Criteria for Siting Dams

3 Dams including Hout Dam

Limpopo Province

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Motivation

The communities living in the Ga-Moeti area in the North West Province are seriously in need of water. Water stored in a strategically located dam would enable the resident population to pipe water under pressure to lands lying below the dam, thus allowing the growth of vegetables and other crops. The sale of this produce will generate income, but perhaps more importantly will supplement the diet of so many who barely subsist on ‘mielie meal’.

Possible Dams

Two possible dam sites have been identified as follows:

Figures 1, 2 and 3 show three catchment areas that have relevance to this analysis:

Figure 1 shows two possible dam sites. The smaller dam may be referred to here as the Ga-Komape dam; the second and larger as the Sengatane dam; after the villages that they are closest to. The associated catchment areas are indicated respectively by small crosses and dotted lines.

Figure 2 shows the area directly west of figure 1. It includes much of the Hout river catchment area and dam. This dam is included in the analysis allowing the proposed new dams to be compared to an existing dam.

Figure 3 shows the balance of the ‘Hout river’ and ‘Sengatane’ catchment areas.

It is possible to position the three figures together to form one complete map of the three catchment areas, and for this purpose matching pairs of locating arrows are indicated.

Table 1 gives the vital statistics of each of these dams, including such physical properties as the height, width-across-the-‘gorge’, longitudinal length along the river bed, the associated catchment area, storage capacity, average annual inflow, and estimates the yield.

An attempt has been made to correctly size the storage capacity in relation to the expected inflow. Inflow in turn is based on an assumed run-off of 10mm for an average rainfall of 500 mm p.a.

Criteria for Siting Dams

In deciding on a suitable dam, careful consideration should be given to the following criteria:

Social considerations

1. The dam should be built to service a community where the need is greatest. Accordingly the proposed dams have been sited near the Ga-Moeti community in response to a plea for assistance by the kgosi Moloto. The two dams are within walking distance from villages that they are named after, and this will facilitate the cultivation of crops by women and children.

2. Initiatives by kgosi Moloto in association with African Pathways will ensure that the community is trained and motivated to use the water for farming productively. Under their joint guidance the community will have to decide on such important issues as ownership of the dam (which may be linked to debt repayment), a management structure, participational rights, etc.

Topographical considerations

1. Ideally a dam should be sited at a point along the river where the two opposite river banks are relatively steep and near to each other. This minimises the length of the wall for a given height. However both of the proposed dams are in relatively flat country, and these dams will therefore be relatively long.

2. In order to retain as much water as possible, the inclination of the river bed behind the dam should be as little as possible. This was generally achieved for both sites, with the inclination of the Ga-Komape dam being 1 in 85, and that for the Sengatane dam being a very favourable 1 in 200. Furthermore in an ideal site for the flanks should open up as wide as possible. In this regard the two dams are not ideal, although they do tend to retain their width as the water becomes shallower. This is preferable to a dam where the surface resembles a triangle.

3. Based on the estimated ‘height’, ‘wall length’ and ‘longitudinal length’, the storage capacity of the two proposed dams have been calculated in table 1. Also included in this table are the corresponding calculations for the Hout dam, for purposes of comparison. The topography was less than ideal, and generally simple triangular sections were assumed in either two or three directions, a conservative approach that errs on the side of minimising the calculated storage. Where the contours allowed the volume of a confined body of water was calculated on the bases being prismatic and/or wedge shaped.

4. The area below the dam should be large enough and flat enough to make commercial farming viable. Substantial irrigable lands are shown for the Sengatane dam, where each square represents 4 hectares. This ground further meets the criteria of being relatively flat. It is however appreciated that as this area has a considerable degree of anti-erosion works, the

lands will need to be somewhat irregular in shape. A site visit is required to confirm the suitability of this ground for agriculture. The contour map does not show the lie of the land to the north of the Ga-Komape dam.

Geological considerations

1. If deep alluvial deposits of porous sand are present, this will result in substantial seepage losses. In practice, this will vary from site to site and will require careful consideration.

2. Soft ground that is too deep to excavate may dictate that the dam be sited elsewhere. A rock-concrete dam must be founded on 'rock', whereas an earth embankment dam only requires that the bearing capacity of the supporting ground exceeds the design criteria for the dam in question.

3. The absence of a nearby clay deposit may rule out an embankment dam, while a shortage of surface rocks will rule out a rock-concrete dam.

Hydrological considerations

1. The ratio of the annual inflow of water to the storage capacity of the dam, shown as [inflow] / [storage] in table 1, should not be too high or too low. If this ratio is less than 1, the dam will rarely be filled, and it is therefore oversized. On the other hand a large ratio (say greater than 6) implies that the dam is likely to have large flows going over the spillway relative to its size. This will require the spillway to be carefully engineered and it will be comparatively large and costly. Rock-concrete dams have an advantage in this respect, since the spillway may be the full length of the dam.

   When sizing a dam, the storage capacities of upsteam dams must be taken into account. Their storage capacities should be added to that of the new dam, maintaining a ratio of not less than 1. The design of the dam under consideration must also consider the stability of upstream dams under flood conditions.

   Consideration should also be given to downstream dams. If a dam is too large such that it seldom or never overflows, downstream dams will dry up. It is therefore advisable to incorporate a pipe and valve in a dam to allow some through-flow.

   In the absence of more information regarding the capacities of the upstream and downstream dams that may be seen on the contour maps, the ratio of inflow to storage capacity was increased from 1,0 to 1,2 for all three dams (see table 1).

2. Table 1 also gives an estimation of the 'yield' of the dam, which is that amount of water that is available for agricultural purposes. In this exercise it is simplistically assumed to be 50% of the storage capacity. This makes allowance for evaporation, seepage and drought conditions. Shallow dams, which have a relatively large surface area in relation to their capacity, will have significantly more evaporation and seepage losses.

3. The catchment area of the various dams is indicated by small dashes/circles/crosses in figures 1 through 3, and quantified in km^2 in table 1. In order to calculate the annual inflow into the dam, a surface runoff of 10mm was assumed for these relatively flat catchment areas. This is typical for an assumed annual rainfall of approximately 500mm in the Pietersburg area.

4. Clearly it is also important to know the variation in rainfall from year to year. When designing for storage capacity, it may be prudent to use the lower figure, while spillway design should be based on maximum expected flows over say a three hour and 24 hour period.

5. Another important ratio is the 'yield' relative to demand. Demand is related to the amount of irrigable land available, crop selection, and the community's commitment to fully utilise the useable land. Clearly, on average this ratio should not exceed 1 or the dam will dry up.

Agricultural considerations

1. The advantage of siting the dam above the proposed agricultural lands is that water may be gravity fed as required without the need for diesel or electric powered pumps. Clearly this will substantially reduce operational and maintenance costs. Given the correct installation of piping and associated irrigation equipment simple pressure operated sprinkler systems may be operated purely under hydrostatic pressure.

2. The ground below the dam should be fertile. Excessively clayey or sandy conditions may mitigate against crop cultivation.

3. Choice of crop type should be considered from a point of maximising cash generation, compatability with soil type, water consumption versus available water, harvests per annum, sensitivity to heat etc.

4. Ways of increasing productivity should be considered, such as carefully positioned gravity operated sprinklers, drip irrigation systems, mechanical equipment such as oxen or tractor driven ploughs, etc.

Conclusion

This preliminary report shows that there are distinct possibilities of harvesting rainfall by means of strategically placed dams in the Ga-Moeti area according to sound dam-engineering principles and social/demographic considerations, in a step towards poverty eradication in South Africa.

However, there is clearly a need for a carefully prepared feasibility study to adequately investigate the social, engineering and agricultural aspects alluded to in this report. This will make it possible to establish the economic viability and sustainability of the project with some level of confidence. It also puts the essential planning into place for the project, and becomes a measurement tool during the execution stage.

Finally, it is hoped that this report will serve as a successful model for the development of many rural micro-economies towards poverty eradication in South Africa.

Suggested Way Forward

1. Meet with the kgosi/councillors to present these ideas and get initial feedback. African Pathways to set up the meeting, and Dams for Africa to make a presentation.

2. Inspect the sites of the three dams. Get a feel for the topography, and ground conditions. This may already make it clear what type of dam is most suitable. If 1. is done in the morning, 2. may be done in the afternoon after a light lunch. Hopefully all parties will be able to attend the site visit.

3. Obtain approval and funding for carefully prepared feasibility studies – generally about 3% of total project cost. Dams for Afrca to do the engineering feasibility study, African Pathways the social aspects. Dams for Africa and African Pathways should jointly facilitate the agricultural study as required.

4. Present the findings of the feasibility study to kgosi Moloto and local government (African Pathways and Dams for Africa).

5. Obtain funding for dam construction, irrigation and farm development (African Pathways and Dams for Africa).

6. Proceed with construction of dam and irrigation (Dams for Africa), as well as farm development (African Pathways).

7. Train farmers and provide ongoing mentoring and support until the community has put in place the necessary management structures and is able to stand on its own feet. (African Pathways).

Table 1 - Analysis of Possible Dams for the Ga-Moeti Community

Name of dam	dam height m	wall length m	longi-tudinal length m	dam storage m^3	surface area ha	catch-ment km^2	run-off mm	inflow/ year m^3	Yield @50% m^3	[inflow/ storage]
Ga-Komape	4.6	620	310	221030	19.22	26.6	10	266300	133150	1.20
Sengatane	5.5	900	500	618750	45	75.5	10	755250	309375	1.22
Hout	10	800	1000	2000000	80	138	10	1384000	1000000	0.69

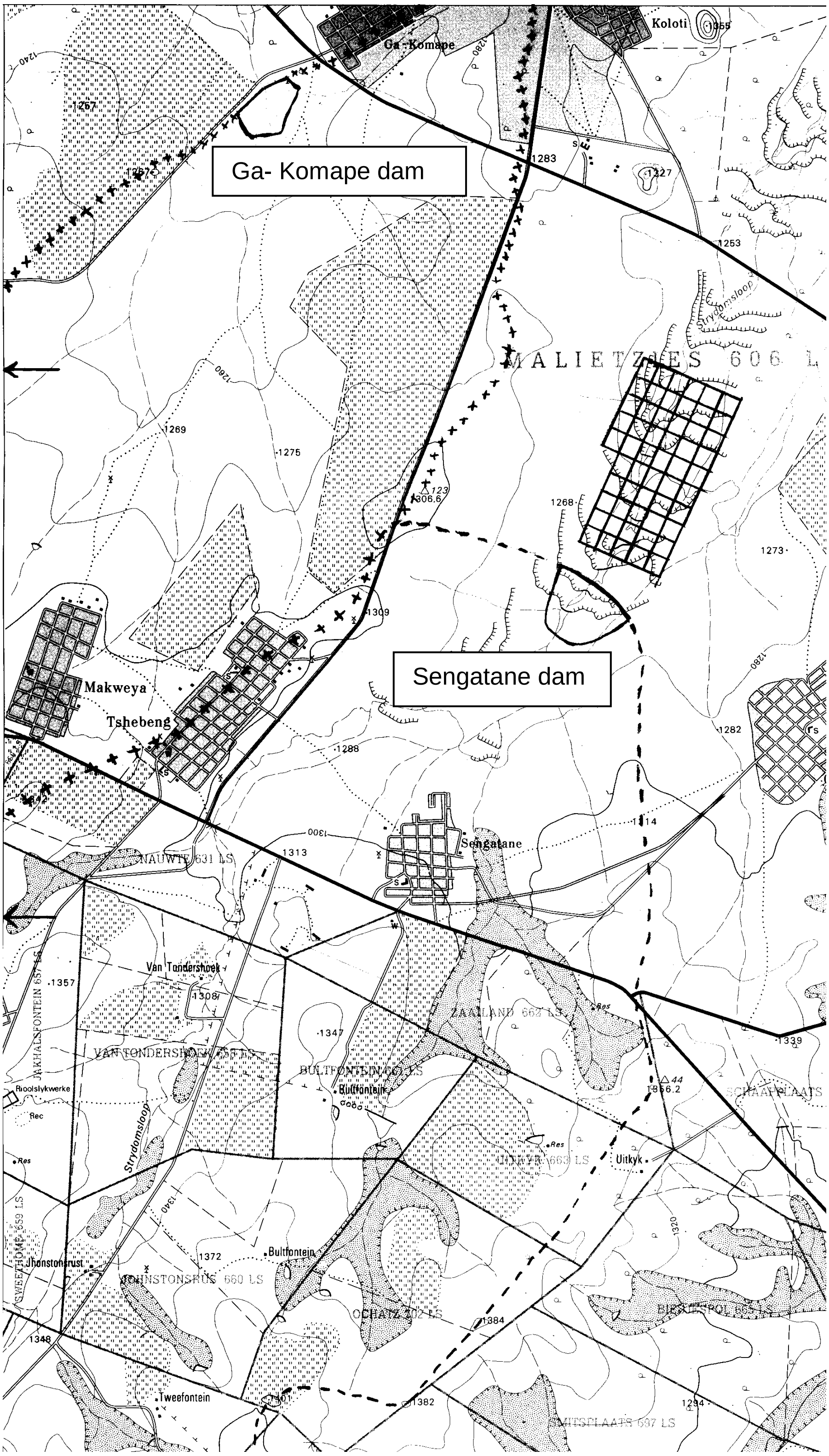

Figure 1 – Possible dam sites at Ga-Komape and Sengatane. The boundaries of the corresponding catchment areas are also indicated.

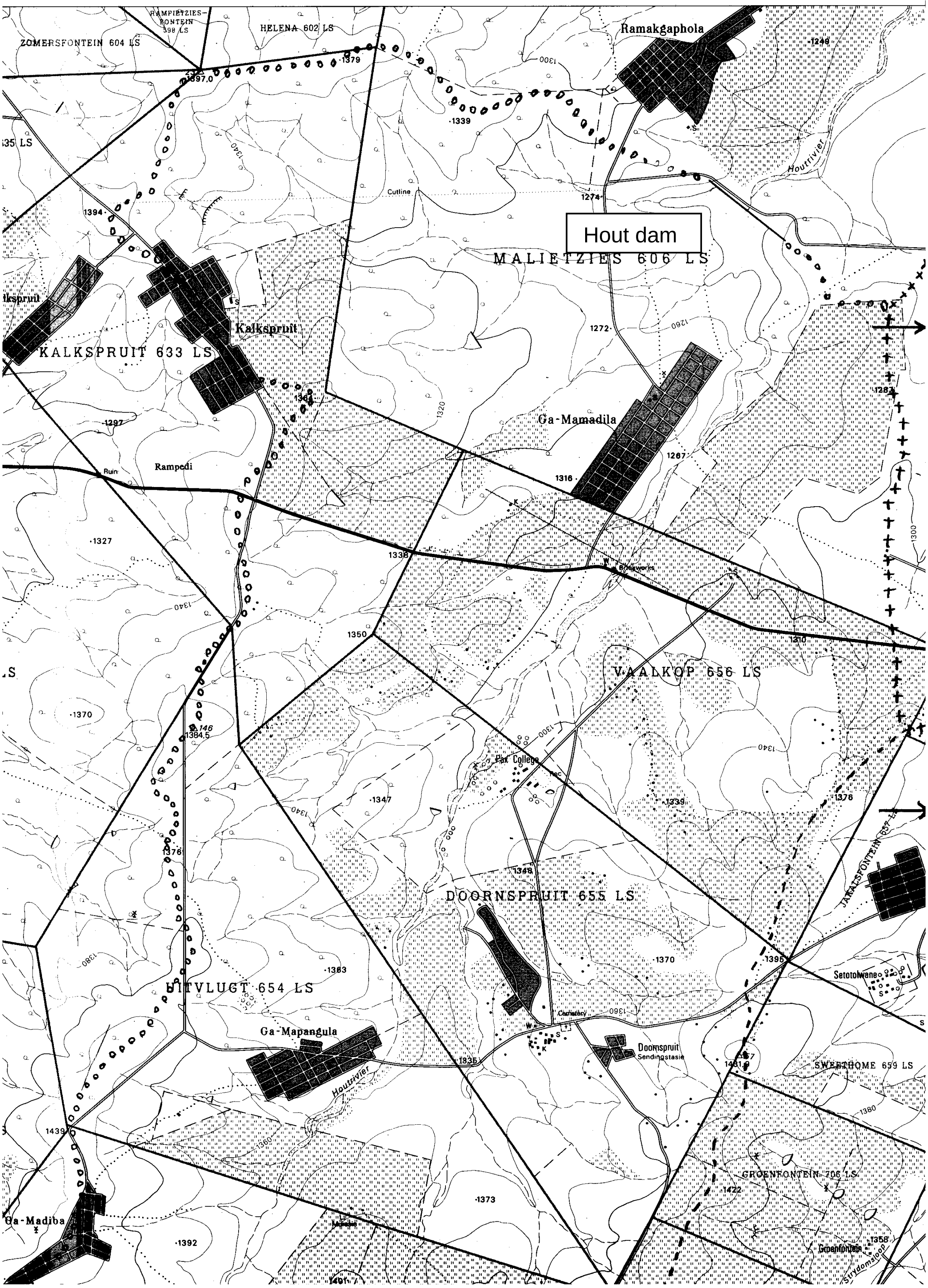

Figure 2 – Hout dam and catchment area

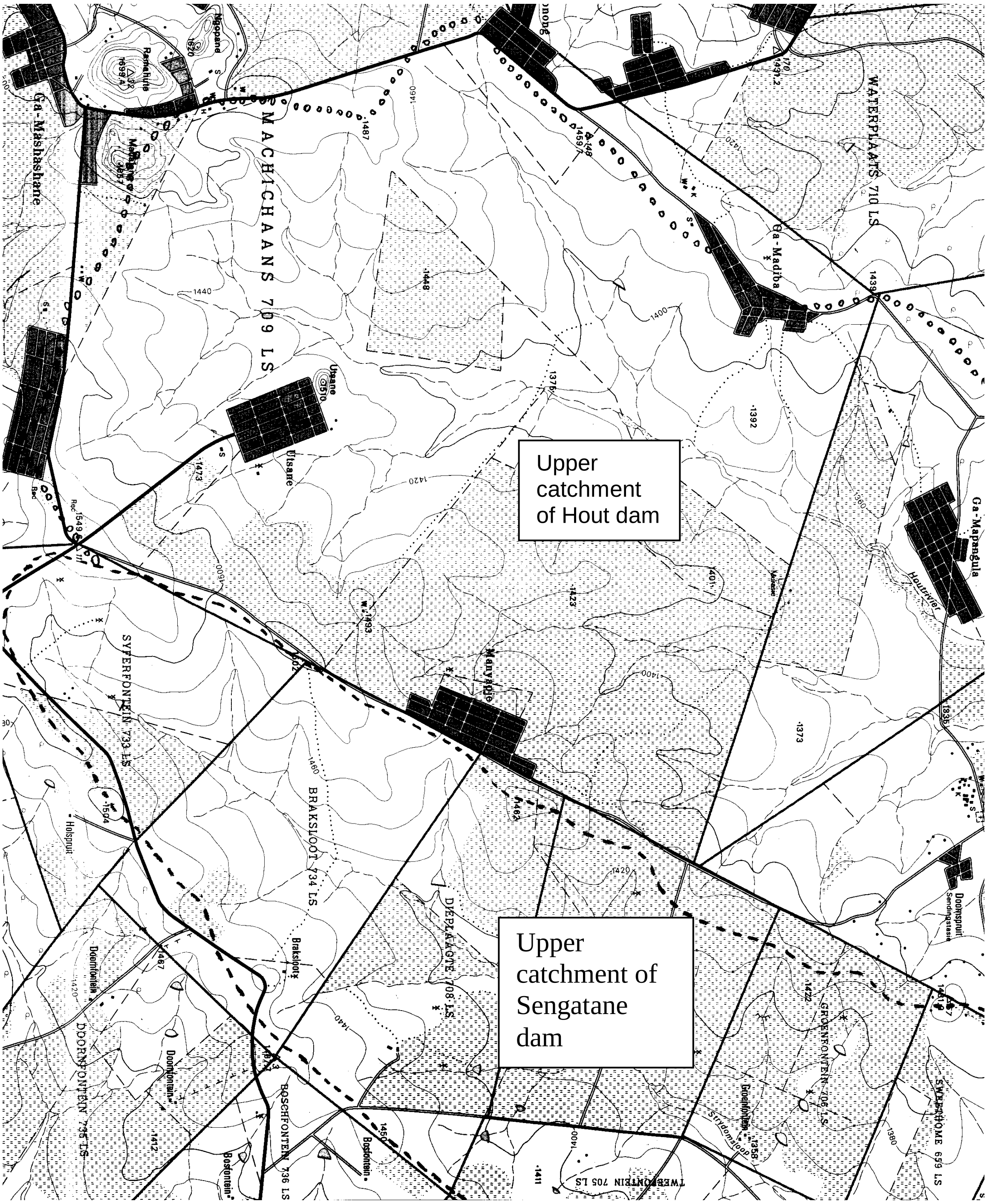

Figure 3 – Upper Catchment areas for the Hout and Sengatane dams. Note that this map as shown here is orientated 90 degrees to figure 1 and 2.

About Dams for Africa

Dams for Africa (Pty) Ltd designs/constructs/rehabilitates water related infrastructure to empower communities in remote rural areas. Typical projects include the construction & rehabilitation of dams, canals, weirs, reservoirs and installation of pipelines and irrigation systems.

DFA recognises the need to be flexible and will tailor its involvement according to each need, from consultations to turnkey projects.

DFA's contribution to a typical project may take the form of an initial consultation, feasibility study, business plan, design, construction/installation.

Whenever practical labour intensive methods will be used in the construction process, sourced from local community.

DFA is also in a position to provide the necessary hydrological, topographical, geological, ecological and social impact studies, and attend to the technicalities and legalities associated with water related infrastructure.

Dams for Africa fully appreciates the need to network and co-operate with partners such as:

1. *Community based organizations* that are in touch with the needs of the resident population.

DFA is aware of the importance of *community involvement* and is, if required, prepared to participate in all stages of this process. This would include a response-to-need request as the first step, assistance with visualization, participation in negotiations, recruitment and training of local residents for the construction stage, facilitation of training in subsequent agriculture and irrigation, and ongoing mentoring as may be required.

2. *Donors/funders* including government and financial institutions.

DFA is prepared to participate in *fundraising* for worthwhile projects, and in the production of 'bankable' documentation.

3. *Training organizations* who teach on farming methods, marketing of produce, and who know the value of ongoing mentoring.

DFA would like to know that its engineering contribution is placed in the hands of a motivated community that has been *equipped* with the necessary skills to put the water infrastructure to good use for many years to come.

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