AFRICA COMMUNITY ACCESS PROGRAMME
USE OF ROAD WORKS TO ENHANCE COMMUNITY WATER SUPPLIES IN MOZAMBIQUE.

PRE-INCEPTION REPORT
NOVEMBER 2012
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LIST OF ABBREVIATIONS

AfCap Africa Community Access Programme
ANE Administração Nacional de Estradas
ARA-Sul Administração Regional de Áquas do Sul
HDPE High Density Polyethylene (sheeting)
PI Plasticity Index
PVC Polyvinylchloride (pipes)
MZN Mozambique Meticais
USD United States Dollar
## UNITS OF MEASUREMENT

<table>
<thead>
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<th>Symbol</th>
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<tr>
<td>m</td>
<td>metre</td>
</tr>
<tr>
<td>mm</td>
<td>millimeter</td>
</tr>
<tr>
<td>m³</td>
<td>cubic metre</td>
</tr>
<tr>
<td>km</td>
<td>kilometer</td>
</tr>
<tr>
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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 Terms of Reference for the assignment are included in Appendix A.

The assignment is to take 5 months commencing 11th October 2012 with reporting as follows:

- Pre-Inception Report – 10th November 2012;
- Inception Report – 10th December 2012;
- Draft Design Report – 10th February 2013;

This report is the Pre-Inception Report covering the following activities carried out by the Consultant in the period 11th October to 10th November 2012:

- Setting-up of steering committee and meetings thereof;
- Review of literature;
- Evaluation of existing road ponds;
- Preliminary conceptual design criteria;
- Preliminary identification of sites for pilot projects.

2 OBJECTIVE

Resettlement of communities alongside upgraded and rehabilitated primary, secondary and tertiary roads has occurred throughout Mozambique. This has resulted in linear villages often with no focal point spread over long distances and, except at designated growth points, often lacking in basic utility services, especially water supply. Climate, relief, geology and soils often exacerbate the precarious water supply situation with regard to both surface and underground resources, which can result in low, unreliable and seasonal yields especially during the dry season.

Photos 1 and 2 indicate the precariousness of the water supply situation where villagers resort to abstracting water from road side drains and mitre drains in order to meet their basic needs including the need for drinking water.

It is recognised that road works can be used to enhance community water supplies either by building structures that utilise the road to retain water or by utilising water that collects in borrow pits from which road making materials have been extracted.

Consequently, the objective of the assignment is to undertake research by initially identifying and designing pilot projects whereby road works can be used to enhance community water supplies on a larger scale in Mozambique.
Photo 1: Villagers scooping water from lined side drain immediately after rain on the N1 near Cheline

Photo 2: Villagers skimming water from a mitre drain after recent rain along the R481 Mavume – Funhalauro tertiary road
3 PROJECT STEERING COMMITTEE

The consultant assisted ANE to establish steering committee of key stakeholders in the project at an inaugural meeting on the 17 September 2012.

The steering committee comprise the following members:

*Table 1: Steering Committee Members*

<table>
<thead>
<tr>
<th>Name</th>
<th>Representing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fernando Dabo</td>
<td>ANE Inhambane (Delegate)</td>
</tr>
<tr>
<td>Kingstone Gongera</td>
<td>Stange Consult</td>
</tr>
<tr>
<td>Jörg Stoll</td>
<td>Stange Consult</td>
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<td>Adonia Mupamba</td>
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<tr>
<td>Daisy dos Santos</td>
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<tr>
<td>Dias Constantino</td>
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</tr>
<tr>
<td>Adriano</td>
<td>DPS Inhambane</td>
</tr>
<tr>
<td>André Chongo</td>
<td>DPOPHI</td>
</tr>
<tr>
<td>Alfonsina Fernandos</td>
<td>DPANE-1</td>
</tr>
</tbody>
</table>

A second steering committee meeting was held on 22nd October 2012 at the provincial ANE offices in Maxixe.

4 REVIEW OF LITERATURE

Prior to commencing the field work a review of relevant literature was carried out. Documents reviewed include the following:-

- Using Road Works to Enhance Community Water Supplies in Mozambique, Phase 1 Final Report – Feasibility Study (AFCAP MOZ 004/A)
- Feasibility Study for a Road Construction and Maintenance Programme in Inhambane Province (by Stange Consult GmbH)
  - Outline Master Plan, Final Report: June 2005
  - Outline Master Plan, Annex 1 Road Inventory & Technical Data: June 2005
  - Outline Master Plan, Annex 2 Socio-Economic Background: June 2005
  - Final Feasibility Report: September 2005
  - Final Feasibility Report, Annex 1 Environmental Assessment: September 2005
Reference has also been made to the following technical literature:-

- South African Bureau of Standards (SABS) Standardised Specification for Civil Engineering Construction:-
  - SABS 1200 AD – 1986 General (Small Dams)
  - SABS 1200 DE – 1984 Small Earth Dams
  - SABS 1200 DK – 1996 Gabions and Pitching

5 EVALUATION OF EXISTING ROAD PONDS

5.1 ROAD STRUCTURES

5.1.1 BIRIRA RIVER WEIR

An existing road structure with which the Consultant was previously associated was inspected 26kms along the ER453 Cruz Mazoe to Chipembere road in Tete Province where it crosses the Birira River. The structure, see Photo 3, was built in 2006 at a cost of approximately MZN 8 million. It comprises a 40m long masonry weir which forms the carriageway and which also functions as the spillway, with earthfill embankments on each flank. Maximum depth of storage is 4m and the capacity is 50,000m$^3$. The catchment area is 46km$^2$. The outlet pipes are slotted PVC of 100mm dia. surrounded by 40mm crushed stone.

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1 The term “Road Ponds” is used in a generic sense to cover all types of installation that store water, including road dams formed by embankments, weirs or vented drifts and excavated reservoirs formed in either virgin ground or old borrow pits.
The structure is in sound condition and well maintained. Sediments had accumulated to a depth of about 2m; the top layer of deposited material was black silt. No surface water was visible at the time of the visit but immediately downstream of the weir there was a pool of water being used for laundry, livestock watering and brick making. It was not established whether the pool of water was formed by percolation through the foundation or was replenished by releases from the outlet valves. It is also apparent that water retained by the weir is also used for garden watering with a number of gardens encroaching into the basin. Domestic supplies of water are taken from a borehole in close proximity.

It is considered that the Birira road pond is a good example of the type of structure that might be built under the current pilot programme.

5.2 Excavated Reservoirs

5.2.1 Introduction

ARA-Sul has a project for providing some water by creating “tank dams” or excavated reservoirs, relying on surface run-off during the rainy season to replenish the storage. There are four trial schemes being implemented in Inhambane Province. All are based on the same general design and arrangement, with some site-specific variations.

5.2.2 Mucuine 1 and 2 (Funhalauro)

These two identical installations are 0.9km apart approximately 1.5km outside Funhalauro. A general view of Mucuine 1 is shown in Photo 4.
Each scheme comprises a reservoir excavated from ground level with inside dimensions of 70m x 35m, 6m deep with 1:3 side slopes and lined with HDPE sheeting. The capacity, allowing for some freeboard, is approximately 30,000m$^3$. Although located in a natural depression they have limited catchment areas of a few hectares of flat and absorbent sandy terrain. There is a sediment trap channel around the perimeter. The entire pond is enclosed by a chain-link fence.

Water is extracted by a floating electric pump and taken to a standardised compact package treatment plant from whence it is transferred to an elevated storage tank of 5,000 litre capacity from where it is distributed to a 40m long livestock drinking trough, a water fountain and a very elaborate ablution block which contains six flush toilets, six shower cubicles and fourteen laundry suites. Waste water from the ablutions is piped to a septic tank and soakaway.

These two schemes were completed in 2011 but have had virtually no utilisation. This is partly on account of the small volume of water retained from the first rainy season, and partly due to the distance from the village where the population has access to at least six boreholes.

The contract cost for the two installations was MZN36,000,048 or approximately USD600,000 each.
5.2.3 **PANGA**

This installation is 5.5km from the village of Panga, which is located on the R900 Morrumbene – Sitila vicinal road, and was substantially completed in 2012. A general view of Panga excavated reservoir is shown in **Photo 5**.

![Photo 5: Panga Excavated Reservoir which is also lined with HDPE. One of two silt traps and the outlet pipe are in the far slope with the abstraction well immediately beyond.](image)

It has an excavated and HDPE lined reservoir of similar dimensions to Mucuine 1 and 2. The reservoir is sited in a pan area, which was reported to remain wet during the rainy season. The catchment area appears larger than for Mucuine 1 and 2 and being a natural pan it is less absorbent. Surface run-off is led into the reservoir via two reinforced concrete silt traps.

The outlet works and supply arrangements are simpler than Mucuine 1 and 2 and comprise a PVC pipe leading to an excavated well about 30m from the reservoir. The well is concrete lined, covered and fitted with a handpump.

This installation has not yet been put into service due to the small volume of water stored since completion earlier in the year.

The contract cost for the installation was MZN11,871,506 or approximately USD400,000.

5.2.4 **MAVANZA**

This scheme is located in a borrow pit immediately to the south of the village of Mavanza on the east side of the N1, 137.5km north of Maxixe. It appears the concept behind the Mucuine
and Panga installations has been modified so as to reduce costs by utilising an existing borrow pit rather than excavating directly from ground level. Nevertheless, with construction only recently commenced, it is apparent an extensive earth moving operation is still required to achieve a depth of 6m as shown in Photo 6.

![Excavated Reservoir at Mavanza in the process of construction](image)

The scheme will follow the same basic design as Mucuine 1 and 2 except that the pond will not be lined with HDPE but will include the same elaborate ablution facilities. It is intended to compact the surfaces of the excavated reservoir to reduce seepage losses and to plant Vetiver grass on the side slopes to reduce erosion. The catchment appears to be limited in area and is in a fairly flat plain of absorbent sandy soils.

The contract cost of the scheme is MZN12,200,843 or approximately USD400,000.

### 5.2.5 Summary

These four schemes, developed by ARA-Sul, are not strictly to the same principles applicable to the present assignment. Only one of the four reservoirs is located in a borrow pit and the standards of water treatment and ablution facilities provided are beyond what is required under the research and demonstration objectives of the proposed pilot projects.

Construction costs for the ARA-Sul excavated reservoirs range from approximately USD400,000 to USD600,000 with the HDPE lining and elaborate ablution facilities contributing significantly to these amounts. In the Phase 1 Feasibility Study, ANE suggest an estimate of USD40,000 for constructing road ponds (small dams), which is a fraction of the cost of the ARA-Sul schemes. Even this amount is equivalent to the cost of drilling and equipping four to five boreholes should hydro-geological conditions be suitable for groundwater abstraction.
6  PRELIMINARY CONCEPTUAL DESIGN CRITERIA

6.1  ROAD PONDS (SMALL DAMS)

The main considerations to be taken into account when planning and designing structures for road ponds or small dams where the road embankment impounds water are as follows:

**Catchment Area and Flood Potential**

As these structures are to be located on streams and natural watercourses, the immediate catchment and coefficient of runoff are not so critical. The total catchment contributing to streamflow will be of the order of several km\(^2\). It is desirable to have an area large enough to yield adequate inflow volume, but not so large as to generate large floods. An area of between 2km\(^2\) and 50km\(^2\) is probably ideal and might typically have an average yield of 80,000m\(^3\) (small area) and a maximum design flood of 100m\(^3\)/sec (large area).

For the class of road likely to be selected for construction of road ponds as part of the current assignment, the ANE design standard is the 20 year return period flood.

**Evaporation**

Loss of stored water due to evaporation is both inevitable and unavoidable. The annual rate of evaporation is about 2,000mm. To avoid complete drying up, road ponds should ideally be not less than 4m depth, but this will not always be feasible, due to topographic and economic constraints. The ponds can be of benefit, however, even if they do not contain water throughout the year.

**Sedimentation**

Sedimentation is also bound to reduce the storage capacity of a road pond over a period of a few years. The hope is that the deposited material will mainly comprise coarser sand bed load, with finer suspended siltation carried over the dam structure. Voids in the sand deposits can have a volume of about 30% of the total capacity, and this water can be drawn-off by suitably designed outlets, or can be exploited by digging temporary wells or waterholes in the reservoir basin. Water held within the voids of the sand medium has lower loss from evaporation.

**Spillway**

When a road pond is constructed over an existing road embankment, there will be a culvert already in place to discharge the design flood flow. The culvert can be extended both downstream and upstream, to accommodate the raised embankment, and a new entrance (drop inlet type) can be built to admit the flood water above the normal storage level.
If the as-built stream crossing is of the drift or unvented causeway design, a new solid structure can be constructed of concrete or masonry, to form both the roadway and spillway section, as at the Birira site in Tete Province.

**Outlets**

As noted under Sedimentation above, the outlets should be designed so as to pass water even if the reservoir basin becomes full of trapped sediments. Releases would be by valves on the downstream side of the structure. No further elaboration, such as treatment works or customised facilities, is envisaged.

**Materials**

Raised embankments, serving both as dam and carriageway should be built of a homogeneous material of moderate plasticity (PI 8 – 15). The top running course should be the same material as used along the road. Construction of a spillway block would require hard sound rock 150 – 300mm in size, or concrete aggregate (size 20mm), as well as suitably graded sand.

**Design Criteria**

Design criteria for the identification of road ponds (small dams) was conceptualised as follows:

- In the near vicinity there should be beneficiaries in need of water;
- The road should cross a defined watercourse preferably on an embankment, incorporating drainage structures, that can be raised;
- The road approaches should be suitable, i.e. at sufficient grade, to optimise the basin size and depth, and to minimise embankment length;
- There should be a recognisable spillway;
- Suitable construction materials should be available locally.

6.2 **Improved Borrow Pits**

The prime considerations affecting the planning and design of improved borrow pits for the research and demonstration pilot projects proposed under this assignment are as follows:

**Inflow**

Obtaining adequate inflow to replenish the volume of stored water in the borrow pit during the rains is the obvious first essential. A total storage capacity of about 30,000m$^3$, as in the ARA-Sul excavated reservoirs seems a reasonable target, which would yield about 60m$^3$ of water per day throughout the year. The topography in Inhambane Province is generally flat or gently undulating and the terrain is largely composed of deep and absorbent sandy soils. Even the road drainage often depends on soakaways rather than long graded mitre drains to lead the water away. An exception is the area of pans or natural depressions (*baixas*) where millennia of siltation have resulted in a more impervious strata, but these areas are not usually suitable for borrow pits.
for road making material; moreover, there is no call for artificial intervention where these pans form natural sources of open or shallow groundwater for much of the year.

Rainfall records can be examined in order to establish the mean annual precipitation, but the unknown factor will be the coefficient of run-off. A first appraisal of the general ground conditions indicates that a coefficient value of 4% could be appropriate. This implies that for a run-off volume of 30,000m$^3$ a catchment area of at least 75ha is required if the annual precipitation were 1,000mm. If the reservoir in the borrow pit is some depth below ground there might be some recharge from groundwater but this is offset by seepage from the reservoir. Run-off from a paved surface (road carriageway) would be much more favourable but a road length of 10km (half-width) would be required to produce a run-off of 30,000m$^3$ assuming a coefficient of 100%.

Assurance of adequate inflow to a reservoir can only be met by siting the reservoir where the catchment area is large enough or possibly by paving an area with asphalt to obtain maximum coefficient of run-off (rainwater harvesting).

**Evaporation**

Evaporation rates in excess of 2,000mm per annum are the biggest cause of loss of stored water. Apart from covering the reservoir (which is not practicable in terms of cost), the only solution is to achieve the best depth / capacity ratio. The ARA-Sul reservoirs are 6m deep; this is probably the maximum that can be expected unless average side slopes steeper than 1:3 can be achieved in better material. For economic reasons, excavations should be kept to a minimum with the shape of the reservoir conforming to the existing shape of the borrow pit.

**Sedimentation**

In spite of the relatively flat terrain it is evident that erosion and sediment transportation are serious issues in the sandy soils that are generally prevalent which, over time, will have the effect of reducing reservoir capacity. Whether or not some type of silt trapping is included in the design of the reservoirs, regular maintenance and removal of deposited sediments will be an essential requirement for the operation of these schemes. It is possible that planned interception of sediment is not effective and regular removal itself is the preferable intervention.

**Seepage**

Loss of stored water will occur due to seepage through the base and side walls of the reservoir. This may be mitigated to some degree by compaction with a roller. The ARA-Sul reservoirs at Mucuine and Panga are lined with HDPE sheeting which, whilst being very effective in preventing seepage, is costly, requires specialist installation, could be punctured by livestock if not fenced-off and when wet it is very slippery, which is a safety issue requiring mitigation measures to prevent accidental drowning.
Seepage could be further reduced by mixing bentonite (±5% by weight) in the top 200mm layer to be compacted or by placing a layer of more impervious clayey material if such material is available locally.

**Water Quality**

To avoid gross contamination of the stored water by livestock or wild animals or domestic activities, the whole area of the reservoir should be securely fenced. There should be no direct access to the water body and draw-off facilities should be provided outside the fenced area. It is envisaged that the outlet would comprise a slotted PVC pipe laid below the base of the reservoir and encased firstly in a grader filter medium (-13mm) and then covered with a layer of relatively coarse sand (-5mm). This pipe would pass beneath one side of the reservoir to lead into a lined well, which could be fitted with a hand pump or other lifting device. The water could be taken directly from the pump and also diverted to laundry slabs and livestock drinking troughs.

There is a high degree of turbidity in the water in the ARA-Sul reservoirs and this phenomenon has also been observed in similar schemes in Botswana. The ultra-fine suspended sediment would take many months to settle out naturally and would require chemical treatment for clarification. These pilot projects are not targeted at the specific provision of potable water, which should be obtained from safer resources such as boreholes, and it is not proposed to include any form of water treatment in the pilot projects.

**Design Criteria**

Design criteria for the identification of borrow pit road ponds was conceptualised as follows:-

- In the near vicinity there should be beneficiaries in need of water;
- Preferably the borrow pits should have been rehabilitated, be of a regular size and consistent depth;
- There should be evidence of water having collected in the pit;
- There should be evidence of inflow from outside the immediate confines of the borrow pit;
- Possibility of diverting road drainage into the pit;
- Local availability of suitable construction materials especially clayey materials for sealing the pit base.
7 PRELIMINARY IDENTIFICATION OF SITES FOR PILOT PROJECTS

7.1 FIELD RECONNAISSANCE

The objective of the field reconnaissance was to identify sites suitable for the two road ponds (small dams) and two borrow pits ponds that are to be developed as pilot projects for research and demonstration purposes in two provinces.

The two chosen provinces are Inhambane and Manica of which the Consultant has intimate knowledge through involvement in the re-opening, rehabilitation, re-construction and maintenance programmes for roads since 1995. Roads to be reconnoitred were identified on the basis of:-

- Road inventories from previous studies and programmes;
- Current maintenance programmes;
- Provincial ANE knowledge.

With the exception of paved national roads all other road categories\(^2\) are considered suitable for road ponds (small dams). Paved roads are considered unsuitable because seepage may cause undesirable consolidation of the embankment. For gravel and earth roads this is not a particular issue because, in the event of consolidation, embankments can be raised relatively inexpensively. All roads are considered suitable for improved borrow pits.

Borrow pits, however, vary considerably in their extent and suitability. In general borrow pits along the N1 cover a large area (greater than 1ha), are regular in shape with excavated depths of 3 – 4m, and are usually rehabilitated with graded side slopes. In contrast, borrow pits on other roads tend to be small and irregular in shape, variable in depth, and usually not rehabilitated.

Roads discarded from the reconnaissance for road ponds (small dams) include paved roads, roads under re-construction to paved standard (e.g. R482 from Maxixe to Homoine in Inhambane Province, N260 from Chimoio to Espungabera in Manica Province) and roads that pass through perennial wetlands.

7.2 INHAMBANE PROVINCE

A total of 14 roads covering a distance of 776kms were reconnoitred in Inhambane Province as shown in Table 2.

For road ponds (small dams) to be constructed in locations where watercourses cross the road, the aim was to identify small seasonal watercourses that flow during the rainy season, but are dry for most of the rest of the year. At the time of the reconnaissance, in mid-October,

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2 These road categories are secondary, tertiary, vicinal and unclassified.
several small streams were observed to be flowing in the wide dune area in the coastal belt south of Maxixe. These streams derive their water from storage in the dunes (similar to the water supply source for Inhambane town), and are being utilised for domestic purposes and livestock watering. There is no justification for creating artificial road ponds (small dams) on the roads that cross these perennial streams, as they already serve as water sources for local communities.

Any damming of these perennial streams would destroy the downstream regime on which other communities depend and would also create additional health hazards from standing water. There is however, considerable scope to improve the off-take arrangements from these perennial water sources, but this is outside the scope of the current assignment.

**Table 2: Roads Reconnoitred in Inhambane Province**

<table>
<thead>
<tr>
<th>No.</th>
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<td>N222</td>
<td>Secondary</td>
<td>Mapinhane – Mabote – Chicaiane</td>
<td>143</td>
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<tr>
<td>R444</td>
<td>Tertiary</td>
<td>Sitila – Funhalauro</td>
<td>71</td>
</tr>
<tr>
<td>R480</td>
<td>Tertiary</td>
<td>Inharrime – Mocumbi</td>
<td>28</td>
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<tr>
<td>R481</td>
<td>Tertiary</td>
<td>Cruz N1 – Mocoduene – Mavume – Funhalauro</td>
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<tr>
<td>R484</td>
<td>Tertiary</td>
<td>Nhachengue – Chicomo – Fornos</td>
<td>72</td>
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<tr>
<td>R485</td>
<td>Tertiary</td>
<td>Homoine – Pembe</td>
<td>25</td>
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<tr>
<td>R900</td>
<td>Vicinal</td>
<td>Morrumbene - Sitila</td>
<td>60</td>
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<td>R902</td>
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<td>Morrumbene – Mocoduene</td>
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<tr>
<td>R911</td>
<td>Vicinal</td>
<td>Homoine – Mocoduene</td>
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<td>R918</td>
<td>Vicinal</td>
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<td></td>
<td>Unclassified</td>
<td>Fornos – Muabsa</td>
<td>20</td>
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</table>

Siting of the pilot schemes for road ponds (small dams) was therefore focussed on more inland areas and on watercourse / road crossing points where flow is seasonal and some real benefit could be obtained. Two sites that meet the criteria have been selected. These are at Tambajane on an unclassified road and at Muabsa on the N222 as indicated in **Figure 1**.

**Tambajane**

Tambajane is considered by the Morrumbene district authorities to be an important centre with agricultural potential. The existing track from Morrumbene to the centre is in need of rehabilitation. This could open up an opportunity for the construction of a road pond (small dam) on the Rio Tendele watercourse that crosses the road immediately to the east of the centre. After being washed away some years ago an existing culvert and embankment has been
replaced with triple culverts in an embankment as shown in Photo 7. There is scope to raise the embankment with a drop inlet type spillway discharging into the existing culverts.

Photo 7: Tambajane: Proposed site for road pond (small dam) on Rio Tendele
Figure 1: Inhambane Province showing location of road pond pilot projects
Muabsa

Muabsa is an important cattle rearing area for both small scale farmers and a number of commercial enterprises who have recently re-established in the area. 37 kms from Mapinhane on the N222 secondary road to Mabote a drainage line crosses the road in a 2m diameter culvert set in an embankment as shown in Photo 8. There is scope to raise the embankment with a left bank drift type spillway across the road.

Photo 8: Muabsa: Proposed site for road pond (small dam)

Inhambane Borrow Pits

Although during the reconnaissance there was fairly heavy and widespread rainfall, with the exception of one pit on the R485 Homoine – Pembe road, no borrow pits were observed to collect water. Numerous borrow pits alongside the N1 and roads tabulated above were inspected, but the vast majority failed to meet the requirements for a variety of reasons, e.g. size, depth or current continued exploitation for road works. In all cases the critical factors of catchment size and anticipated inflow proved a constraint to development. It is noted that the morphology in Inhambane Province is very different from that in northern Tete Province, where initial studies were carried out as reported in the Phase 1 Feasibility Study. The relief in Inhambane Province is predominantly flat and soils are very sandy and porous, hence having lower run-off coefficient and potentially greater seepage losses.

Following the inspections of borrow pits two were selected for survey and assessment of catchment areas and run-off characteristics with a view to sealing the base with either bentonite or locally available clayey material. These are the one on the R485 mentioned above and a
large rehabilitated pit on the east side of the N1, 9kms north of Unguana as shown in Photos 9 and 10 and as indicated in Figure 1 above.

Photo 9:  R485 Homoine – Pembe, Km11.4R: Borrow Pit with potential for road pond

Photo 10:  N1: Rehabilitated borrow pit 9kms north of Unguana
7.3 **Manica Province**

Roads covering 533 kms were reconnoitred in Manica Province as shown in Table 3.

<table>
<thead>
<tr>
<th>No.</th>
<th>Designation</th>
<th>Route</th>
<th>Distance [kms]</th>
</tr>
</thead>
<tbody>
<tr>
<td>N260</td>
<td>Secondary</td>
<td>Espungabera – Lucite (Dombe) – Chimoio</td>
<td>225</td>
</tr>
<tr>
<td>N261</td>
<td>Secondary</td>
<td>Cruz N7 – Dunda – Macossa</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>Muxungue – Chibavava</td>
<td>40</td>
</tr>
<tr>
<td>R441</td>
<td>Tertiary</td>
<td>Inhacufera – Espungabera</td>
<td>36</td>
</tr>
<tr>
<td>R521</td>
<td>Tertiary</td>
<td>Cruz Chibabava – Machaze – Inhacufera</td>
<td>147</td>
</tr>
</tbody>
</table>

In contrast to Inhambane Province, on moving inland to Manica Province the general relief and soils are much more conducive to the construction of road ponds. This is particularly so on roads that skirt watersheds such as the R521 from Cruz Chibabava to Inhacufera and the N261 from Cruz N7 to Macossa where catchment areas upstream of the road are correspondingly smaller and therefore suitable for road ponds (small dams).

Along the N260 north of Sussendenga to Chimoio there are a number of suitable locations for road ponds where embankments are already of sufficient height (4 to 6m) to form small dams simply by providing a drop inlet type spillway discharging into the embankment culvert(s). However, since this road is under major re-construction, possibly on a different alignment which may interfere with the existing alignment, these locations were not considered further.

**Cruz. Guezanhe**

There are a number of locations for road ponds (small dams) on the R521 in the section either side of Cruz Guezanhe, 36 to 40kms from Cruz Chibabava, where a series of triple pipe culverts and road alignment suggest there is good potential to raise embankments.

**Dunda**

A similar situation exists on the N261 road 17km from Cruz N7 immediately before the village of Dunda where scarcity of water is readily apparent.

Both these locations are shown in Figure 2.
Figure 2: Manica Province showing location of road pond pilot projects
Manica Borrow Pits

In general borrow pits on the minor roads tended to be small, scratchy affairs. However, after recent rains a number of pits were found to be holding water. Two of these are in use by local communities. The first is on the re-constructed road from Lucite to Chimoio, 15kms after the Lucite bridge, 4kms before Dombe. See Photo 11. Considering the proximity of the Lucite River, use of this pit is probably more convenient after the recent rain.

Photo 11: Dombe: Water retained in borrow pit being used by local community for laundry

The contractor re-constructing the N260 road to Chimoio has already rehabilitated a borrow pit 11kms north of Dombe. See Photo 12. The possibility of sealing this pit to hold water is to be investigated in the next stage of the assignment.
The borrow pit found to have the most potential however, is 29kms along the N261 Macossa road, in a very dry area, where the local community is entirely dependent on water that had collected in the pit. See Photo 13. Local inhabitants indicated the pit held water all year round, and although the water level was low at the time of the reconnaissance, it was being used for laundry and livestock watering.
The potential to enhance community water supplies by improving two of these three borrow pits with safer draw-off arrangements, fencing etc will be investigated further in the next stage of the assignment.

8 WORK PLAN FOR NEXT STAGE

The Work Plan for the next, Inception, stage of the assignment (this being the pre-inception stage) will focus on carrying out the following activities:-

- Topographical surveys of the road pond (small dams) and borrow pits identified in Section .. above.
- Initial sociological study of the communities likely to benefit from the pilot schemes – see the Community Questionnaire in Appendix B.
- Conceptual design for each of the road ponds (small dam) structures by identifying catchment areas (from 1:50,000 scale mapping), optimisation of dam and spillway structure, and examination of means to enhance safe water use for the various types of demand.
- Conceptual design for demonstration of borrow pit improvements.
Appendix A
Terms of Reference

Use of Road Works to Enhance Community Water Supplies and Climate Resilience in Mozambique

Coordination, Research, Conceptual Design and Technical Oversight

1. Background
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. For example, crossing structures built on waterways can be designed to retain water during the rains. The stored water can be used by local communities in the dry season, thus reducing the period when long trips must be made to collect water. The stored water also helps to re-charge ground water reserves.

Water is also stored in materials borrow-pits established during the construction of roads. This water is often used by local communities, but access to the water by the community is seldom considered by the contractors responsible for opening borrow-pits and rehabilitating them at the end of the construction period.

The small bodies of water retained by crossing structures and in borrow-pits have become referred to as Road Ponds.

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. It is expected that the research will also have applications in other African countries. The research is being carried out in three phases: 1. Feasibility study of possible interventions (complete); 2. Design and construction of pilot projects, and technical monitoring for a two year period (the current phase); 3. production of manuals for the design, construction and utilisation of road ponds, and dissemination of the project findings.

Phase 1 has been completed and the Final Report distributed to stakeholders. (It is available on the AFCAP web site www.afcap.org). The outcome of the feasibility study was that communities in arid regions are highly supportive of improved water supplies in their area through the construction of Road Ponds, but there are health risks associated with stagnant water that need to be considered.

Phase 2 is the object of these Terms of Reference. Phase 3 will proceed only if sufficient positive impacts are demonstrated by the pilot projects constructed under Phase 2 and if further funding is available.

The success of the project depends on establishing effective collaboration with relevant government agencies at both national, provincial and district level, including the National Directorate of Water and the Ministry of Agriculture. Collaboration is also required with development partners, including UN agencies and NGOs, and with local communities.

The Consultant will be expected to ensure that all relevant stakeholders participate in the implementation of the project.

The Consultant will provide engineering services required for the detailed design of the works. This includes the preparation of tender dossiers, and technical oversight during
construction of the research/demonstration structures and modifications to borrow-pits. In addition, the Consultant will monitor the impact of the works on the environment and on local communities.

Should Phase 3 proceed, this will be for the development of a manual for the design, construction, maintenance and utilisation of Community Road Ponds in Mozambique.

2. Objectives
The objective of the current Terms of Reference is to undertake Phase 2 of the research on using road works to enhance community water supplies on a larger scale in Mozambique.

It involves the identification of sites for the construction of new structures for research and demonstration purposes, preparation of engineering designs and tender documents, construction of demonstration structures and borrow-pit improvements, and monitoring & evaluation of the impact of the works.

Oversight for the project will be provided by the National Road Administration (ANE) with support from the Africa Community Access Programme (AFCAP)\(^1\).

3. Scope of the Services
The Consultant will provide the following services.

- Assist ANE to establish a Project Steering Committee of key stakeholders in the project
- Identify two provinces for the construction of research and demonstration sites
- Identify at least two sites in each of the two provinces where road pond structures could be built and two sites where borrow pit improvements could be carried out (the number of demonstration sites will depend on the budget provided for the works by ANE)
- Prepare a conceptual design for each of the proposed road pond structures indicating its location, recommended type of structure, alignment, height of the water retaining structure, and approximate volume of water to be retained.
- Prepare a conceptual design for demonstration of borrow-pit improvements
- Prepare detailed technical designs and specifications for the pilot road pond structures
- Prepare draft tender documents in collaboration with ANE and the Provincial Maintenance Consultants. Procurement, works contracts management and supervision of construction works will be undertaken by ANE, in accordance with the normal procedures
- Provide technical oversight of the construction process to ensure compliance with the specifications
- Establish participatory, representative community road pond committees at each of the sites. These groups will represent community views concerning the design and operation of the ponds. Efforts should be made to have representative involvement in these project groups and extra effort may be needed to involve traditionally excluded members of the community, such as women and female heads of households. The capacity of the community road pond committees to manage and maintain the community road ponds should be developed. This will include training for the operation and maintenance of the infrastructure and controlling water quality.
- Monitor the behaviour of the ponds over one full rainy season, including their durability, their operation and management and their impact on the local environment, the local

\(^1\) AFCAP is a research programme funded by the UK government, which is promoting safe and sustainable rural access in Africa. AFCAP supports knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. The management of AFCAP has been contracted by DFID to Crown Agents
economy, social and community development, and the health and safety of the community and road users.

- Obtain Environmental Impact Assessment (EIA) licence and the necessary approvals from relevant authorities.

4. Transfer of Knowledge/Training

Capacity building and transfer of knowledge are key components of this assignment. The recipients of this support will include provincial and district staff, as well as local communities.

The assignment is a component of a set of inter-related projects across Africa as part of the AFCAP programme. The implementing organisation is required to share and exchange knowledge and experiences between other projects within the AFCAP programme.

5. Minimum Experience requirements

The Consultant will form a team of experts, field workers and stakeholders to undertake the assignment. The team should be led by an experienced Project Manager and must possess the following skills and experience:

i. Project management

ii. Design and construction of similar structures in the Sub-Saharan Africa

iii. Research skills including data collection, analysis and documentation.

iv. The development of rural water supplies in Mozambique and the region

v. Hydrology

vi. Community-based participatory development

vii. Social, economic and environmental impact assessment and evaluation

viii. Good communication skills, report writing, manual preparation and training experience.

ix. Working knowledge of both Portuguese and English, as well as local languages in the demonstration communities.

It is estimated that approximately 22 person-months of input will be required to complete the assignment.

6. Assignment Period

It is anticipated that the full assignment will take 15 months, starting in early 2012. This assumes that construction of the research/demonstration structures and borrow-pit improvements are completed before the 2012/2013 rains.

7. Facilities, services and resources to be provided by the Consultant

The Consultant must provide all office accommodation, office equipment and consumables, field accommodation, transport and other support required by the team to complete the assignment.

8. Reporting & Deliverables

The Consultant will submit the following reports:

i. An Inception Report within one month of the commencement of the assignment. This should include:

   a. Records of meetings with local authorities and communities

   b. The evaluation of a sample of existing road ponds (including borrow-pits)
c. Location of identified sites for research/demonstration pilot projects

d. Baseline report outlining conditions prior to construction/improvement of road ponds.

e. Conceptual design criteria for the road ponds including the class of road where ponds could be created and typical functions and uses of the ponds.

f. Detailed programme of activities and milestones to completion of assignment

ii. A design report within four months of the commencement of the assignment providing the general arrangement drawings and details for the research/demonstration structures, as well as full tender dossiers using standard ANE procedures.

iii. Brief quarterly progress reports of project activities. The first report should be submitted three months after submission of the draft design report.

iv. An impact assessment report at the end of the monitoring period, including a summary of the completed works, data collected during the monitoring phase, data analysis and results, and recommendations for expanding the road pond approach on a wider scale in Mozambique.

v. Brief Guidelines on routine maintenance of the road pond structures

Reports must be submitted in Portuguese and English. Tender documents, detailed designs and guidelines are to be submitted in Portuguese.

9. Assignment management and administration

The Consultant will receive direction from the project Steering Group for all aspects of the implementation of the project.

The Consultant will report to the Technical Manager (Roads) of the Africa Community Access Programme (AFCAP) for all technical aspects of the implementation of the project and submission of deliverables. For all contractual and administrative matters the Consultant will report to the AFCAP Procurement Manager at Crown Agents in the UK.
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<thead>
<tr>
<th>BASE DATA</th>
</tr>
</thead>
<tbody>
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<td>Province</td>
</tr>
<tr>
<td>Road</td>
</tr>
<tr>
<td>Day</td>
</tr>
<tr>
<td>Interviewer</td>
</tr>
<tr>
<td>Recent weather conditions:</td>
</tr>
<tr>
<td>Proposed Works:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee:</td>
</tr>
<tr>
<td>Name</td>
</tr>
<tr>
<td>Community Served:</td>
</tr>
<tr>
<td>Community Population:</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Cattle</td>
</tr>
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<td>Female</td>
</tr>
<tr>
<td>Children</td>
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<td>Total</td>
</tr>
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Additional notes:
## WATER SOURCES AND USAGE

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<th>What are the Communities’ main water sources</th>
<th>Type</th>
<th>Distance to source</th>
<th>Months Available</th>
<th>Main Source</th>
<th>Alternative source</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How is the water used and where does it come from?</th>
<th>Drinking/ cooking</th>
<th>Washing</th>
<th>Laundry</th>
<th>Gardening</th>
<th>Livestock</th>
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<tbody>
<tr>
<td>Additional notes:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Is there adequate water all year?</th>
<th>Yes / No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If no, when is the shortage most severe?</td>
<td></td>
</tr>
</tbody>
</table>
### HEALTH

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there a health centre in the area?</td>
<td></td>
</tr>
<tr>
<td>What is the incidence of the following illnesses? Indicate prevalence and time of year when most prevalent</td>
<td>Stomach upsets</td>
</tr>
<tr>
<td>Additional notes:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malaria</td>
</tr>
<tr>
<td></td>
<td>Bilharzia</td>
</tr>
</tbody>
</table>

### WATER SUPPLY AND MANAGEMENT

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have any water supply projects been done for the community in last 3 years?</td>
<td></td>
</tr>
<tr>
<td>What were they and who organised them?</td>
<td></td>
</tr>
<tr>
<td>What type of improvements would you like to see for the community water supply?</td>
<td></td>
</tr>
<tr>
<td>What inputs would the community be prepared to make to improve the supply?</td>
<td></td>
</tr>
<tr>
<td>Would the community be prepared to look after water structures?</td>
<td></td>
</tr>
</tbody>
</table>

Interviewer’s Comments and Assessment:-