica	Livestock, vegetable cultivation	Not indicated
Pambara	Livestock and human consumption	vegetable growing
Magaro	Livestock, laundry, bathing and human consumption	Fish production
Guezanhe	Livestock, laundry, bathing, human consume	Fish production
Saibera	Laundry, household consumption, livestock and gardening.	Brick production, baptism, fish production
Dunda	Laundry, household consumption, livestock and gardening.	Brick production, baptism, fish production

Source: Community meeting

7.4.1.2 Health issues

Health problems related to water source at project sites due to contamination of drinking water are widespread at the project sites and consist predominantly on diverse stomach upsets and Bilharzia; as well as on malaria, the later causing the main child mortality rate at most sites.¹⁰

¹⁰ District development plans

Opinions regarding the impact of the improvements of borrow pits on water pollution and consequent health improvement, as well as measures for mosquito prevention and/or control have been explored during the community meetings, local opinions and suggestions on health issues related to the road ponds being shown below.

Table 21: Local Opinions and Suggestions related to Health Issues

Site	Pollution Issues	Mosquito prevention and/or control
Inhamussa	Not viewed as a major problem, since the pond will not be used for human consumption.	Weeding of surroundings of the pond and use of mosquito nets
Tambajane	Not viewed as a problem.	Weeding of surroundings of the pond
Nhambuica	Fencing is considered to be an important contribution for avoiding livestock polluting the water.	Felt as irrelevant. Anyway, the pond is situated on an open and windy space
Pambara	Fencing the reservoir and thus leaving out livestock will reduce pollution	Mosquitoes were not seen as a problem.
Magaro	The used water will be spilled outside the pond, therefor the pond remaining clean	Fish production has been foreseen
Guezanhe	Not an issue	Once the project be established, the road pond management committee will approach SDAE for getting technical advice for fish production in the pond
Saibera	Fencing the pond and keeping out livestock will reduce pollution	Mosquitos were not considered as a problem. Weeding the surroundings of the pond. Use of mosquito nets Fish production, proposed by the project team, will be considered once the project being implemented
Dunda	Not an issue	Mosquitos were not considered as a problem. Weeding the surroundings of the pond. Use of mosquito nets. Fish production, proposed by the project team, will be considered once the project being implemented

Source: Community meetings

7.4.1.3 Organisation of the Local Road Pond Management Committees

At the final stage of the community meetings the responsibilities for maintenance and management of the road pond was discussed and agreed. The project team asked the group to organise a road ponds management committee composed of men and women.

On almost all sites, committee organisation had to be pushed as the groups first wanted to see and to appraise the proposed improvements before planning their use and management. However, for seven of the eight sites, road pond committee management committees have been established.

As shown below, the management mainly consist of keeping pond edges clear, taking care of the maintenance of the pump and raising users contributions.

Table 22: Community responsibilities regarding pond management

Site	Responsibilities regarding pond management
Inhamussa	Weeding of the pond; regulation of the amount of water passing from the pond through the culvert and drop inlet towards the agricultural land.
Tambajane	Weeding around the pond, aimed at facilitating access to the water and avoidance of proliferation of mosquitoes.
Nhambuica	Maintenance of the pump and weeding of the pond borders.
Pambara	To take care of the maintenance of the pump and to raise users' contributions for fixing possible breakdowns
Magaro	Maintenance of the pump and of the site, the main being concerns the pump.
Guezanhe	Weeding of the pond surroundings; to request for a fish production project at SDAE and seeking maintenance of the dam with ANE and district authorities.
Saibera	Requesting contributions of the users for buying tools for the weeding and inquires for supply of mosquito nets on the district.
Dunda	Weeding the pond, to guarantee access to the water and for avoiding proliferation of mosquitoes.

Source: Community meetings

7.4.2 RELEVANT STAKEHOLDERS

During the fieldwork, relevant stakeholders for specific project sites were identified. Most of these stakeholders belong to formal institutional structures related to rural water supply, but

within the frame of the pilot project they can be approached at district and community level. For the long term the road ponds project needs to formalise the articulation between road work and water supply.

The table below lists stakeholders who should be involved with the implementation.

Table 23: Relevant Stakeholders at each Site

Inhamussa Road Dam	<p>Besides the community authorities and members of Inhamussa and Madeula, relevant stakeholders are SDPI and SDAE, both situated at the town of Homoine. Both institutions focus on the improvement of water sources at district level, the latter envisages especially agriculture and livestock. Their respective directors understand and welcome the project.</p> <p>SDAE operates a cashew nursery near the site whose nursery manager is involved with agriculture in the area and due to both, her official position and her permanent presence at the area, she has good access to local stakeholders and will facilitate the establishment of the pond management committee¹¹.</p> <p>The community members were keen to participate in various activities¹².</p>
Tambajane Road Dam	<p>At district level SDPI and SDAE are relevant stakeholders of the project. However no district activities are being implemented in Tambajane at this time.</p> <p>Tambajane community quite passive towards development projects.¹³ Community leaders were weary of the project and its objectives but some community members were positive towards the project; specifically the community water management committee, which will also lead the road pond management committee.</p>
Nhambuica Borrow Pit	<p>Water supply is a major concern at district level. SDPI's director and technical staff participated on the community meeting, held at the project site, and they are very interested in participating at the implementation of the project.</p> <p>At community level, the active participation and interest of the community "regulo" (traditional leader) on the meeting was outstanding.</p>

¹¹ At Inhamussa no committee has been established

¹² See details on excavations wanted under opinions and suggestions

¹³ Accordingly to ANE and to DPOH technician

Pambara Borrow Pit	<p>Both, SDPI and SDAE are relevant stakeholders at district level; especially SDAE, which at present supports commercial agriculture at the area of influence of the project. SDAE director wishes to be informed once the project starts, for his technicians to participate on the improvements of the borrow pit.</p> <p>The first community leader, who besides of being the biggest farmer is an important political figure at the whole area, knows the site thoroughly and could contribute with valuable suggestions at the moment of the exact localisation of the pump and distribution points, based on his (local) knowledge and experience.</p> <p>The users of the borrow pit (men and women), even if not believing on any project promises, are very interested on improved availability and quality of water at the site. Once the project activities were to begin at the site, they won't hesitate on participating and contributing actively to its appropriate functioning.</p>
Magaro Borrow Pit	<p>Besides of SDPI and SDAE of Sussendenga, the administrative post at Dombe locality constitutes a relevant and committed stakeholder, whose director welcomed the project and spontaneously assigned the local fish production technician to accompany any further project activities; particularly to support possible fish production.</p>
Guezanhe Road Dam	<p>At district level SDPI and SDAE are relevant stakeholder, the SDPI director being very involved on projects.</p> <p>The Guezanhe community leader (regulo) is a very active and leader and he would ensure local participation and management of the pond. The main constraint for active participation of all community members on the project is the absence of the majority of men who work away from the area</p>
Saibera Improved Borrow Pit Dunda Road Dam	<p>At district level, SDPI and SDAE are relevant stakeholders -.</p> <p>At local level, it should be taken into account that the community leaders at Dunda lead the inhabitants of two sites, Saibera (borrow pit) and Dunda (Dam).</p>

7.5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR PROJECT PROCESS

There is no question that lack of water in rural areas is a major constraint for human and economic development. As can be seen from the sociological survey findings lack of water is a severe problem for all the areas which were covered.

Over 3.000 families (comprising up to 50 000 people) live within the influence areas of the (eight) pond projects. There are also some 5.500 head of cattle within this area. This means that significant numbers of people could benefit from improved water storage through projects such as this.

7.5.1 WATER USAGE, AVAILABILITY AND QUALITY

In all the communities visited boreholes provide the main permanent source of water for all types of water usage. The number of boreholes is limited and there is an over demand for the water which is available from these boreholes. This creates numerous problems in accessing water because of competition for the supply and time waiting for a turn at the pumps.

Establishment of alternative water sources for uses such as, livestock watering, laundry, washing and gardening could significantly reduce the pressure on the community boreholes. Also improved water availability through storage of run off from rain water could be utilised for increasing livestock numbers and crop production for the local communities contributing towards improved livelihood.

7.5.2 HEALTH ISSUES

The threat of an increase in mosquitos was not seen as a significant problem by local stakeholders; There was overall agreement that effective measures could be taken for their mitigation. The important issue was additional water availability.

Fencing of the road ponds, establishing remote facilities for the extraction of the water and preventing used water flowing back into the pond would significantly reduce the pollution factor and this would be a welcome improvement in water quality for whatever use.

7.5.3 STAKEHOLDERS OF PILOT ROAD PONDS IMPLEMENTATION AND MAINTENANCE

Both designated Community Representatives (Chefe da Comunidade) and Traditional Leadership (Regulo) need to give their support for the initiatives and must be involved with their development from selection through to their operation..

The SDAE (District Services for Economic Activities) and SPDI (District Services for Planning and Infrastructure) as responsible organisations for planning and implementing local development programs and projects are relevant stakeholders and should provide technical knowledge for water supply and usages.

At all the sites the communities welcomed the proposed work, identified themselves with the project and are aware of their responsibility in using and managing these water sources efficiently. The Communities agree on the importance of establishing functional management committees for road ponds. However they were reluctant to commit themselves before the project becomes more than a proposal.

There are many existing community water management committees which have been established since the mid-2000's,. These offer an appropriate model for the structure of the Community Road Ponds Management Committees and give the responsibilities and functions. Their roles and functions are defined by the government in the Manual for Implementation of Rural Water Projects (MIPAR, 2001).

At present there is not much regarding management systems of open water sources (ponds, lagoons, rivers, etc). As pump maintenance is the main issue resources tend to be aimed at the boreholes.

7.5.4 IMPLEMENTATION PLAN

Implementation of this project should be coordinated and shared with the respective district directorates and services, since these are the instances which plan, implement and coordinate community water supply and local development.

ANE does not have the structure or function to remain involved with the ponds after there construction except in as far as there are normal road maintenance and repair issues in regard to the road way. ANE would hand over the operation of the pond to the respective communities.

Besides the local participation in development and implementation of the road pond project, a key aspect for their sustainability will centre around the user's taking over the maintenance and management of the road ponds.

This implies support and training of local road ponds management committees on issues such as community organization, accountability, pump maintenance, acquirement of spare parts, pump reparation, relationships to district services, monitoring and control of water quality etc¹⁴. This will be coordinated with the relevant authorities to provide support as an extension to existing programmes.

With regards to composition, responsibilities and functions of the community road pond management committees, the model of already existing community borehole management committees should be adopted, since many communities have implement these for over ten years, and have proved their functionality and effectiveness¹⁵.

7.5.5 PROJECT MONITORING

Monitoring the behaviour of the ponds, such as their durability, operation, management and impact on the local environment should follow the participative project approach and involve the community management committee and/or community leaders from its planning stage on (e.g. defining criteria). Representative community road pond management committees should be contacted through the community authorities and leaders.

7.5.6 FUTURE ROAD POND ACTIONS

If ANE will be continuing to provide road ponds in the future a formal approach will need to be adopted in order to ensure coordination between the end users (communities) and the provider of the physical ponds (ANE).

The process needs to be properly handled as it has to find suitable sites which

- Fit in with the ANE Road Process,
- Meet technical and environmental requirements in terms of collecting and storing water, and
- Serve a useful purpose to the community and therefore be required by the community.

¹⁴ As evidenced through countless water supply programs and projects executed at rural areas in Mozambique and all over the world

¹⁵ If receiving training and technical and organizative support

This involves a number of different organisations, authorities and departments and requires a high level of organisation and coordination to bring all aspects together.

Annex cc presents a suggested process for doing this and highlights the main players and functions for implementing a project

7.6 SUMMARY OF BASE LINE DATA

The following 2 tables summarise the base line data which is given above.

Table 24: Base Line Data - Summary Population and Water Sources

Name of site	District Province Location	Nr. of families Total Persons	Permanent available water sources	Main usages of water from sources	Management and Maintenance of sources	Comments
Inhamussa	Homoine Inhambane On R 482, 11 km from Maxixe towards Homoine, between Inhamussa and Muduele communities	200	Community borehole	Mainly human	Under Ministry of Agriculture, located at cashew nursery	Frequent pump breakdowns – shortage
		2.400	Inhhanombe River,	Mainly livestock	None	Need for more water sources for extension of livestock production
Tambajane	Morrumbene Inhambane 21 km from Morrumbene towards Tambajane Mubule community, 1 km before Tambajane	1000	Up surging stream	Mainly agriculture	Farmers maintain their own irrigation canals	Break downs. Competition between human use and livestock
		14.000	Two community boreholes	All usages	Community water management committee	Break downs. Competition between human use and livestock. Over demand causes delay at pump; women spending 3 – 5 hours at borehole
Nhambuica	Massinga Inhambane On N1, at 9 km north of the locality of Unguana, at the community Nhambuica	1000 12.000	Two community boreholes	All usages	Community water management committee in charge of maintenance of all pumps at Nhambuica	Break downs. Competition between human use and livestock. Over demand causes delay at pump; women spending 3 – 5 hours at borehole

Name of site	District Province Location	Nr. of families Total Persons	Permanent available water sources	Main usages of water from sources	Management and Maintenance of sources	Comments
Pambara	Vilankulo Inhambane At 6 km west of N1, from community Pambara/sub community Mussunga	105 1.500 Main users: 100	Borehole	Mainly human consumption and livestock.	Located at the house of community leaders who collect user's contributions in case of break downs	High demand and competition between human use and livestock. Break downs.
			Well and lagoon at borrow pit	Mainly drinking	No maintenance	Pollution, especially during dry season
Magaro	Sussundenga Manica On N260, from Chimolo to Lucite at, 4 km west of the locality of Dombe	28 240	Nearby borehole	All usages	Community pump attendant, yearly household contributions	More water of good quality, at safe from crocodiles, for all kind of usages. (More boreholes)
			Lucite River Borrow pit	All usages All usages	None None	Crocodiles. Two small crocodiles and heavy pollution and bad smell towards the end of dry season
Guezanhe	Machaze Manica On R 521, from Muxungue to Machaze, about 3 km west of Guezanhe	20 to 50 Guezanhe: 500 Near site: 300	3 boreholes.	All usages	In the event of the borehole breaking down, users contribute for spares and repair	Heavy competition between people and livestock, especially during dry season

Name of site	District Province Location	Nr. of families Total Persons	Permanent available water sources	Main usages of water from sources	Management and Maintenance of sources	Comments
Salibera (Gravel)	Macossa Manica Province On R 261 to Macossa, at 29 km from N7 and 10 km after the community of Dunda.	58 1.000	Community pump	All usages	Community leader is responsible for maintenance.	During dry season, strong competition between people and livestock. The most felt need is water for irrigation
Dunda	Macossa Manica On R 261, at 29 km from Cruz N1 to Macossa, 1,5km before Dunda.	700 17.500	Private well Two boreholes	Mainly irrigation All usages	Private In the event of the borehole breaking down, users contribute for spares and repair	Private. The most felt need is more water for irrigation During dry season, strong competition between people and livestock. The most felt need is water for irrigation

Table 25: Base Line Data - Summary Agricultural and Activities

Name of site	Community Agricultural Activities					Other Commercial Activities		
	Type of Agriculture	Area of Cultivation /family	Potential for agriculture	Livestock. No of Cattle No of Goats	Main Constraints	Activities	Location	Comments
Inhamussa	Mainly subsistence with some cashews for sold commercially for cash. Mainly rainfed. Irrigation from river basin	0,1 to 2,0 ha	High potential for diverse annual crops and cassava, mango, coconut, cashew nuts	400 < 100	No stored water - so water availability seasonal relying on rain fall	Commerce of agriculture produce, mainly vegetables, cashew nuts and coconut (copra). Commerce of meat	Roadside markets or nearby town markets	All commerce is very small scale.
Tambajane	Subsistence rainfed agriculture	1 ha	Fertile soils	80 > 1000	Dry area – low rainfall	Small scale informal commerce of agriculture surplus and local products (mainly beverages)	local	Few income sources close to the community.
Nhambuica	Subsistence rainfed agriculture	1 ha	Fertile soils	2000 > 5000	No stored water - so water availability seasonal relying on rain fall	Small scale commerce of agricultural surplus. Migrant labour working on mines	Roadside markets or nearby town markets	There are no major sources of income in Massingira District

Name of site	Community Agricultural Activities					Other Commercial Activities		
	Type of Agriculture	Area of Cultivation /family	Potential for agriculture	Livestock. No of Cattle No of Goats	Main Constraints	Activities	Location	Comments
Pambara	Subsistence agriculture with some commercial maize production Mainly rainfed	subsistence 1 ha, 3+ ha cash crops (17 farmers)	Fertile soils. Permanent water sources for possible irrigation	2500 > 3000	Dry area	Some commercial agriculture, mainly maize. Some commerce in local products (beverages, food) Production of aggregate	Vilankulo and surrounding areas. Along N1	Commercial agriculture and cattle production is promoted by SDAE but so far this only involves a few farmers.
Magaro	Subsistence and commercial production of maize, sesame and cotton	subsistence 1 ha; 2 - 4 ha cash crops	Fertile soils	29 > 1000	No stored water - so water availability seasonal relying on rain fall	Some Commercial Agriculture	Private purchasers	Commercial agriculture very small scale.
Guezanhe	Subsistence and cashew for cash.	1,5ha	Potential for cashew nuts	500 <> 200	Dry area	Small scale commerce of cashew nuts Migrant labour working on mines	Commerce of cashew nuts through SDAE. South Africa.	Most men leave to work on SA mines during the whole year.

Name of site	Community Agricultural Activities					Other Commercial Activities		
	Type of Agriculture	Area of Cultivation /family	Potential for agriculture	Livestock. No of Cattle No of Goats	Main Constraints	Activities	Location	Comments
Saibera (Gravel)	Subsistence and commercial maize, cotton sesame for cash	1,5 – 2 ha	Fertile soils	Nil > 15.000	No stored water - so water availability seasonal relying on rain fall	Commercial Agriculture. Brick production	Private purchasers	Commercial agriculture very small scale.
Dunda	Subsistence and commercial maize, cotton sesame for cash	1,5 – 2 ha	Fertile soils	20 – 30 200-300	No stored water - so water availability seasonal relying on rain fall	Commercial Agriculture. Brick production	Private purchasers	Commercial agriculture very small scale.