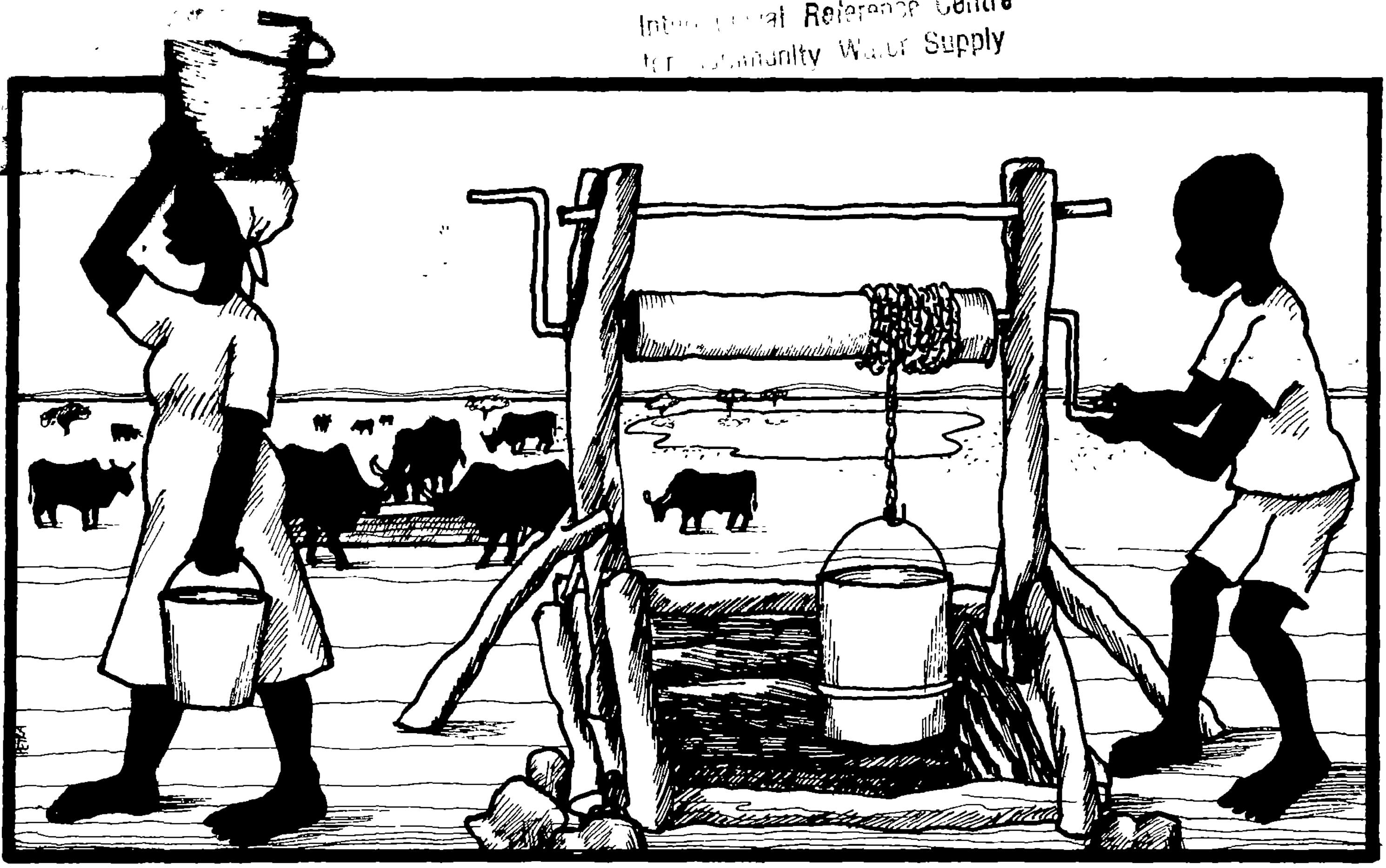
Water Use in Eastern Botswana: Policy Guide & Summary of the Water Points Survey



Ministry of Agriculture, Botswana

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WATER USE IN EASTERN BOTSWANA:
POLICY GUIDE AND SUMMARY OF THE WATER POINTS SURVEY

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Ministry of Agriculture
Republic of Botswana

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SUMMARY OF RECOMMENDATIONS[1]

A. IMPROVING COMMUNAL WATER USE AND LAND USE PLANNING

1. The Ministry of Agriculture should undertake a programme of mixed water point development in the eastern communal lands and cattleposts aimed at improving the accessibility of water supplies to agricultural producers. Water development should be based on the resources in the area in question. This requires a flexible programme which can deal with a wide variety of physical and management types. Greater thought should be given to involving local labour and local expertise. A component of this programme should be the scattered site sinking of open wells, where cost and hydrogeological conditions permit. Accessibility would be improved by providing convenient, reliable and inexpensive water for both domestic and livestock purposes in the arable and grazing areas of the east. Group management that restricts wet season access to livestock fallback points should be encouraged by MoA extension staff as a way of conserving grazing around water points for dry season use. This programme would have to be planned and implemented in close consultation with the Ministries of Local Government and Lands and Mineral Resources and Water Affairs.

2. The ALDEP team should approach both the Ministry of Commerce and Industry and the various intermediate technology groups in Botswana concerning the feasibility of rural production units in manufacturing low cost rainwater catchment tanks suitable for capturing water from grass and thatched roofs of rondovels and huts. Paralleling the Pelotshetlha threshing floor tanks, these above-ground rainwater tanks should provide convenient domestic water at the lands.

3. Soil and water conservation projects should be developed by the Ministry of Agriculture with the objectives of (1) extending the interim period between the end of the rainy season and the beginning of the dry season in terms of increased man-made water point use and (2) conserving wet season grazing. Consideration should be given to projects to halt sheet erosion

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1. See also Guidelines for Planning Projects Which Affect Livestock and Domestic Use of Water in Eastern Botswana; Guidelines for Choosing Types of Water Points and Sites for Water Development in the Communal Areas of Eastern Botswana; and Guidelines for Group Management of Dams.

in the mixed lands and cattleposts and to retain donga water.

4. The Range Ecology Unit, in conjunction with the Animal Production Research Unit and statisticians in the Planning and Statistics Unit (MoA), should undertake the long-term monitoring of range and livestock conditions at a selected sample of water points in the eastern communal areas. It is important that both individual water point types and fallback systems of water points be monitored in this exercise.

5. In the absence of such long-term monitoring, it is recommended that in conjunction with the continuation of the EDF monitoring by the Planning and Statistics Unit:

(a) The Range Ecology Unit should continue monitoring the 46 water points at the twelve Survey sites on a seasonal basis; and

(b) The Animal Production Research Unit should take over the monitoring of the Survey's sample livestock holders at several of its sites. A primary aim would be to complement proposed APRU monitoring of the EDF sites in major areas presently not covered by the EDF team.

6. Communal area water use planning has great potential in certain areas of the east. Some areas suffering a perceived grazing shortage may be willing to undertake selective measures for community-based grazing control. The short-term objectives of such planning would be the control of herd movements in order to conserve wet season grazing around dry season fallback water points. Restricting wet season access of livestock to such points will be a major way of conserving this grazing and can involve a number of strategies, including closing the water point, shortening its hours of operation, raising or establishing wet season watering fees and selective fencing scheme. Regulating herd movements into and round an area's arable and grazing lands would be the immediate objective of such controls, not decreasing the stocking rate of the areas concerned. In those areas willing to initiative and adopt measures to improve wet season grazing around fallback water points, consideration should be given to allowing the local election of members to a conservation committee, with the approval and consent of the Minister of Agriculture under Sections 20 and 21 of the Agricultural Resources Conservation Act.

7. The Ministries of Local Government and Lands and Mineral Resources and Water Affairs should investigate public works and labour intensive methods of expanding existing village water supply systems provided by District Councils. If feasible, such projects could be adopted as drought relief schemes as well.

8. Water development should be based on a clear knowledge of the water points in the area and how they are used. The only way to produce a complete and accurate water point census is by on-the-ground counting. This effort can be assisted by technical tools,such as air photos, but they are not adequate in themselves.

9. Sand rivers are an under-utilized resource. The Department of Water Affairs should continue and expand its efforts to better utilize sand rivers. The Ministry of Agriculture proposed Water Points Unit (see below) should identify possible sand river locations for domestic and livestock water sources in the mixed lands and cattleposts of eastern Botswana.

B. EQUITY CONSIDERATIONS

1. The village borehole programme appears to have been successful in assisting the poor. Ministry of Agriculture programmes have had a somewhat lower success rate. An alternative strategy might be to undertake the improvement of those sources already primarily used by the poor. This would involve the improvement of haffirs and sand river wells. The latter might involve the construction of sub-surface dams in sand rivers,complemented by an improved open well technology.

2. Access to open wells by labour-short households might be improved by equipping wells with hand pumps.

3. No change in communal land tenure in eastern Botswana should be undertaken unless the rights of access to fallback water points by community members are guaranteed.

C. MEASURES TO IMPROVE SMALL DAM UNIT EFFICIENCY

1. The SDU should be reconstituted as a Water Points Unit which can provide expertise on a variety of waterpoints,including springs, open wells, seep wells and sub-surface dams. Technical staff expertise in the SDU should be increased to improve the site evaluation procedures, both for dams and for open wells. No dam should be built without competent professional siting, including soil testing and determination of the catchment area. No new dams should be built until this capacity has been developed.

Field testing of different types of hand pumps and well casings should be undertaken before any one type is used exclusively by the SDU. The SDU should consult intermediate technology groups in Botswana concerning types of hand pumps which would make open wells easier to use for labour-short households. ALDEP's <u>Consultant's Report on Small Scale Rural Water Supplies</u> should be used for this. SDU should undertake a simple programme of performance monitoring of some existing dam structures in order to provide information for re-designing the dam structures in the future. It might be necessary to contract out this monitoring exercise.

2. A number of the dams observed had 2/1 or 3/1 side slopes. These showed substantial erosion within five years of construction. Design side slopes of 5/1 or 6/1, while increasing the volume of fill required, would markedly reduce the erosion hazard and subsequent maintenance costs.

3. The Small Dam Unit should be re-organized into two or three operating units, each of which would have sufficient technical staff and construction capability to operate across several adjacent regions. Information on the construction costs of haffir-dams supports a much expanded role for private sector contractors as well. Similarly, use of local expertise in the siting and sinking of scattered open wells(wherever possible)should be the policy of the SDU as a Water Points Unit.

4. In future construction, the SDU should give consideration to fencing the dam wall and spillway, but leaving the reservoir pit unfenced. The communities who wish to have the reservoir pit fenced, should be encouraged to apply for AE10 funds. The actual fencing can be done by the community, by a private oontractor, or by an SDU fencing team. In the future, communities who wish to use water troughs at their dams should also be encouraged to apply for AE10 and AG15 funds.

5. The SDU should maintain a <u>small</u> spare parts supply (not a full-fledged store),where groups could purchase replacements forthe hand pumps they are using. The SDU should not be involved in the repair and maintenance of existing dams, save where structural design and construction faults have necessitated the repairs.

6. The Small Dam Unit should publish its proposed schedule of dam building within the next three months. This should be a realistic time table.

It should be presented to all groups currently awaiting construction of a dam. The failure to accurately inform groups about the building schedule has caused bitter feelings in some areas.

7. No new dam groups should be formed until the SDU has met its outstanding commitments and the groups can be assured that the SDU will start building within six months.

8. Agricultural Demonstrators and Group Development Officers should, in co-operation with the proposed Water Points Unit, help would-be dam groups undertake alternative ways of improving their water situation. ALDEP's Consultant's Report on Small Scale Rural Water Supplies should be used in this effort.

D. SUPPORT FOR DAM GROUPS

Either Land Boards or the Agricultural Resources Board should be designated as the body to which dam groups can appeal for assistance in regulating the use of their dams. There is particular need in specific areas for personnel and vehicles to prevent the abuse of group dams by unauthorised outsiders with large herds of cattle.

E. GRAZING EVALUATION

1. The Range Ecology Unit should continue its effort to redesign its range condition scorecard with the following factors in mind:

a. The lower layer cover counts of good and intermediate species should not be replaced, unless the proposed procedures can be used as point-in-time measures of grazing quality. There is a need for both point-in-time and intermediate term carrying capacity indices in the new scorecard.
b. The present procedure for estimating tree and shrub counts should be abandoned. Not only are computational errors encouraged under the existing scorecard, but it is dubious whether or not low bush encroachment means better grazing in some areas.
c. Unless made less subjective, the subscores for plant vigour, erosion and litter should be abandoned.

2. Until these long-term recommendations can be adopted, the Range Ecology Unit should consider the following short-term modifications in the existing scorecard and scoring procedure:

a. The counts for trees and shrubs should follow immediately the estimation of the lower layer cover counts of good and intermediate species.
b. Trainees should be used in completing scorecards for official govern-

ment projects only with adequate training and thorough supervision.

c. All computations should be made on the scorecard (if necessary on the back). If calculators are not being used in the field, they should be used in the future since accurate raw counts may be just as important as subscores.

d. The following additions to each scoreboard are recommended:

- Name of general area scored
- Name of reference point from which transect is taken
- Degree bearing of transect, if appropriate
- Date of scoring
- Name or initials of scorer
- Interval distance
- Total of the 10 squares of lower layer counts
- Indicate, if applicable, the subtraction of 2 points from the trees and shrub counts.
- Rounding of counts should be done consistently.

F. VILLAGE RECOMMENDATIONS

A. Mokatako

1. The Southern District Council should investigate irregularities in the operation of its syndicated boreholes at Gakikana and Freestaat in the Barolong Farms. It appears that no memorandum of agreement between Council and the Gakikana syndicates was ever signed and that the Freestaat memorandum has been allowed to lapse. This needs to be confirmed.

2. The Southern District Council should consider revising this memorandum of agreement. Council should waive any fees owed it by the Gakikana and Freestaat syndicates should these lands syndicates agree to water both domestic users year-round and draft oxen in the ploughing season, at no cost to these users. The syndicate would agree to bear these costs out of its own pocket, in return for which they would pay no Council fees. If the syndicate agrees, Council should announce this agreement at a kgotla meeting in Mokatako.

3. The District Commissioner, Kanye, should investigate possible labour hiring mispractises at the Gakikana borehole involving payment or non-payment of the pumper there.

4. The District Agricultural Officer, Good Hope, should determine if a viable farmers committee or village development committee exists, which would be interested in applying to the Small Dam Unit to have Molete dam deepened in the future. If no such group already exists, the Southern

District Council should consider requesting funds to have the dam deepened directly.

5. The Southern District Council should consider developing a village borehole scheme at Ditlharapa, an area that has some of the highest domestic water fees found by the Water Points Survey. It may be more reasonable to purchase one of the private boreholes already existing in or near the village than to have a completely new borehole drilled.

6. The District Officer (Lands), Barolong Farms and the Rolong Land Board should reconsider the present and future alignments of drift fences in the Barolong Farms, taking into consideration factors mentioned in the Guidelines. In particular, the fencing of the Gakikana livestock watering borehole into a lands area may eventually increase crop damage and arable/grazing conflict, unless the fence is realigned, or secondary cordon fencing is provided or the present syndicate members' cattle are removed from the area altogether.

7. If the proposed Mokatako drift fence is constructed according to its proposed alignment (fencing the Gakikana borehole into the lands area), the District Agricultural Officer, Good Hope, should consider developing a set of open wells with hand pumps in the grazing area, to be managed by farmers committees. This assumes that the Molopo River will no longer act as a dry season water source.

B. Ntlhantlhe

1. The Southern District Council and the District Agricultural Officer, Kanye, should investigate the operation of the SDU-built dam at Magolthwane and, if they find irregularities in its operation, consider placing the dam under the management of either the village development committee or an established farmers committee.

2. Unless the long unresolved difficulties between the chairman and vice-chairman of the SDU dam at Mehane are resolved within three months, Council should disband the group and set up a new one consisting of only those people who live more than six months in the lands area there.

C. Gamodubu

1. The Kweneng District Council should request the Rapalana dam group to cooperate more with its parent VDC in Mmakanke and should ensure that the Mmanoko dam group is cooperative as well. The Council should assist the VDC in encouraging people to make contributions to the better management of the dams in Mmanoko, Motloletshetsega and Rapalana.

2. Since there is really no dam group presently operating the Mmamohiko SDU

dam, the Kweneng District Council should determine if the Gamodubu VDC is willing and able to set up a sub-committee for the dams operation.
3. The Kweneng District Council should investigate allegations of mis-management of the private borehole in Gamodubu (which it subsidizes by providing free diesel).

D. Lentsweletau

1. On the basis of evidence provided in this report, the Kweneng District Council should determine if fee collection at its cattle watering borehole could not be improved. Moreover Council should consider raising its fees of 20t/beast/month, given that the average fee of alternative livestock watering points in the Lentsweletau area is between 25t - 40t per beast per month.
2. The Kweneng District Council should either suspend operation of the Lentsweletau cattle watering borehole or substantially shorten its hours of operations in a good wet season, in order to conserve grazing there for dry season livestock use.

E. Matebele

1. The Kgatleng District Council should continue its efforts to help Oodi and Matebele residents fence and desilt Kgalapitse dam.
2. The District Agricultural Officer, Mochudi, and the Kgatleng District Council Secretary should investigate the community need for repairing, desilting and fencing Three Kopi dam.

F. Dikgonnye

1. If the Kgatleng District Council commits funds for a village borehole in Dikgonnye, it should be used for domestic purposes only.
2. The Kgatleng District Council should continue its efforts to help residents with the longstanding project to fence and desilt Dikgonnye dam.
3. The District Agricultural Officer, Mochudi, should investigate the community need for one or two open wells with hand pumps in the lands south and east of Dikgonnye. If the DAO feels there is a strong community commitment to manage these wells on a group basis for domestic and draft oxen purposes only, he should approach the SDU for well-siting assistance.

G. Mmaphashalala

1. The District Agricultural Officer, Mahalapye, should investigate the community need for one or two open wells with hand pumps in the lands (northern and western sides) of Mmaphashalala. If the DAO considers there to/be a strong commitment to manage these wells on a group basis for domestic and draft oxen

purposes only, then he should approach the SDU for well-siting assistance.
2. The Central District Council should consider larger storage tanks for the village water supply in order to ensure a more continuous supply to villagers.

H. Mosolotshane

1. The Central District Council village borehole reticulation system should be expanded to the middle and western parts of the village.
2. The District Agricultural Officer, Mahalapye, should investigate the community need for one or two open wells with hand pumps in the area. If the DAO considers there to be a strong community commitment to manage these wells on a group basis for domestic and draft oxen purposes only, then he should approach the SDU for well-siting assistance.

I. Ramokgonami

1. The Small Dam Unit should complete installation of hand pumps and troughs at three of the four SDU dams in the area.

J. Motongolong

1. The Agricultural Supervisor, Bobonong South, should assist the farmers in applying for AE10 or SLOCA funds for equipping their wells with hand pumps.
2. The District Agricultural Officer, Bobonong, should explore with the SDU the feasibility of protecting the spring at Famo.
3. The District Agricultural Officer, Bobonong, should explore with the SDU the possibility of constructing subsurface dams along the Macloutse River.
4. Central District Council should consider the provision of a supply of spare parts for the village borehole to improve ease of maintenance.

K. Phokoje

1. The Agricultural Demonstrator, Mmadinare South, should assist the farmers in applying for AE10 or SLOCA funds for lining their seep wells or equipping their wells with hand pumps.
2. The District Agricultural Officer, Bobonong, should explore with the SDU the possibility of constructing subsurface dams along the sand rivers north and south of Mmadinare.
3. The Head of the SDU should inform the people of Mmadinare of the date on which he intends to begin construction of the dams which they have requested since 1977.
4. The Agricultural Demonstrator, Mmadinare North, should assist farmers in applying for AE10 or SLOCA funds for lining seep wells in the Mmadinare

North lands area. He should also join with the District Agricultural Officer, Bobonong, in exploring with the SDU the feasibility of sinking open wells in that area.

5. The District Agricultural Officer, Bobonong, should request the Ministry of Agriculture veterinarians to determine the effects on cattle of watering in run-off from the Selebi-Phikwe mines. If this proves to have detrimental effect, appropriate action should be taken in cooperation with Bangwato Concessions Limited.

L. Makaleng

1. NorthEast District Council and the Group Development Officer should assist the Makaleng Borehole Project Committee in establishing a simple book-keeping system and in setting fees which reflect operating costs.

2. NorthEast District Council should provide a supply of spare parts for the sand river extractor and train the pumper in repairs.

3. The Regional Agricultural Officer and the Group Development Officer should ensure that immediate action is taken on the application of the Toteng Ward for AE10 funds to establish a well for domestic water supply. The SDU should provide technical advice for this project.

4. The Regional Agricultural Officer and the Group Development Officer should cooperate with the SDU in determining what should be done in the repair of the Regimental Dam and in assisting the village to secure necessary funds.

5. The Regional Agricultural Officer should explore with the SDU the feasibility of constructing sub-surface dams in the Shashe River.

6. NorthEast District Council should give attention to the provision of domestic water in the outlying wards of Toteng, Botalaote and Matenge.

Guidelines For Planning Projects Which Affect Livestock and Domestic Water Use in Eastern Botswana

During the Survey's fieldwork, a number of projects were encountered, either being planned or already completed, which (will) alter water use patterns at selected lands or mixed lands and cattleposts of eastern Botswana. In particular, the construction of SDU dams has directly affected water use, while the construction of drift fences does so indirectly by shifting and restricting grazing areas. This type of planning has increased recently and much of it is working. Some planning, however, has not taken into account what the Water Points Survey has found to be important factors in rural water use, especially for livestock purposes. The following list of factors to think about is meant to help decision-makers better plan water-related projects. This list does not offer any solutions. For reasons that will become clear below, solutions vary from site to site. All that is offered here are those factors planners should think about if they want to catch big mistakes before they happen.

1. Know the fallback water points in the area being planned. This means knowing the primary sources used seasonally, as well as those alternative water points used at any given time when the primary water source breaks down or dries up. Drought fallbacks may be different than the dry season fallback points. Identifying where people and livestock water when is important, especially since this information identifies alternative grazing areas. For example, a drift fence is to be constructed at Mokatako which will fence an alternative livestock watering borehole within the lands side of the fence. If there is a short rainy season and the rainy season water sources on the grazing side dry up before harvest, then significant problems could arise in watering livestock at the borehole.

2. Because people and livestock water within a system of water points, plans to use one water source to control grazing patterns or stocking rates in an area will rarely work. Water use in the hardveld is often not like that in the sandveld. In the east, to control water use in terms of water points means the fallbacks have to be controlled

as well.

3. <u>Think spatially</u>. It is <u>movements</u> of people and their herds to and around water points that must be understood. Knowing where grazing pressure, trampling and crop damage are heaviest and lightest is important, especially in terms of drift fence alignment. Identify major corridors and routes to and from fallback water points that are used seasonally or in emergencies. In some cases, such as drought, herd movements from outside the area into it (or vice versa) may be more important than movements of community members' herds within the area.

4. Know what primary fallback points are <u>restricted access</u> and which ones are <u>open access</u>. Access here means open or restricted to members of the same community, since some open access sources can still be closed to use by outsiders. In fact, it is probably more important to know the type of access and, if restricted, the kinds of limitations involved for how long, than it is to know who owns or manages the water point. Moreover, identify those man-made water points that suspend or continue operation in the wet season. A livestock borehole that has to operate in a good rainy season indicates a high stocking pressure in the area, such that efforts to ensure wet season grazing around such points may be difficult. On the other hand, fallback water points not used in the wet season, but operated in the dry season, may provide sources for future attempts to conserve wet season grazing.

Knowing during which months and the extent to which people and their herds rely on rivers is crucial in understanding the extent to which planners can use restricted access fallbacks to improve grazing and herd movement patterns. As long as people can rely on the open and free surface and sub-surface water in rivers, controlling man-made fallbacks as a form of controlling range conditions will be made difficult.

5. Water points may be for multiple purposes or just for a single purpose. In addition, the purposes may change seasonally, e.g. a domestic land haffir in the wet season may water cattle at the beginning of the dry season. Since some people value <u>convenient</u> (nearby) water as much as <u>reliable</u> (year-round) water, it is futile to expect a government-supplied water point to

be used primarily for livestock purposes when convenient dry season domestic water is at a premium, as it is in many communal areas. As noted throughout this Report, management of a single purpose water point is typically different than management for a multiple purpose one. Planners need to know when a water point is used and for what purpose: domestic use, general livestock purposes, and specifically draft oxen use. Often, draft and other livestock watering go together at a water point but it may be useful for future agricultural planning to identify those water points which mainly supply draft oxen, even if only for part of the year.

6. Understand how grazing, water and crop damage disputes are settled in the area for which the water-related project is planned. Also, try to identify what factor - grazing or water - is the more serious year-round problem in the area. If grazing is the limiting factor and not water, then the role of water development alone may be restricted more to opening up new grazing areas rather than to improving poor range conditions around existing water points. To gather this kind of information adequately will mean talking to more than the headman and village AD. Visit water points and talk both to men and women about lands and water shortages and disputes. In particular, distinguish between disagreements between community members and disputes involving community members and outsiders. Those areas that have a history of settling disputes or see the need for some local institutions to do such dispute settling might be priority areas for future planning attention.

7. Think small. Where groundwater is available, scattered open wells can provide more convenient and reliable water at substantially less capital costs than many other types of water points. A major disadvantage of wells - the comparatively high labour costs associated with drawing water - may not be so much of a problem in areas where labour is abundant and alternative productive opportunities few.

8. Last, but not least, each area is unique because each area's configuration of fallback points and grazing routes is unique. A solution in one area may be no solution in another.

Guidelines For Choosing Types of Water Points and Sites For Water Development in the Communal Areas of Eastern Botswana

Over the course of this Survey, two important policy questions have been asked of us in addition to those originally outlined in our terms of reference:

- "How do you tell (a) if an area needs new water points and (b) what areas need them the most?"
- "What happens to an area's stocking rate once a new livestock watering point is added?"

Our guidelines for answering these questions are based on Survey field experience and therefore apply only to the communal lands and cattleposts of eastern Botswana.

There is a risk that the following guidelines will be seen as primarily concerning new livestock watering points. This is not the case. It must be emphasized here, as it is throughout this Report, that the provision of domestic water supplies is a priority in the communal areas. To continue to treat new livestock points as the main water need for many lands and cattleposts is to ignore one of the major findings of the Water Points Survey.

I. Guidelines For Choosing Water Development Areas

1. It is easier to decide if an area needs more water points than it is to decide which areas are needier. Assume all communal areas need more water sources because they fall short of recognized minimum standards for domestic and livestock consumption levels.

The Animal Production Reserach Unit recommends that "water should be available to all stock at all times to ensure... optimum performance," but, as Bailey found,

> "This standard of water supply is not reached by any farmer who responded to the questionnaires of the Water Points Survey .... Most cattle holders can reach water within 30 to 45 minutes [from their kraals]. However, this is still a far cry from reaching the APRU ideal of a continuous and freely available supply of water for cattle." (Keeping Cattle and the Cost of Water in Eastern Botswana)

Only at open access surface water points, such as dams and rivers, are livestock likely to have unrestricted water consumption. Similarly, the ideal daily domestic consumption of 30 to 45 litres of water per person has been achieved by only a few of the major villages. Many people in the lands and cattleposts are probably consuming only a fraction of this standard, especially in the dry season (see Table 1 in the section in Improved Water Supplies, Appendix C). Certainly, the majority of people perceive a need for additional water points at the lands (page 4).

The reasons why many communal areas do not have more government-sponsored water sources range from lack of funds and implementing capacity to legitimate concerns over the consequence of such development; it is not, however, because of a lack of need for more water.

2. If the basis for deciding whether or not an area needs water is a minimum standard of water consumption, then the criterion for choosing needier areas follows directly: choose for water development those sites with the greatest population estimated to be consuming the least water over the longest period of time. In other words, choose those water-short areas with the greatest consumption gap between existing levels and minimally acceptable levels.

Unfortunately for planners, people and livestock rarely consume water in order to meet some recommended standard. People do not want just more water; they want more reliable, convenient and inexpensive water, especially in the dry season. Year-round, nearby and cheap water is what households would like to have in order not to worry about their water supply. This means that households behave as if they face three kinds of water shortage and this should be recognized in the selection criterion for water development areas.

3. The Procedure A two-step procedure is proposed for site selection, designed so that those who do not have the time or resources to undertake the first step can do the second directly.

Step I

The aim of Step I is to rank sites in terms of how great each area's water shortage is estimated to be. The underlying assumption of this step, which is set out in detail in Attachment 1 to these guidelines, is that an area needs more domestic or livestock watering points, when, in comparison to other areas, it has:

- a higher number of people or beasts per year-round water point;
- higher charges for domestic or livestock water;
- fewer months of available water point operation for livestock;
- greater straightline distance for people or livestock to trek- to dry season water.

Step II

This step refines the initial ranking of sites. Before making a decision on the basis of the ranking alone, check to see if any of the areas exhibit factors listed in Chart 1. It is our experience that such indicators, although imprecise, reflect water needs as much as those mentioned for Step I. Much of the reasoning for our classification is obvious and what is not can be found in the text of the Report. This Step II ranking remains preliminary until suitable locations are found for the physical type of water point(s) being developed.

4. This two-step procedure is as easy or as difficult as one makes it. While it does not require perfect information, it is not a desk exercise. There is necessarily an element of judgment involved in this, as no site will fit the criteria perfectly. It depends largely on how the people in the areas regard the importance of more reliable, convenient or cheaper water. (Just remember - without a reliable dry season water supply, questions of cost and convenience become academic.) Do not even try to follow this procedure if you are unwilling or unable to talk to farmers directly about water use in each area.

II. Guidelines For Choosing Water Point Types

Domestic

1. The perfect lands water point for domestic purposes would be a free, reliable standpipe in every lolwapa. Since this is not possible, domestic water development in the communal areas has to rely on a variety of water point types, each of which has its own advantages and disadvantages (see Attachment 2). Households face trade-offs in water supply. Open wells may be reliable and often convenient (nearby), but they require high labour costs. Boreholes are reliable, but not always conveniently located or free. Dams may be convenient and cheap, but they are more likely than not to be unreliable

CHART 1

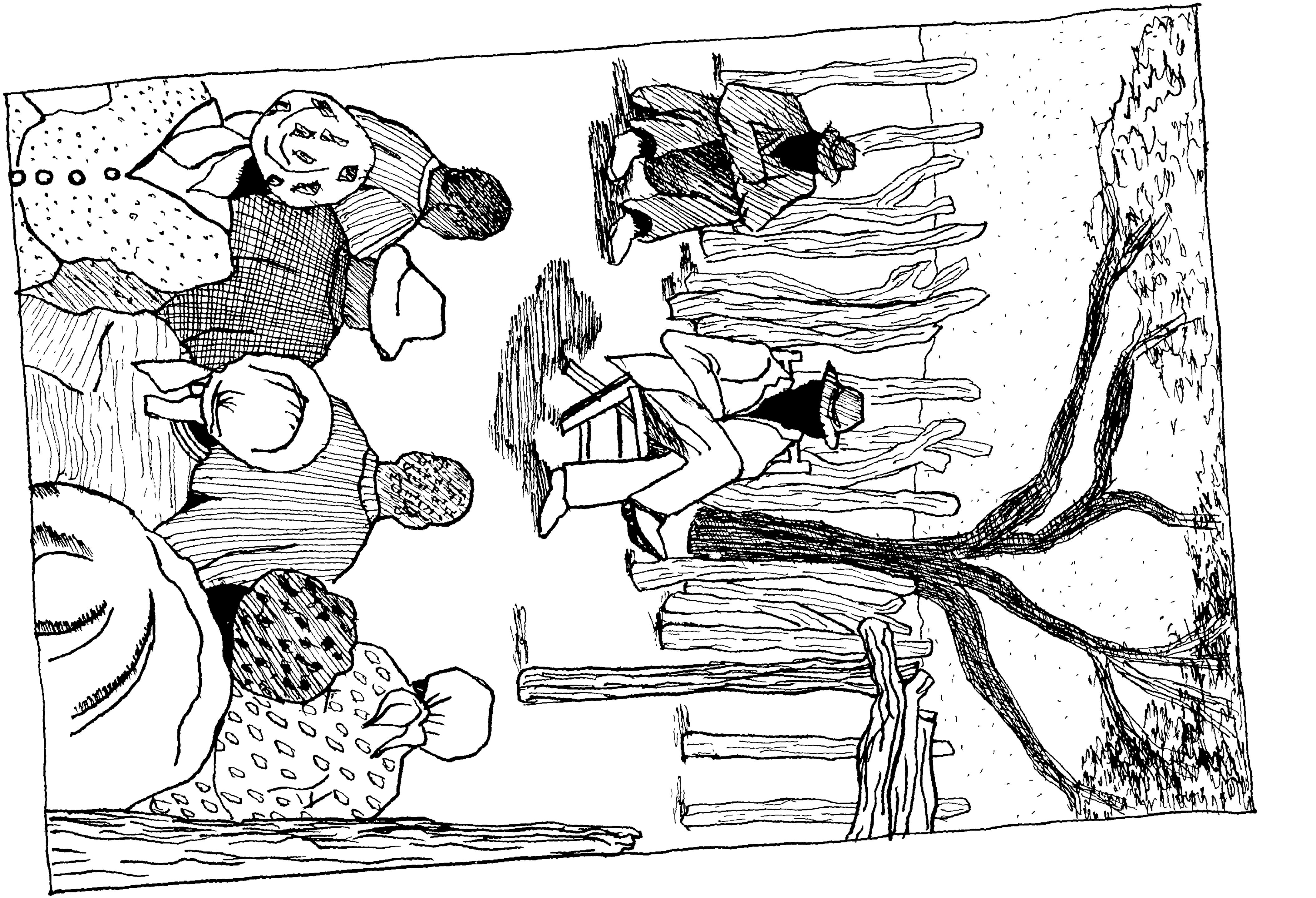
AREA WATER DEVELOPMENT INDICATORS

FOR MORE WATER DEVELOPMENT

- payment for transported water.
- complaints about long hours fetching water or too few trips.
- negative perceptions about dominant water point type, e.g., people complaining about lack of labour for lifting water at open wells (see Attachment 2).
- area lacking major open access surface water sources for unrestricted cattle watering.
- past history of group water point management, especially rationing livestock water for domestic purposes in dry season.
- drought water points furthest away from water use area.
- complaints that people cannot shift herds to more remote water points until after harvest when field labour is freed up (this may leave rationing of surface water sources until too late in the season); similarly complaints that lack of water prevents timely access to the lands
- prevalence of year-long multiple function water sources (if reliable, convenient or cheap water is scarce, people "load" uses onto one water point, often causing management problems).
- people continually rating "shortage" of water as much more of a problem than shortage of grazing (this question is sensitive to the period of the year when asked).

AGAINST MORE WATER DEVELOPMENT

- long standing complaints about grazing shortages being worse than water shortages.
- complaints about arable/grazing conflicts, especially disputes over crop damage.
- prevalence of year-long single function water sources either for domestic or livestock uses.
- a "large" number of abandoned groundwater sources, such as wells and boreholes.
- operation of livestock boreholes and equipped wells in a good rainy season (except for draft watering purposes).
- no history of group management of water points.
- drought fallback points within water use area.
- pressure to privatize grazing around new water points.
- lack of community support for restricting access in the wet season to the dry season fallback water points for livestock.



(and, if pollution is considered to be a cost, they are not always "cheap" to use!).

2. This has four implications:
   - Water development should be based on the resources in the area in question. Why sink boreholes where extraction from sand rivers can be utilized more cheaply?
   - The water point type developed should depend in part on how people rank the need for more reliable, convenient or inexpensive domestic water.
   - Unless a communal area has no potential for developing other reliable water point types, boreholes can rarely be justified for domestic purposes only.
   - Technology can change the trade-offs. So can management. Standpipes make boreholes more convenient; fences and deep reservoirs reduce the potential for dam pollution; hand pumps lessen labour costs; rationing water is a way of conserving it. The question then becomes: is that extra gain in accessibility worth the additional cost? This, however, takes us back to our original ranking of water-short areas to see if there are any other sites where the gain from water development would be greater at the same cost.

<u>Livestock</u>

1. There is no single, simple answer to our second question about the effect on an area's stocking rate when a new livestock watering point is added. In the first place, if it is a reliable, large capacity point, it will probably alter <u>herd movements</u>, such that the increase in the area's stocking rate would be off-set by a decline in another area's rate. The real issue, though, is how large the "savings" are to the livestock holders from using a more reliable, convenient or inexpensive livestock watering point. The greater the <u>economic</u> value of these savings, the more likely will be an increase in the number of cattle held in the area, given the present terms of trade favouring investment in cattle over the non-livestock sector. But at the present time, no one can measure these savings in terms of pulas or beasts. We do not really know how each new unit of water improves communal herd performance in terms of lower mortality rates, better weight gains, etc; and we do not know the alternative productive uses the farmers can put their "savings", if <u>they</u> consider their gains not large enough to reinvest into cattle. In other words, we cannot measure how large the gain must be before

being converted into cattle.

The policy issue, then, is choosing a mix of water point types which will minimize the adverse effects of new livestock water development in an area.[1] We are looking for the least-harm combination of water points for improving a water-short area's livestock watering situation.

2. The term "combination of water points" has several meanings. In the first place, it means that in many areas it will take more than just one single water point to solve an area's water shortage, especially where there is a scarcity of convenient water. Second, areas vary greatly in terms of the physical potential for more water development, e.g., sand river extraction is possible in Makaleng but less likely in Dikgonnye. In addition, whatever the type of water that is constructed, its use will be set in combination with its next best alternative, e.g. one dam group in Kweneng District is able to restrict use of their haffir-dam largely to domestic use because the Lentsweletau cattle watering borehole is nearby. Finally, "water point type" means both the physical type and the management of a water point. Even though they are both open wells, a restricted access well will have different effects on the range than will an open access well.

3. The emphasis on the least-harm combination has three important consequences for planners:

- Any government water development programme will necessarily be a compromise between what people consider the most desirable solution and the least harm solution.
- In some water short areas, it may be less a matter of new water point development than of re-distributing use around existing water points, e.g., reducing the operation of man-made livestock points in a good wet season for livestock other than draft oxen.
- The least-harm combination of water points may or may not include the

1. It is assumed that refusing water development for livestock in those areas that are ranked as very water short is not politically acceptable. For example, prohibiting water development in the eastern communal areas might work against the smallholder there in favour of the freehold and sandveld cattle owners. It should be noted that, historically, high stocking rates in eastern Botswana have had less to do with expanded water development than with the low offtake rates. It is unclear how water development can be blamed for these low figures.

most cost effective water point type, as measured in accounting terms. For example, while open wells cost considerably less to construct than do Ministry of Agriculture designed haffir-dams, haffir-dams have a lower estimated annual cost per cubic meter of water supplied because open wells require relatively more labour to draw each unit of water. However, if water pollution is considered to be a "cost", then the balance may tip back in favour of constructing individual open wells rather than a haffir-dam. Areas with low stocking rates may be better able to trade-off increases in stocking rates against savings in costs of construction or operation. Certainly, Small Dam Unit haffir-dams have not been shown to be better or worse in terms of promoting overgrazing than other types of water points.

4. We know that water points with restricted access (through the imposition of the labour or membership requirements) are likely to have better grazing conditions than those points of the same type which are open access. We know that many individual wells have comparatively low stocking rates. We also suspect that, if you want better conditioned cattle associated with a watering point, fewer numbers watering at the point is a start in the right direction. Moreover, there can be no single, compelling reason for new livestock borehole development in communal areas except in the case of drought. Only when an area is ranked as overwhelmingly water short, in terms of most, if not all, of the factors listed in Step I and Chart 1 should boreholes even be considered in the mix of water points.

But we do not know the least harm combination. It depends on the water short areas in question. It is up to the people to rank their priorities, not only in terms of convenience, reliability and cost, but also to identify the pros and cons associated with each type (physical and management) proposed; and it is up to the planner to negotiate with these people to ensure that the livestock water development minimises the harm.

5. Finally, if people want more water points so that they need not have to worry about reliable, convenient or cheap water, then the addition of each new water point in any area may lessen the desire to manage that water point. Planners should monitor existing and new group management of water points to see how improving a group's accessibility to water affects its desire to manage the water.

Attachment 1: Detailed Instructions for Step I

(a) Inventory all major wet and dry season water points that are used by people when they are living in each site. You should inolude all boreholes, open wells and rivers that are used, though the more physical types listed, the better. Remember:

- What may seem like a small water point to you may be very important to the people. You just cannot assume boreholes are the major water supplier in each area. Sand river wells are small but, as a group, they account for over 20% of the monthly cattle use in Ntlhantlhe. This means that, whenever possible, seep wells, pans, dams and haffirs should be listed, especially when one of these types is the predominant water source.
- List the same physical types for all areas, e.g., do not count haffirs in one site and fail to do so in another. (Stretches of the same river used either for surface water or sand river wells should be listed individually.)

Your listing should include the following information for each water point: its locality in the area; its use (domestic, livestock or both); the kind of access to each use (open or restricted); if restricted access, the kinds and amounts of charges levied on use; and, if a dry season source, whether or not it is available as a fallback point throughout the dry season. Also find out where people get water in a drought for each kind of use, should some of the dry season sources dry up or the associated grazing disappear.

(b) If you did not do so when compiling the inventories, take time to revise your initial ideas about the boundaries of each area. Site selection should be based on differences in water use areas, not on some administrative or artificial boundary. Do not worry about the exact boundaries just as long as when you map, the area's perimeter includes the major wet and dry season sources. (Use the most detailed Census enumeration maps for your district.) Similarly, do not worry if all or some of the drought fallback water points fall outside your boundaries for the wet and dry season sources. Where there are strong attachments to a major village of allegiance, this can be expected.

(c) Estimate the human and livestock population for each area. Since the Census enumeration maps often show how many households are in each enumeration area, you can estimate total human population even if the water use area overlaps several enumeration areas or falls inside one. Unless you have better information, just assume households are distributed in each enumeration area evenly, so that the percentage of the enumeration area that fall inside or outside your water use area is also the percentage for the population falling inside or outside. If you want more accuracy, use the latest air photos which identify major clusters of households and adjust your estimate of the water use area's population. Better yet, when you visit each area, make an on-the-ground estimation with key informants as to the population distribution. Cattle crush figures or Ministry of Agriculture Planning and Statistics livestock figures for sub-regions in the districts can be used for estimating the livestock population. Again, do not worry about accuracy to the last decimal place. What you want to be able to do is (1) rank the area in terms of human and livestock populations and (2) have a feeling as to how large the differences are among the areas.

(d) Although there is no completely satisfactory way to rank areas in terms of how convenient their water supplies are, the following is proposed as a "quick and dirty" method: If you do not know where in your area major clusters of households are, then just measure the straightline distance from the midpoint of each water use area to the nearest dry season water point that is available for use during the entire dry season. Assume kraals are next to households, so that the same straightline distance applies for livestock. If you want more accuracy, use air photos or on-the-ground checks, so that you can measure the straightline distance from major clusters of households. Whatever you do for one site, you should do for all sites, however. You can now tell how many people walked how far to the nearest dry season fallback point, since the Census map tells you how many households are in each enumeration area and the Census tables tell you the average number of persons per occupied dwelling in each area. Do not become obsessed with accuracy or spend too much time on this exercise. All you want is some crude ranking of areas in terms of numbers of people and livestock furthest away from the nearest year-round watering point.

(e) With this information you can calculate four rough measures for comparing water use areas:

- Average number of people per domestic water point; average number of beasts per livestock watering point (averages should also be computed for dry season sources only);

- Differences among areas in terms of fees and charges paid;
- The average straightline distance people and livestock have to walk to the nearest dry season fallback point;
- The average number of months all livestock watering points stayed open per beast (count the number of wet and dry season livestock watering points in each area for each type; multiply these counts against the average number of months each water point stayed in operation for the Survey's sample livestock holders[2]; and total for all types, dividing this total by estimated area livestock numbers).

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2. See Table 13 in Charles Bailey's Keeping Cattle and the Cost of Water in Eastern Botswana.

Attachment 2: Perceptions About Water Points (Chart 1)

During discussions, key informant interviews and the Survey's review of the literature, a number of opinions about the advantages and disadvantages of water point types were encountered. No one villager would hold all of these opinions. However, people's views about water points should be taken into account when planning water development projects,even though officials may think the views are wrong.

Opinions About Dams

People like dams for the following reasons:

- There is little or no labour involved in watering cattle at a dam.
- There are low maintenance and operating costs associated with dams.
- Surface water is generally considered a communal good and is available free of charge.
- The government constructs dams at no cost to the people.

People dislike dams for the following reasons:

- Because dams are dependent on the rains, they are not reliable and are likely to go dry before the end of the dry season.
- There are high evaporation losses.
- Dam walls can be destroyed by cattle trampling, sledge dragging, flooding and seepage ruptures, rill erosion and so on.
- Dams are too public. Access is often open and any one can water there, whereas borehole water can be more easily regulated.
- Water is not as pure as that found in many boreholes. It is easily polluted if the dam is used for livestock watering. Seventy three percent of the Survey respondents who did not use a dam said the problem was dirty water.
- Dams which are located in lands areas encourage crop damage.
- Dams may encourage overstocking and overgrazing.
- There is a lack of an adequate catchment area in some places.
- There is often a problem of high rates of siltation in dams. Some animals get stuck in the mud and die there.

Opinions about Open Wells

People like open wells for the following reasons:

- Wells have relatively low maintenance and diesel costs in comparison to boreholes.
- They do not go dry as often as most surface water sources.

- Wells are cheaper and easier to construct than boreholes.
- In some areas there is local expertise in sinking wells.

People dislike wells for the following reasons:

- Wells do not contain enough water or are too costly to use for watering large herds.
- Getting water from wells is too tedious and laborious for children, women and older people. This is particularly true for watering cattle.
- Wells may be too distant. Fifty percent of the respondents who did not use a well said it was too far away.
- Open well shafts are dangerous for children and small animals, especially at night. A child was drowned in a well at one site during the Survey.
- The water table in some wells is highly dependent on rainfall.
- Wells near rivers may be flooded in the rainy season and need to be desilted later. Drought may necessitate the deepening of other wells.
- Wells are the old "traditional" way of getting water.
- There are no good well sites in some areas.
- Dynamiting through rock to sink a well can be dangerous. Restrictions on the use of explosives hinder well sinking in some rocky areas.
- Well water can be polluted by things which fall down the shaft. Twenty two percent of those who did not use an open well said the water was dirty. One member of the Survey team was astonished to find a snake swimming in a Survey area well.

Opinions about Boreholes

People like boreholes because:

- Boreholes are permanent water sources.
- Water is easier to get from a borehole than it is from an open well.
- Water quality is often better at a borehole.
- Boreholes are the "modern" source which progressive cattle owners use.
- Village standpipes are popular to use.

People dislike boreholes because:

- Boreholes are more difficult to maintain than most other rural water sources.
- Water fees are often higher at boreholes and can be expected to continue to increase with the rising price of diesel.

- In some areas there is a high risk of drilling an unsuccessful bore. The yield may be too low or the water may be salty or hard. Nearly a third of those who do not use a borehole said the water was too salty.
- Boreholes encourage overstocking and crop damage in some mixed lands and cattlepost areas.
- Boreholes are sometimes too crowded when stock are watering and the watering turnover is slow.
- In some areas the borehole is too far away. Sixty-six percent of those who did not use a borehole said it was too far away.

Opinions about Rivers

People like rivers because

- Surface water is considered to be a free and communal good.
- In some lands areas sand river wells are the only convenient and reliable water source.
- Sub-surface water is often readily available even in the dry season.
- Livestock often find the river unaided and water themselves.

People dislike rivers because:

- Sand beds are easily polluted making the water unfit for use. Ninety three percent of the respondents who did not use a river complained of dirty water.
- Some rivers are "too far away" to be of any use. Four percent of those who did not use a river said it was too far away.

Guidelines for Group Management of Dams

1. Dam groups should be formed in advance of the construction of the dam. The group should be consulted about the location and equipping of the dam.

2. Dam groups should not be formed a long time before the dam is actually to be constructed or handed over to the group. Certainly, the waiting period between the formation of the group and the start of construction should be no longer than a year. At all times the group should be kept accurately informed about plans and changes in plans.

3. At no time should the government undertake construction of new water points or changes in the status of existing water points (constructing fences, for example) without informing and consulting the local people.

4. It is better if a dam group represents a community rather than being a collection of private individuals. Such groups might include the VDC or farmers' committees. Groups which represent a community are in a stronger position to enforce restrictions or collect fees. Community groups also avoid problems of who inherits what rights ,as the right remains with the community.

5. Dam groups should have control of a system of water points in order to allow them to maintain a fallback strategy.

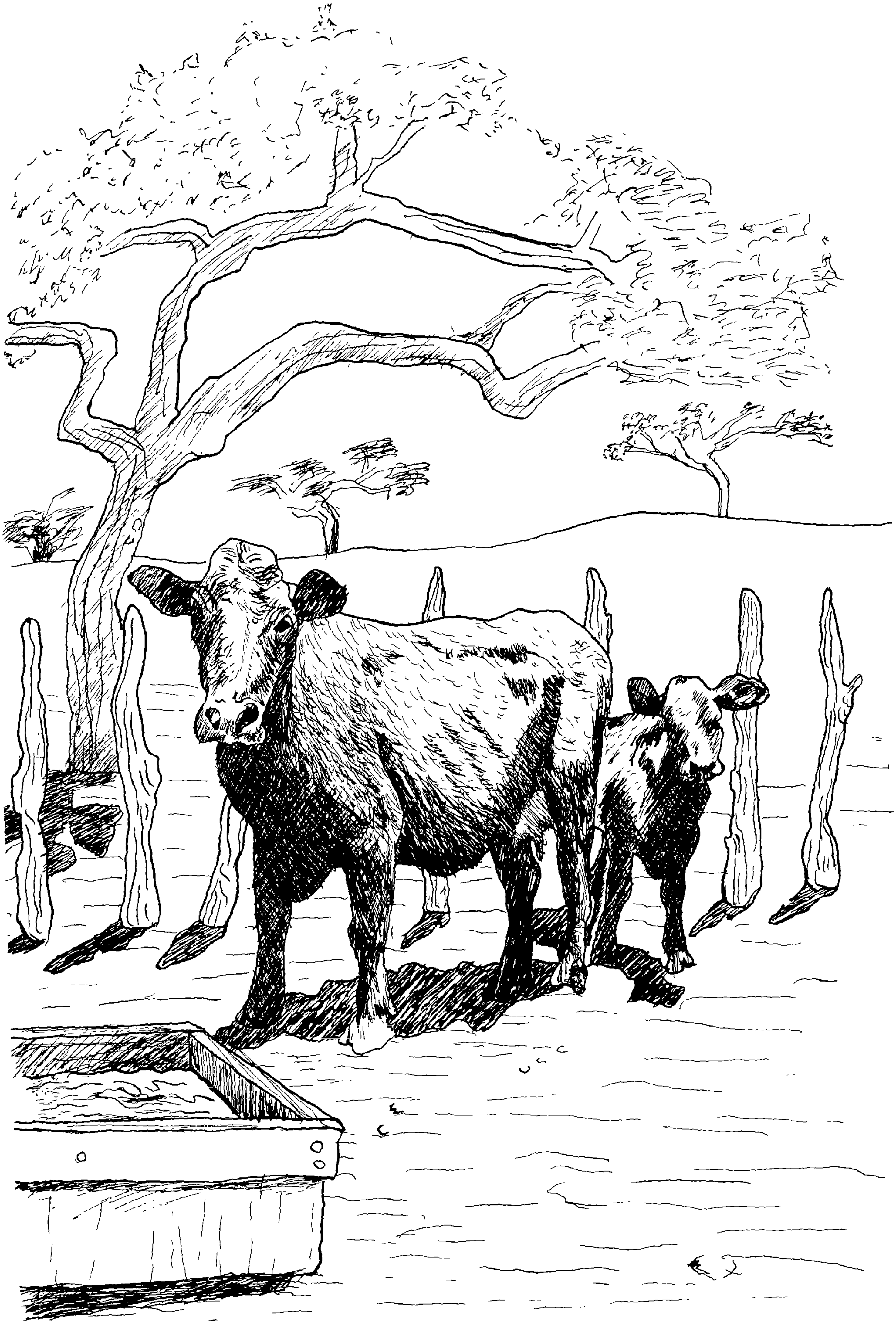
6. Groups should be helped to set up and maintain records which will help to determine operating costs of the water point.

7. Fees for water points which have continuous operating costs ,such as boreholes ,should be set to cover those costs.

8. The 72 thebe per beast fee at dams should be abolished. Dam groups should be assisted in determining what their long run maintenance costs might be and in setting up a system of collecting revenue to meet those costs.

9. Technical solutions should be found for those maintenance activities which groups are unlikely to undertake. (In the case of dams ,this could mean fencing the dam wall and spillway rather than the entire reservoir in order to protect these structures from damage).

10. Dam groups should be actively involved in as many aspects of planning and construction as possible. This could include assisting in siting the dam and full responsibility for fencing it.



Introduction

The Water Points Survey was undertaken "to provide policy guidance for future planning and implementation of both dam construction and water development under the Tribal Grazing Land and Arable Lands Development Programme". The Survey was asked to answer three basic sets of questions for the eastern communal areas:

1. What is the effect on the range of different physical types of water points and different kinds of water point management?
2. Who benefits from publicly provided livestock water?
3. How successful is group management of dams?

To answer these questions interviews with a random sample of households, monitoring of range and cattle condition around water points, and interviews with people knowledgeable about water points and water development were undertaken at twelve sites in the eastern communal areas. (See Figure 1). In addition, household interviews were done in three lands areas known to have water shortages.

This report is only a short summary of the Survey findings. Anyone interested in the detailed findings and descriptions of the Survey methods should consult Charles Bailey, 1980, Keeping Cattle and the Cost of Water in Eastern Botswana, Ministry of Agriculture, and Louise Fortmann and Emery Roe, 1981, The Water Points Survey, Ministry of Agriculture.

Background Information

The eastern communal areas have a great number and a large variety of water points. A description of physical types and their Setswana names can be found in Appendix A. An average of forty water points per site (482 in all) were mapped in the twelve Survey sites. The 358 respondents in these sites used 337 different water points, an average of 28 per site. This in fact underestimates the water points used, since during the rainy season puddles may serve as water sources for a number of days at a time. The number and kind of water points mapped at each Survey site are listed in Table 1.[1] The important point to be learned is that water systems are by

1. All tables can be found in Appendix B.

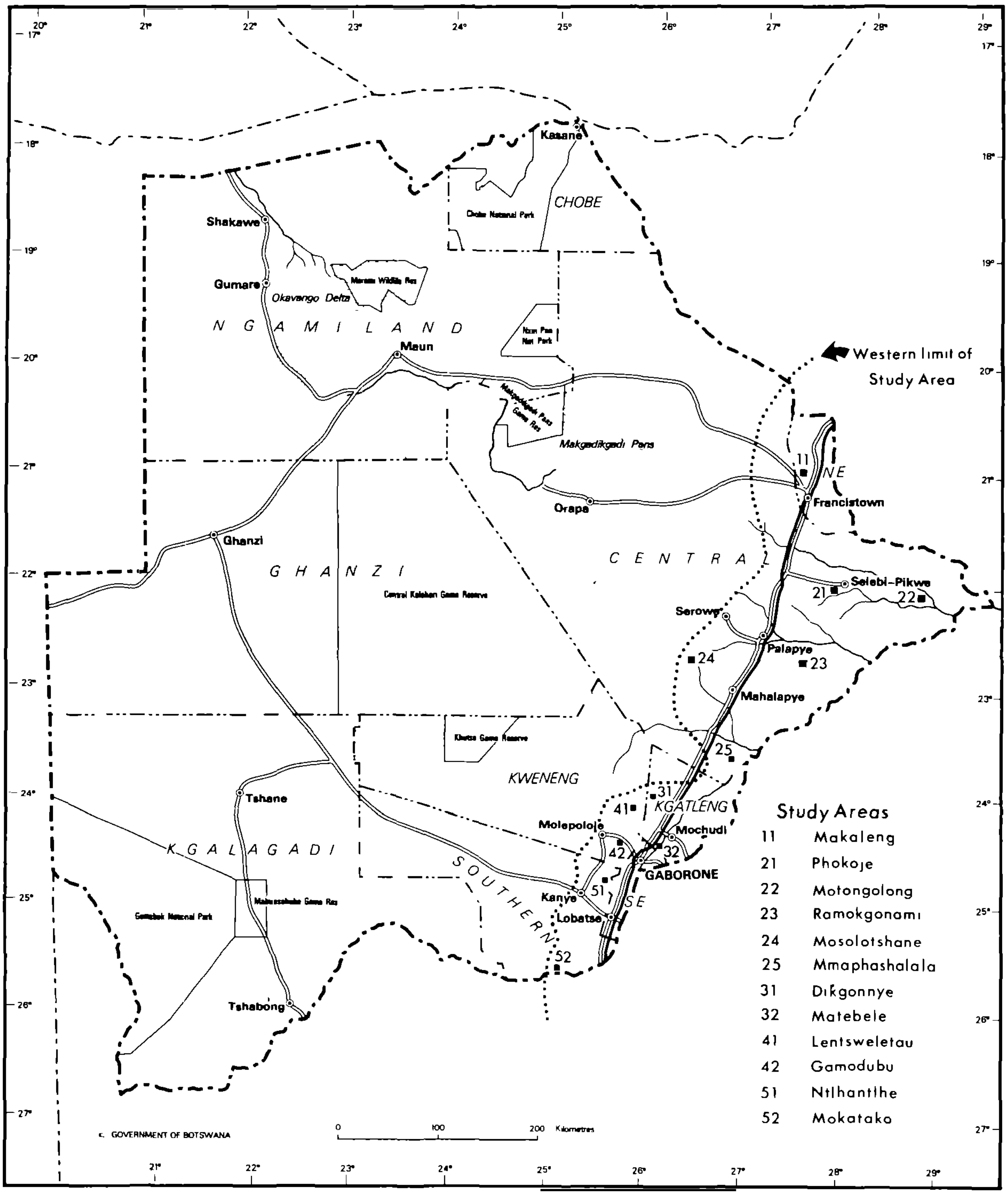


Figure 1 Water Point Survey Study Area

no means uniform in the communities of the eastern hardveld. They vary in the number and kind of physical types available during different seasons. Water use planning and development must be prepared to utilise and adapt to this diversity.

Tables 2 - 10 show the use of different kinds of water points at the village, lands and cattlepost. The most important water point in most villages is the Council borehole. At the lands privately owned open wells and haffirs are the most important water points. At the cattlepost, privately owned wells are the most important source.

The Fallback Strategy

Although there are many water points in the eastern communal areas, many of them go dry or break down each year. When the water point a household is using goes dry, the household moves to other, sometimes less convenient or more costly water sources. These fallback points vary from village to village depending on the nature of available water sources and from year to year, depending on the volume and distribution of the rainfall. However, there are some general rules which apply:

1. The household fallback strategy involves obtaining water with the least effort at the lowest cost throughout the year.
2. Few households have year-round free water as near to their houses as they would like. The household fallback strategy involves trade-offs between three interrelated factors:

   reliability: is the water available as and when the household needs it?

   cost: how much must the household pay for the water?

   convenience: how much effort (either in the form of walking to the water point or in labour required to get the water) is involved in using the water point?
3. A household's fallback strategy varies with the use it makes of water. Fallback water points for livestock may be different from those used by households needing only domestic water.
4. In eastern Botswana reliable sources are more often ground water sources, such as boreholes, open and equipped wells, and sand river wells.
5. The pattern of use of an individual water point may change as part

of the fallback strategy. Use of a water point may change from single to multiple purpose or vice versa, as the season changes or as water needs change. In extreme drought, a water point which has been used for only one purpose may be used for all purposes. This most frequently takes the form of allowing livestock to water at boreholes intended for human use. Similarly lands haffirs may be reserved for human use during the wet season, being used for livestock only when other sources dry up.

6. When all else fails, households move back to their major village of allegiance which is increasingly likely to have a Council managed borehole. In this fashion the village has become the "cattlepost of last resort". Physically moving the entire household is the final fallback strategy.

Is Water Development Needed?

The greatest need for water development identified by sample households is for domestic water at the lands where 66 percent of the sample of 358 households maintain residences. Most of the 87 percent of the sample who had a residence in the village do not think they needed another water point there. On the whole village water is closer and more likely to be free that water at the lands or cattleposts. The twenty percent of the sample who have cattle posts have relatively few complaints about the water there. It is unlikely that they would have established a cattlepost in the absence of a reasonable water supply. However, people feel a need for water development at the lands and mixed lands and cattlepost areas. In particular they want more and nearer domestic water. People at the lands go further for water than people in the village and they are more likely to pay for it. Even where more water points are not needed, people want their water source to be improved (for example, by equipping wells with hand pumps) so that fetching water takes less effort. Convenience is particularly important at the lands since labour is needed for agricultural work. Hence it is desirable not to have a lot of effort involved in fetching domestic water nor to have oxen walking great distances for water during the plowing season.

What are the Effects of Water Development?

Government has several options in undertaking water development. It can provide different physical types of water points. It has the choice of encouraging private management, group management, or it can manage water points itself. Depending on the kind of need for water and on the priorities of government, different strategies may be chosen. Two kinds of effects are considered here: whom does water development serve and what is the effect of water development on range and cattle conditions. These findings apply to the eastern communal areas only and should not be assumed to apply to the sandveld.

Whom Does Water Development Serve?

The Survey shows that not all households use all kinds of water points. The poorest (as defined by an index of possessions) are not less likely to use boreholes than the moderately poor and moderately rich, probably because the Council boreholes in villages serve all residents free of charge. The richest, on the other hand, are more likely to use boreholes than the moderately rich and moderately poor. It is probably the case that they are the primary users of private boreholes. Poorer people are more likely to use haffirs and sand river wells, both small sources which a family can provide for itself through the simple exertion of labour. The publicly provided livestock water points serve both rich and poor livestock holders. However, the richer livestock holders are more likely to use them than are the poor.

What is the Effect of Water Development on Livestock Numbers, Range and Cattle Condition?

It is commonly assumed that the grazing around a water point is influenced by that water point's physical type, by the management practices associated with its operation or by a combination of both factors. Certain types of water points such as dams and boreholes are seen as encouraging overstocking thereby contributing to overgrazing and low livestock productivity. Table 11 shows average daily livestock units counted at different physical types of water points during the Survey. These figures raise some questions:

- Does the larger number of livestock watering at boreholes mean there is greater overgrazing around them? If there is overgrazing, how does this show up in the condition of livestock watering there? How does this compare with cattle condition at other types of water points?
- Does the large number of livestock watering daily at haffir-dams mean they have led to overstocking in the mixed lands and cattleposts?

Has group management worsened the range around water points?

Three kinds of information were collected at a sample of water points in order to see how the type of water source was related to overstocking, overgrazing and low livestock productivity: number of livestock watering per day at each point; the condition of the range around the point; and the condition of the cattle (oxen) watering there. Four physical types were compared: haffir-dams; boreholes and equipped wells; open wells; and dams. Since management means different things to different people, each water point was classified in three different ways: by its owner, by its manager, and by the kind of access community users had to it.[2] Owners and managers were separated into three categories: 1) private individuals or families; 2) groups and government authorities and 3) natural and communally held water sources. Access to a water point was defined by its use in practice; namely whether the water point was open to the community or restricted in use at a given time by the imposition of fees, labour or membership requirements.

The Relationship Between Water Point Type and Livestock Watering Numbers[3]

1. There are significant differences in the numbers of livestock watering at different physical types of water points, particularly in the dry season. Boreholes have considerably higher dry season livestock loads than do open wells. It may also be that at certain times of the year, dams water significantly more livestock than boreholes, haffir dams and open wells, though too few dams were monitored to permit further generalization.

2. Differences in the number of livestock watering at water points with different management types are less pronounced. The Survey evidence suggests that group and government owned or managed water points may water significantly more livestock than privately controlled water points - again only in the dry season. Evidence suggests that privately owned or managed boreholes have

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2. A syndicated Council borehole may be managed as a privately owned borehole; a privately owned open well may be used by the community as a communally held, open access facility. It is not uncommon to find a water point having a different owner and manager or being used in a manner not originally intended by either owner or manager.

3. Information on 12-month cattle usage at various types of water points is drawn from Charles Bailey, 1980, Keeping Cattle and the Cost of Water in Eastern Botswana

fewer dry season livestock numbers than do group and government controlled boreholes. In some cases, the type of access may be important in distinguishing load differences among water sources. Restricted access boreholes have greater dry season loads than restricted access wells.

3. Both daily and monthly livestock watering figures indicate a lag of some two months between the end of the rainy season and the beginning of the dry season in terms of increased water use at man-made points. It was not until May that the dry season physical and management type differences in livestock loads first became apparent. A good wet season appears to over-ride many, if not most, physical and management type differences in livestock watering numbers. For example, many boreholes cease or reduce their operation in the wet season, when natural, rain-fed water points provide more convenient, cheaper water for livestock. Thus, ways of extending the effective length of the wet season should be investigated. One possibility might be low cost, labour-intensive soil, water and grazing conservation projects for improving soil water retention, halting sheet erosion, and retaining donga water.

4. Ranking the physical types of water points by their average daily livestock loads (as in Table 11) is different from ranking them by the percentage of total monthly cattle usage of each physical type. For example, while individual open wells have comparatively smaller livestock watering numbers per day, Bailey's figures show that as a group these wells account for 17.1 percent of the total 12-month cattle usage estimated at water points mentioned by Survey livestock holders; conversely, while dams and haffir-dams are recorded as having high daily livestock loads, these physical types, as a whole, only accounted for 7.3 percent of this 12-month usage by cattle.

5. In general communal and natural water points (specifically rivers) water substantial numbers of livestock in the communal areas. Rivers and sand river wells accounted for 22.4 percent of the total monthly usage by cattle at water points mentioned by the Survey's livestock holders between April 1979 and March 1980; in turn, communal and natural sources accounted for 34.3 percent of the 12-month cattle usage.

The Relationship Between Water Point Type and Range Condition[4]

1. Tables 12 and 13 provide information on differences in grazing quality at different distances from the water point, during the wet and dry season, and in the north to south regions of the eastern hardveld. (Each site's scores are based on averaging individual water point scores for that site). For the eastern communal areas, as a whole, changes in grazing conditions roughly follow the expected pattern. The average percentage counts for good and intermediate species improve with distance from the watering point (Table 12). Second, such wet season grazing is typically better than dry season grazing. Third, regional differences seem to exist in forage conditions, with the northern region having lower average percentage counts for good and intermediate species than the southern sites. In addition, bush encroachment counts for the northern region are substantially higher (Table 13).

According to the Range Ecology Unit the averages for the total grazing scores in Table 13 fall merely within the fair range condition class for the eastern hardveld as a whole, and the poor range condition class for the north. Moreover, the average counts for the good and intermediate species are very low. This means that a statistically significant difference among water point types in terms of range condition does not imply one type is a substantial improvement over another type. Type differences are likely to occur within a given range condition class as well as between classes.

2. Survey evidence supports the conclusion that different water point types do affect range condition differently, though this is a less straightforward process than originally assumed.

(a) Group and government owned or managed water points have better dry season range conditions associated with them than do privately owned or managed water points. Some of this difference, though, can be attributed to the fact that private open wells seem to have poorer range conditions than

4. While is was not possible to measure the total area being grazed around each of the 46 water points monitored, three types of grazing scores were taken at intervals along a transect (averaging three kilometres in length) from each water point: counts of good and intermediate species as the best measure of grazing quality; less reliable counts of trees and shrubs per hectare as a measure of bush encroachment; and an overall total grazing score for the transect interval being evaluated.

do some Small Dam Unit built haffir-dams and group/government boreholes. The comparatively longer periods of use of some of the open wells monitored, along with their clustering in certain areas, partially explains the higher incidence of overgrazing recorded at them.

In terms of management differences, then, the Survey evidence does not support the conclusion that publically provided water points cause more range damage, as measured along a transect, than privately owned ones. Nor does the evidence show that groups manage water points worse than those managed privately. In fact, a water point that is privately owned or managed has no better guarantee of any less intensive overgrazing, even though these managers and owners may have had more time to control grazing pressure and a steadily increasing number of alternative water points available to them.

(b) Fewer range differences emerge when comparing physical types, and these centre around open wells having poorer total grazing scores and greater bush encroachment than some other physical types of water points, particularly boreholes. Once again, many wells have been used longer and have been more clustered together than boreholes.

(c) Although group and government owned or managed boreholes may have significantly more livestock watering at them than their private counterparts in the dry season, there is no real Survey evidence of significantly different dry season range conditions between them. Reduction in the levels of livestock use and operation at some boreholes during the wet season may well act as a means of conserving and evening out wet season grazing for dry season use.

(d) There is some evidence that the grazing around natural and communally held water sources may be poorer and less able to recover in the wet season, perhaps because of longer and more intensive periods of prior use in comparison to other types of water points.

(e) The type of access livestock users have to watering points best explains differences in range conditions across these water points in the eastern communal areas. Specifically, restricted access watering points for livestock use have significantly better grazing quality around them than do open access facilities, particularly in the wet season. In addition, restricted access sources recover better than open access points between the dry and wet seasons. The practice of restricting access to a water point - either through requiring user charges in cash or in kind or through regulating the water point's period and intensity of use - is an important management tool in maintaining better grazing control around the points. In other words, rainy season restrictions on livestock use, by allowing the forage to rest during the period of maximum rainfall, are especially significant in improving the grazing quality around the water sources. Knowing what kind of access livestock users have to a water point as well as knowing how long this kind of access has been maintained, tells much more about grazing conditions around that water point than does knowing either who has owned or managed it, or for that matter, its physical type.

The Relationship Between Water Point Type and Cattle Condition

1. There may be some differences among water point types and the condition of cattle (oxen) watering at these points. At first glance, privately managed water points have significantly better cattle condition scores than do natural and communal water points or those managed by groups and the government. For example, privately managed boreholes have associated with them significantly better dry season cattle condition scores than do group and government managed boreholes. It may be, however, that a person who can afford to water his cattle at a private borehole might be in a position to have a better herd than those who cannot afford to do so, though this remains conjectural.

2. There is some evidence that the condition of cattle at a water point may be inversely related to the number of livestock watering there. Many large man-made water points are typically overgrazed within a half of a kilometre of the source, such that some of the lower cattle condition scores associated with larger livestock numbers may be accounted for by longer watering periods in these areas where grazing must be deferred until after watering. Slower watering turnover at congested water points may be a contributing factor to poorer cattle condition, especially during the dry season.

Additional Observations

A 15 percent sample of all haffir-dams and haffirs built by or for the Ministry of Agriculture's Small Dam Unit in the eastern communal areas was monitored for livestock load, range condition and cattle condition. The evidence from these monitorings shows no consistent pattern in livestock watering differences with respect to haffir-dams (the physical type most often constructed by the SDU). First, their daily livestock watering figures are not significantly different from boreholes (on the high side) and open wells (on the low side). Only rarely do SDU haffir-dams exceed the 400 livestock unit stock limitation, and then only in the dry season. Second, the Survey evidence does not show that haffir-dams are any worse than other physical types in terms of the range condition surrounding them; in fact, there is some evidence that the opposite may be the case for certain kinds of haffir-dams. Third, since most of the haffir-dams lie in the mixed lands and cattleposts, some of the poorer cattle condition associated with them is probably due to the effect on oxen of ploughing and transporting, especially in the wet season. Thus, there is no real evidence from this Survey that SDU haffir dams are any better or any worse than other types of livestock watering points in evening out an area's cattle distribution or, for that matter, in leading to overstocking in an area or around the haffir-dam itself.

Significant differences involving open wells occurred repeatedly in the monitoring, even when management type was controlled for. Several comparisons of boreholes and wells show individual wells having fewer livestock numbers with better cattle condition, though with significantly poorer range condition than boreholes. It is important to ensure that, should new wells be sunk in the future, they should not be clustered together nor should they have open access.

Although the type of access livestock users have to a watering point is the most critical factor to know when describing differences among water point types, the Survey evidence suggests no pattern of use which ties together livestock numbers, range condition and cattle condition in a consistent way. For example, just because a restricted access water point has fewer cattle and better grazing associated with it does not mean that the condition of livestock will be better at such water points. In part this is because access to use apparently affects different factors in different seasons (grazing primarily in the wet season, cattle condition and livestock loads primarily in the dry season). Also, the relationship of livestock load, grazing, and cattle condition is rarely direct, since it is common for other factors to intervene: although having large livestock numbers on average, some dams and boreholes cease to be used in the wet season; many dams conserve grazing by merely drying up; wealthier households and their herds are more likely to use open wells unlike users of dams or haffir-dams; poor cattle condition around haffir-dams is probably more of a function of oxen being used for ploughing and other activities; and boreholes have been used for shorter periods of time than many open wells. More important, the availability of alternative water points is a major influence both on the decisions of owners or managers to operate a water source in a given fashion as well as on the preference of livestock users for one water point over another, such that a predictable and consistent relationship involving access across different sites is unlikely. Yet it is because access to a water point is the operational link between its owner or manager and its user that makes the kind of use associated with a water point the best overall measure of the differences among types.

If the use made of a water point by livestock holders is largely a function of the alternative water points available to the holders, then the better wet season grazing around restricted access sources may be as much due to the increase in additional open access (surface) water sources in the rainy season as due to the restrictions. Thus, as these surface water sources dry up, the pattern of water point use and access can be expected to shift as well in an area, e.g. some users ration haffir-dam water for domestic purposes in the dry season, thereby forcing cattle to water elsewhere. As seasons change and progress, livestock holders shift from fallback point to fallback point. This is significant not merely because the range, cattle and stocking conditions around any one water point are rarely independent of those conditions around alternative water points at a given time. More important is the fact that these conditions vary with herd movements to and around each fallback point. As a dry season continues with fewer and fewer fallback points available, cattle numbers at the remaining points increase substantially and herd movements become more and more limited. The consequences of such herd movements on the range and cattle condition associated with a set of fallback water points should be examined in greater detail both by the Range Ecology Unit and the Animal Production Research Unit under a long-term monitoring system in the eastern communal areas.

Under such a fallback system it is easy to understand the merits of those who argue that overgrazing is due to the overstocking of an area or due to too few water points in that area. An area's stocking rate will ultimately determine the numbers of cattle at the remaining, late dry season water points. But, cattle condition and grazing variation among water sources is affected by the herd movements and fallback water point used prior to this late dry season water use. Similarly, too few water points relative to an area's stocking rate account for much of the water points' overstocking, but this occurs in the dry season when grazing quality is at its lowest most everywhere. To even out late dry season grazing pressure by the development of new water points assumes that comparatively better dry season grazing areas exist than exist around present water points.

Thus, in addition to those policy options for improving grazing conditions by lowering stocking rates and developing new water points, a third option should be considered: controlling herd movements to and around water points throughout the year. Restricting access to livestock watering points need not be the only way to achieve such control, e.g. controlling where kraals are located in different seasons will influence such movements. Nonetheless, the use of water points to regulate herd movements assumes the ability to restrict access not only to a given water point, but also to alternative water points. For government to come into an area and control its strategic fallback points would not only be expensive, but in many cases, impossible since many of the fallback points are rivers which account for a large portion of the livestock water usage in the eastern communal areas. Clearly, the control of herd movements to and around water points in such areas will have to rely on more measures than attempts to restrict direct access to water points, either by controlling one or several water sources. Grazing committees, initiated and elected by local communities and legally empowered through the Agricultural Resources Conservation Act (Sections 20 and 21),are a possible organizational structure for more broad-based control in these locations.

However, in those places with limited alternative water supplies, where a few man-made sources act as the strategic fallback points, it may be cheaper to control herd movements through the purchase and regulation of these few points (or through the development of comparatively more reliable, convenient or less costly water sources) than it would be to employ other means to control the herd movements of hundreds of individual stock holders scattered over thousands of hectares. It is difficult to see how using water points in such a manner for improving grazing control can succeed with individualized tenure to the grazing land in the mixed lands and cattleposts of eastern Botswana.

What Does Water Development Cost?

Table 14 shows the unit cost of water for cattle calculated by Charles Bailey assuming a 2 percent interest rate for government-financed projects and a 12 percent interest rate for all other projects. Under these assumptions, a group haffir-dam built by a private contractor is the lowest cost water point at P 0.54 per cubic metre. A privately owned borehole drilled by a private contractor is the most expensive water point, providing water at a cost of P3.32 per cubic metre. Water at open wells costs P1.55 per cubic metre being this expensive primarily because of the calculated cost of the labour necessary for lifting it to ground level.

Wells fare better in terms of construction cost. The total construction cost for an open well 28.5 metres deep and 1.5 metres wide is approximately P681. Dams constructed by a private contractor cost P15,686 or P1.09 per cubic metre of storage capacity created. Those built by the Ministry of Agriculture Small Dam Unit cost P29,238 or P2.02 per cubic metre of storage capacity created. Drilling a borehole may cost from P7,040 to P15,267, the latter being the government cost for a successful borehole using a Schramm rig. Equipping has run from P4,544 to P7,007. The reader should consult Charles Bailey, 1980, Keeping Cattle and the Cost of Water in Eastern Botswana, Ministry of Agriculture, for detailed calculations on the cost effectiveness of different types of water.

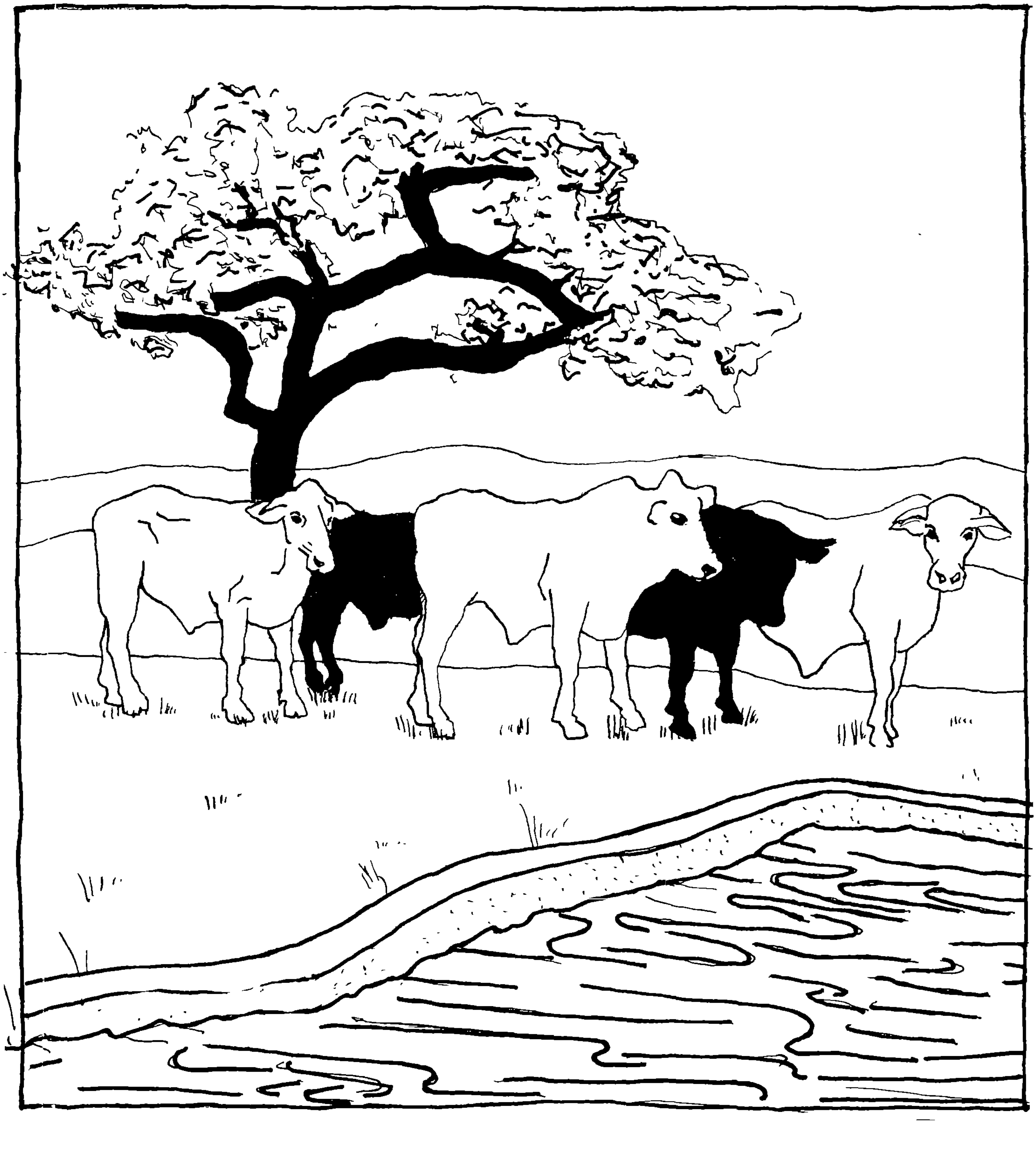
How Dam Groups Work

What Dam Groups are Expected to Do

In January 1974, the Government of Botswana declared its policy (still in effect) on haffirs and dams constructed by the Ministry of Agriculture. According to the policy statement, dams are to be "primarily" for stock watering purposes in the lands and cattleposts and they are not intended to serve as village (domestic) water supplies. They are to be large enough to ensure that, given normal rainfall, they can water up to 400 adult cattle for 12 months. In practice, capacity varies from dam to dam averaging about one-fifth of the capacity of the dams built by the Ministry of Agriculture in the late 1960's.

The Central Government undertakes to pay the full construction costs of these small stock dams, which are to be "built for agreed groups by building them and handing them over to District Councils free of charge".

No council has chosen to manage the dams directly. Dam groups have overwhelmingly assumed management responsibilities, even though formal handovers by councils to groups have been rare.



Under the policy, a dam group is to consist of approximately 15 members each of them owning an average of fewer than 20 adult cattle. (Users are expected to increase their herds over time.) No single person is to be allowed to water more than 50 head. Each group is expected to be formed before the dam is constructed and should consist of farmers who want the dam and are "willing to control their grazing". The Ministry of Agriculture extension staff is expected "to take the initiative in organising groups who want dams". Prior to dam construction each group should sign a standard form, "Terms of Agreement", as a precondition to the dam's handover. The three major conditions to be accepted by the group in this formal agreement are:

1. The group members will maintain and repair the dam.
2. Each member will pay 72 thebe per adult beast per year, the revenue from which will be used for dam maintenance and repair.
3. The group agrees to allowing no more than 400 adult cattle (or their equivalent) to water at the dam.

The Dam Group Policy in Operation

Group management of a water supply is meant to ensure exclusive and timely access to that supply for the group members. Management activities can be divided into three types:

1. Maintenance: keeping the physical structure in proper repair and working order. This is primarily concerned with preventing destruction of the dam wall and reducing siltation. Grass can be planted on the dam wall to reduce rill erosion. Animals should be kept off the dam wall and spillway, because trampling weakens them. Siltation is reduced if livestock are kept out of the reservoir and away from the inlet. Much of this type of control can be accomplished by maintaining strong fences.
2. Regulation: laying down and enforcing the amount of water that may be used, by whom (or by what sort of stock), and when and how it may be used.
3. Revenue Generation: raising money for operating or repairing the structure. Fees can also be used as a regulatory mechanism by pricing the water beyond the reach of would-be users or as a means

of earning revenue for activities not related to dam management.

What Dam Groups Do

In Table 15 information on the dams observed in the course of this Survey is summarized. There are 24 dams, 21 of which have some sort of group management.

Maintenance Functions

One of the appealing features of dams is that there is no technically complicated maintenance associated with them unless the wall actually collapses or the dam silts up. Maintenance is largely preventative and its absence is not immediately apparent.

Half the groups do some sort of maintenance. We found no dam group which adhered fully to the suggested maintenance activities. No groups have planted grass on the dam walls, although in some cases natural growth has occurred. The Mmamonkge dam group in Southern District has been reported to have put cow manure on the rills of the dam wall in preparation for seeding. The predominant maintenance activity is maintaining the fence. In contrast to their earlier relatives most SDU dams still have their original fences in reasonably good repair. In some cases groups have even improved the original fences by adding droppers or piling thorn bushes around the wire to keep out smallstock. Two groups have hired caretakers whose duties include keeping cattle away from the fence; caretakers were also said to have been used by two other groups. It is apparent that fences are maintained less for the Ministry's reason of extending the life of the dam than because they are an essential tool for regulation which is the most common management activity.

Regulatory Functions

All groups attempted to regulate the use of their dams. In addition, at two dams without groups the chief or the headman occasionally exhorted the people to use the dam properly. As the ephemeral rainy season sources start drying up, the use of dams begins to be restricted in many areas. Again, the regulations may not necessarily take the form laid down by the Ministry of Agriculture (we know of no SDU dam group for example, which deliberately limits the number of stock as prescribed), but they do assist in a rational strategy of overall water management. Four kinds of regulations are common:

1. The numbers of users may be limited. This appears to be accomplished by turning away outsiders even when they are willing to pay fees, rather than by turning away non-paying group or community members.
2. The types of use may be restricted. Six dams are limited to domestic use, either permanently or seasonally as other sources start to go dry. (Sometimes watering of calves and smallstock is allowed at domestic water points). Adult cattle drink such large amounts of water, that, rather than try to ration use by cattle, the group simply excludes them completely in order to ensure a convenient domestic water supply.
3. The manner of use may also be controlled. This strategy tends to be associated with a priority for domestic use, in part for reasons of hygiene. Dams used for domestic purposes are more likely to have limitation on the access of cattle to the reservoir. Ironically the exclusion of cattle from the reservoir, an important maintenance activity in the eyes of the government, occurs mainly in conjunction with the use of the water by humans, a major use for which these dams were never intended.
4. The time of use may be regulated. This usually occurs for one of two reasons. In some cases, dams are used as fallback points for other water points which are subject to breakdowns, such as boreholes. Such dams are kept closed (by the simple expedient of locking the gate) and opened only when the primary water point is not functioning. Makaleng haffir-dam is controlled in this way. Other dams are part of the sequential system of fallback points. The water source most likely to go dry is used first, followed by the other, more reliable, sources. In Sechele Village (North-East District), one haffir dam is used first, while a second, deeper haffir is kept locked. When the first goes dry, the second is unlocked. When that is finished, the herds are taken to "the cattle post of last resort", the village, and watered for a few weeks at the Council borehole, intended only for human consumption.

In general then, it appears that regulatory activities take place in an attempt to preserve water quantity and quality over time as the more plentiful and convenient rainy season water supply diminishes.

Revenue Generating Activities

Because there are few, if any, operating costs of dams, users are less likely to perceive a need for fees than they are in the case of water points equipped with pumps and engines. Nine groups said they charged fees. As noted above, the Ministry recommends a water fee for SDU dams of 72 thebe per beast per year. We know of no dam where such a fee is collected. Revenue is generated, however, in response to specific needs often in the form of a contribution, e.g. paying a caretaker. Groups may have a membership fee or a requirement for contributing labour and a penalty for non-compliance, but such penalties are rarely enforced. Under these circumstances it is not surprising to find that record-keeping is also rarely practiced by the groups. If records are kept, they are unlikely to be sufficient to determine either total revenue or total costs within a given period. Contributions for a specific purpose seem to constitute a more acceptable way of raising revenue. In this fashion, people are not made to feel that they are paying for water or, in the absence of trust, "throwing their money away", but rather that they are contributing to keep the effort going - rather in the nature of a self-help contribution.

No group seems to be collecting more than a small fraction of what the government recommendations envisaged. On the other hand few groups seem inhibited by want of funds from taking essential action for essential purposes. It may be that government overestimated the real costs of dam management, or that in the longer term these costs will emerge. "Essential action" for the users does not include saving to deal with long-term costs.

Why People Do What They Do

Why People Follow Government Management Procedures

Dams do serve a useful purpose. Rural water users value reliable, low cost, and convenient supplies - every hour not spent carrying water can be spent doing something else or in leisure. Hence, it is worthwhile to protect and preserve a nearby supply. Fences are maintained because people can see them working as a management tool. When a dam comes under stress within a fallback system, its supply is regulated.

Why People Do Not Follow Government Management Procedures

There would seem to be two sets of factors which encourage groups to depart from the Terms of Agreement - one technical and one social/organizational.

Technical Factors

1. The Small Capacity of the Dams

It was always the intention of the government that these dams should hold water through the dry season. But even given sufficient rain, many small dams do not hold water throughout the dry season. Sometimes this is due to the pressure of relatively large numbers of stock. If a dam is going to go dry anyway, it makes perfect sense to "mine" the water while it is there. Other dams go dry because, as admitted by SDU personnel, they have not always been properly sited.

2. Dams as Low Maintenance Structures

Many people favour dams precisely because they do not have to worry about their maintenance. Where there are low maintenance requirements, there is even less incentive to pay fees.

3. The Role of Seasonality and the Position of Dams in the Fallback System

The role of dams is significantly affected by the seasonal water fallback system. Dams have their greatest potential for use when they are least needed - during the rainy season. At that time there is little incentive to pay attention to them. Moreover, many dams extend the rainy season supply through only part of the dry season, though this varied from year to year. On the whole SDU dams have a reputation for going dry before the end of the dry season. During both the rainy season when water is plentiful and during the late dry season, there is little payoff in labour devoted to dams. The payoff comes only when the dam begins to function as a fallback point or when the structure is in obvious need of repair. Management occurs, but it is management under stress at that time of year when use of the dam is critical.

4. Dams as Multiple-Purpose Water Points

If fencing and deep reservoirs are successful in restricting direct livestock access to dam water, users will be encouraged to use this water for other purposes - especially in many mixed lands and cattlepost areas where convenient domestic water supplies are at a premium at the start of the dry season. Twenty of the twenty four dams were used for domestic water. As noted above, the principles applied in managing a dam for both domestic and livestock watering purposes are different from those applied in managing it as a livestock watering source only. More important, calculation of fee payments on the basis of use can become more complicated when a dam is managed for multiple purposes.

Social Organizational Factors

1. Shortage of Labour

Use of the SDU dams in the mixed lands and cattlepost areas where many of them are sited is affected by a perceived labour shortage in cattle-herding. Those who have traditionally cared for livestock, young men and boys, are now occupied in the wage sector or at school. This means that adult owners, truant children, or low-paid hired herders take care of the livestock. Livestock watering dams are appealing to such herders because in some cases, cattle can simply water themselves at these single-purpose dams without deep reservoirs and locked gates. Herders would much rather open a gate and allow cattle to water freely than spend their time and energy using a hand pump. The labour constraint makes itself felt in other ways as well. The Motloletshetsega dam group in Kweneng District could not ration its dam water for domestic purposes until after harvest, when field labour becomes available to herd the cattle to more distant water points.

Low wages in cattle-herding and the consequent labour shortage have two other effects. Labour-intensive dam maintenance tasks may not be done for lack of labour. And the very lack of fences and deep reservoirs may in fact increase the value of the dams to labour-short stock holders who use the dams for livestock watering purposes only. In other words individual cattle-owners may have a vested interest in minimising their own costs by ensuring that some small dams are not managed and controlled as intended by the government.

2. Local-level Perceptions Affecting Dam Use

Government dams are often considered to be government property, the local perception sometimes being that government will take care of them as it does its other property. Although the government policy of prior consultation and agreement is meant to give a sense of local ownership it does not always work.

In addition, surface water, particularly when it is for domestic purposes, is considered to be a common good, like fresh air. In effect, a SDU dam is commonly perceived as belonging either to government or to the community in which it is located; rarely is it seen by community members as belonging exclusively to only a small group of people in that community.

3. Dam Groups as a Creature of the Government

It is often, but not always, the case that dam groups have no life of their own. The members are 15 to 20 people who have signed up with the agricultural extension agent to get a dam. They are not particularly deserving of getting a dam. They were simply in the right place at the right time. It is especially at this point that government and community perceptions can run afoul of each other. Groups who try to exclude others from using the dam or to collect fees find themselves on rather tenuous ground. They may have no real basis of legitimacy. As noted above, there are rarely community norms on which to draw for support for such actions. Further, in communities in which there is still a certain amount of mutual assistance, a group is unlikely to wish to create antagonisms by turning away would-be benefactors from the dam. Thus groups may have to sacrifice the "interests" of dam management in favour of preserving their standing in other social networks in the community. It is for this reason that one finds would-be fee paying outsiders turned away in favour of "freeloading" community members. Moreover since groups typically have committed no resources to the dam, and since the group itself is not particularly strong, its members have no reason to exert themselves.

Some Lessons

Dam groups do not perform as the government might wish. On the other hand, the state of SDU dams is not as bad as that of their predecessors after some five years of use.

To claim that group-controlled dams are mismanaged because the government-designed Terms of Agreement are not followed is too narrow a view, resting on preconceived notions of what groups are, what true costs of dam management are, and how fees fit into management. The dam groups monitored by the Water Points Survey were essentially ad hoc working groups, seasonal in nature and community-based. They regulated water use. They occasionally organised the maintenance of dams on a short-term basis by contributing time, labour and, in some cases, cash. Their sole purposes was to enable their members to have timely access to a convenient, but not very reliable, water point. To expect such working groups to behave as if they were fully-fledged permanent standing committees, with an on-going basis for operation, is unrealistic. Moreover, under these circumstances, the failure to obey stock limitations is balanced by the fact that grazing pressure on a dam is rarely sustained the entire year. As noted above, there is no real evidence that the SDU dams are any better or any worse in affecting the associated range conditions than other types of water points used presently in the same areas as these dams are now located.

The alternatives to group management are not necessarily better. One possibility is that councils could, as they do with village water supplies, take over the running of the dams. Even if councils could afford the ever increasing wage bill for a cadre of over 100 caretakers, evidence collected in this Survey suggests that there is no guarantee that such control would assure that fees were collected or stock numbers limited.

Another alternative would be to sell dams to private individuals, on condition that they followed government maintenance regulations, including stock limitation. But private leasing of grazing land in Botswana has nowhere secured improved management of the range. Moreover, Survey evidence even raises questions about how effective private ownership of a water point is in controlling grazing pressure. Privatising these dams and/or the surrounding grazing would certainly disrupt many areas' fallback systems to the detriment of the smallholder and many poorer domestic users.

If groups are to remain the chief instrument of dam management, there is much which could be done to make them more effective in the longer term. Much could also be done to improve the efficiency of dam structures as sources of water supply. And groups could begin to manage water sources other than dams.

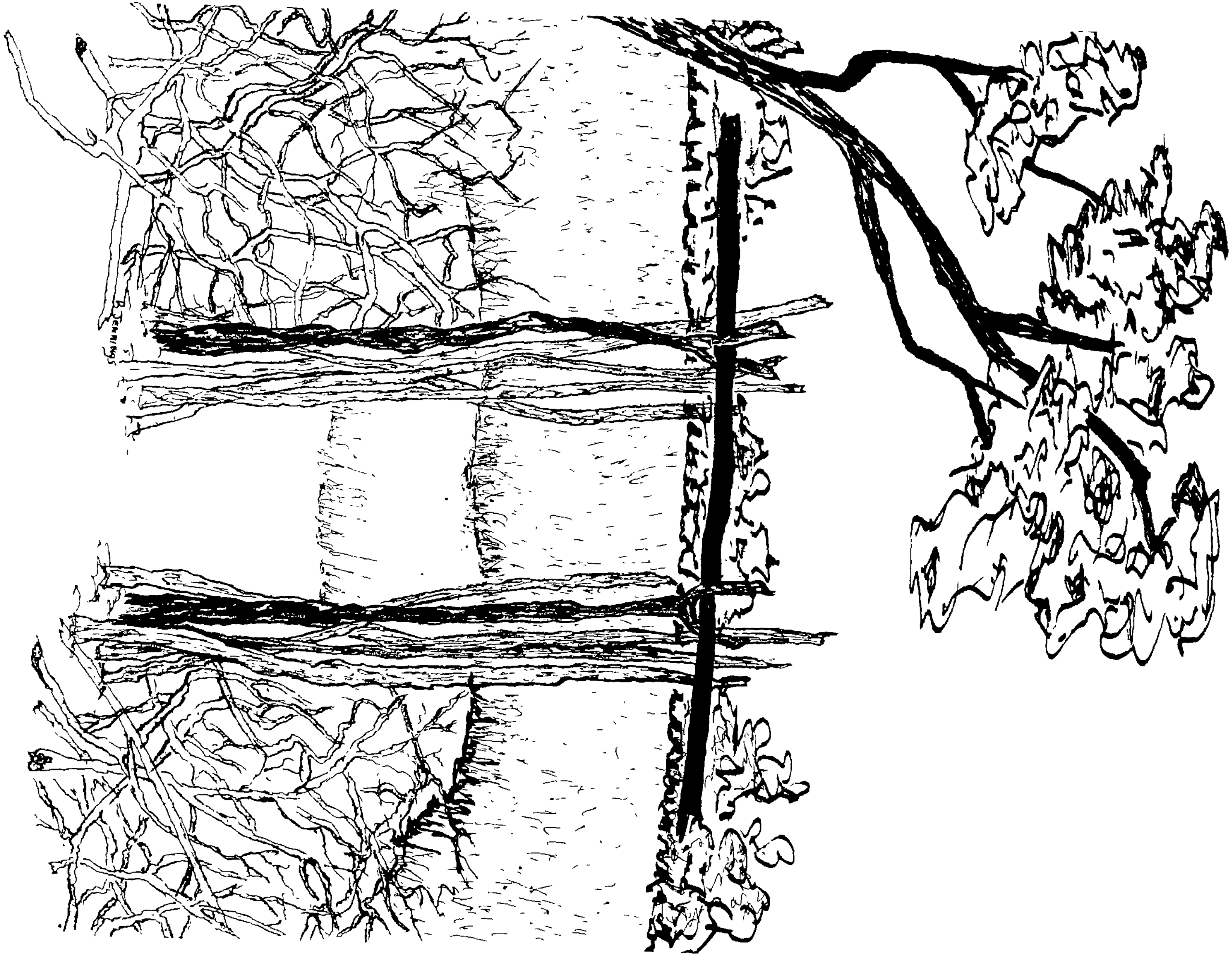
Improving the Efficiency of the Small Dam Unit[5]

1. Technical staff expertise in the SDU should be increased to improve site evaluation procedures, both for dams and for open wells. Dam site evaluation should include on-site and air photo measurement and characterization of the proposed catchment area (to improve the runoff estimates and to identify any siltation hazard); physical examination of the subsoil (especially under the proposed dam, but also at other locations in the area to identify leakage potentials); and identification of the appropriate spillway location.
2. Some of the dams observed had 2:1 or 3:1 side slopes. These showed substantial erosion within five years of construction. Designing side slopes of 5:1 or 6:1, while increasing the volume of fill required (and therefore the initial capital cost) would markedly reduce the erosion hazard and subsequent maintenance cost.
3. The SDU should be re-organised into two or three operationally independent units, each with enough technical staff and equipment to cover a specified region. Regional planning of operations should improve the efficiency of the SDU operations by concentrating equipment in more limited areas. Equipment breakdowns could more easily be dealt with when the distances between equipment and repair facilities are at a minimum.
4. Trampling of the dam wall and spillway by livestock is evident at many dams. The dam wall and spillway should be fenced, even when the reservoir pit is left unfenced. This would recognise the labour constraint in some areas. Those communities who wish to have the reservoir pit fenced should be encouraged to apply for grant funds

5. The following recommendations have been largely adapted from the report of the agricultural engineer for the Water Points Survey (Professor G. Levine), "Observations of Botswana Water Points", dated 1st February 1980.

under National Development Plan Project AE10 (Small Agricultural Projects). The SDU dam fencing teams could contract to perform the actual fencing for them, where necessary. Communities who wish to use water troughs at their dams should also be encouraged to apply for AE10 funds, with the SDU acting as the contractor, where necessary.

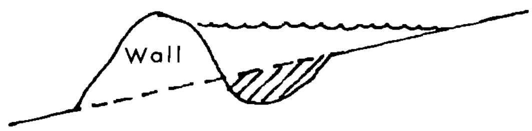
5. The SDU should maintain a small spare parts supply (not a full-fledged store) where groups could purchase replacements to the hand pumps they are using. The parts should be made available at cost (i.e. at a subsidised price). The SDU should not be involved in the repair and maintenance of existing dams, save where structural design faults have necessitated the repairs.
6. The SDU should be restructured into a Water Points Unit which can provide expertise on a variety of water points including open wells, springs, seep wells and subsurface dams. In particular, where hydrogeologically possible, the SDU should consider sinking open wells for those groups in whose areas wells provide a cheaper and more reliable water source than haffir dams. Priority should be given to hiring private contractors to sink such wells, not to expanding the construction teams of the Small Dam Unit. Technical staff for siting both dams and open wells will, of course, be essential.



APPENDIX A: Definitions of Water Point Physical Type

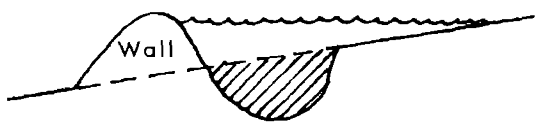
Definitions of Water Point-Physical Types

1. DAM:



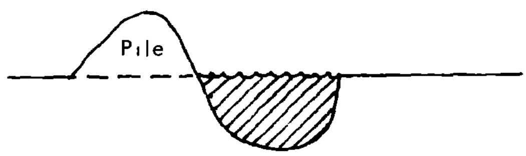
In a dam, the dam wall holds back the water, and more than half of the water at full storage lies above the ground level that existed before the dam was built. (Setswana: tamo, letamo, letlamo; Sekhalanga: damu).

2. HAFFIR-DAM:



In a haffir-dam the dam wall holds back the water, but less than half of the water at full storage lies above the ground level that existed before the haffir-dam was built. (Setswana: tamo e nnye, mahuti, letlamo, letangwana).

3. HAFFIR



In a haffir, the wall is just a convenient place to put the soil taken out of the hole. It does not hold back standing water. All of the water at full storage lies below ground level in a hole or pit. (Setswana: letamole lennye, letamo, lekidi, letlamo, letangwana, tamo e nnye, tangwana).

4. RIVER: A seasonal or perennial flow of water along a defined water course. A linear rather than a point source of water. (Setswana: molapo, noka).

5. PAN: A low spot or depression in which water seasonally collects. (Setswana: mogobe, letsha, letlodi).

6. BOREHOLE: A machine-drilled, small diameter hole of variable depth, often lined with casing pipe. An engine and pump, or a hand pump is required for obtaining water. (Setswana: sediba se se dirisaleng engine, motobetso,

//// = Water lying below the original ground level (shown by dashed lines).

mokhenyembule, sediba, sediba sa engine, sediba se se thunthunyetswang, dipompo; Sebirwa: gwege; Sekhalanga:borabora).

7. <u>OPEN WELL</u>: A shaft deeper than it is wide, the top portion of which is lined with logs to prevent cave-ins. It is commonly equipped with a roller, chain and bucket. Some owners have installed a hand pump or an engine and pump.
(Setswana: sediba se se epilweng, petse, sediba, sediba se se tiraesewang, sediba se se epilweng sa terai, sediba sa petse).

8. <u>SAND RIVER WELL</u>: A shallow well penetrating to ground water in sand rivers. It is reconstructed after every rainy season which causes water to flow over the surface of the sand. Water is obtained with a bucket.
(Setswana: sediba se se epilweng mo molapong, sediba se se mo nokeng, sedibana se se tswelang se epilwe fa nokeng).

9. <u>SEEP WELL OR PIT</u>: A pit often wider than it is deep, unlined in the top portion, and tapping groundwater which lies above an impervious layer. Water is obtained with a bucket.
(Setswana: Sediba se se epilweng, sediba, petse, madutledi, sediba se se fato lotsweng gore metsi atswe ka diatla, lehoti, motswedi, mokorwana).

10. <u>SPRING</u>: A spontaneous flow of water out of the ground. The volume typically varies with the season.
(Setswana: mosenyana, motswedi, molatswana, madutledi).

APPENDIX B: Tables

TABLE 1: Water Points Mapped at Each Survey Site

Village	Dams	Haffir Dams	Haffirs	Rivers	Pans	Boreholes	Open Wells	Sand River Wells	Seep Well	Springs
Makaleng	12.5% 3	4% 1	12.5% 3	8% 2	8% 2(used as sources for haffir dams	17% 4	4% 1	17% 4 areas of sand pits[a] 1 sand-river extractor	17% 4	0
Phokoje and associated cattle posts	3% 2	0	18% 13	3% 2	9% 6	7% 5	37% 26(7 of which are equipped	1% 1 area of sandpits	21% 15	1% 1
Motongolong	0	0	0	5.5% 1	28% 5	11% 2	50% 9	0	0	5.5% 1
Ramokgonami	25% 1	16% 6	16% 6	2.5% 1	29% 11	13% 5	0	0	16% 6	5% 2
Mosolotshane	8% 2	4% 1	18% 5	0	18% 5	26% 7	18% 5	4% 1 area of sand pits	4% 1	0

a. 95 sandpits in the Makaleng - Toteng - Botalaote stretch of the Shashe River

TABLE 1: Water Points Mapped at Each Survey Site Cont.... 2

Village	Dams	Haffir Dams	Haffirs	Rivers	Pans	Boreholes	Open Wells	Sand River Wells	Seep Well	Springs
Mmapha-shalala	2% 1	0	9% 4	0	39% 17	20% 9	30% 13 (4 of which are equipped)	0	0	0
Dikgonnye	5% 2	0	55% 23	2% 1	0	17% 7	21% 9	0	0	0
Matebele	14% 2	8% 1	50% 7	14% 2	0	14% 2	0	0	0	0
Lentswele-tau	3% 2	14% 8	30% 18	7% 4	9% 5	12% 7	25% (15 of which 3 are equipped)	0	0	0
Gamodubu	0	6% 4	25% 16	8% 5	1% 1	13% 8	20% 13	8% 5 areas of sand pits	19% 12	0
Ntlhantlhe	0	7% 3	36% 15	26% 11	0	9% 4	0	7 areas 17% (67 separate pits counted)	5% 2	0

TABLE 1: Water Points Mapped at Each Survey Site Cont.... ...3

Village	Dams	Haffir Dams	Haffirs	Rivers	Pans	Boreholes	Open Wells	Sand River Wells	Seep Well	Springs
Mokatako/ Ditlharara	4% 2	9% 4	39% 18	4% 2	7% 3	24% 11	13% 6	0	0	0
Total 485	3% 17	6% 28	26% 128	6% 31	11% 55	15% 71	20% 97	4% 18	8% 40	1% 4

Source: Key to Water Points Survey Maps

Some water points listed in the key are not included in this count as the maps cover more than the Survey area.

TABLE 2 Twelve Survey Sites: Water Points Used by Sample Households When They are in Residence in the Village

Type of Water Point	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points		Total[a]	
	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points
Dam	-	-	1	1 0	3	2 9	-	-	4	3 9
Haffir Dam	1	1.0	-	-	-	-	2	1.9	3	2.9
Haffir	-	-	6	5.9	1	1.0	-	-	7	6.9
River	-	-	-	-	1	1.0	-	-	1	1.0
Pan	-	-	-	-	-	-	-	-	-	-
Borehole	12	11 7	3	2.9	-	-	-	-	15	14.7
Open Well	-	-	17	16.7	-	-	1	1.0	18	17.6
Sand River Well	-	-	33	32 3	5	4.9	-	-	38	37.2
Sandriver Extractor	1	1.0	-	-	-	-	-	-	1	1.0
Seep Well	-	-	13	12.7	1	1.0	1	1.0	15	14.7
Total[a]	14	13 7	73	71.5	11	10.8	4	3.9	102	100

Source Water Points Household Survey, October - November 1979

a May not sum to 100 percent due to rounding error

TABLE 3 Twelve Survey Sites: Average Number of Households per Water Point Type and Percent of "Use"[a] at each Water Point Type when Sample Households are in Residence in the Village

Type of Water Point	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points		Total	
	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]
Dam	-	-	1	0.2	3	1 6	-	-	3	1.8
Haffir Dam	2	0.4	-	-	-	-	9	3.1	6	3.5
Haffir	-	-	3	2.9	1	0.2	-	-	2	3.1
River	-	-	-	-	5	0.9	-	-	5	0.9
Pan	-	-	-	-	-	-	-	-	-	-
Borehole	21	45.3	5	2.7	-	-	-	-	18	48.0
Open Well	-	-	6	17.2	-	-	1	0.2	5	17.3
Sand River Well	-	-	1	7.3	5	4.9	-	-	2	12.2
Sand River Extractor	20	3.6	-	-	-	-	-	-	20	3.7
Seep Well	-	-	4	8.8	3	0.6	1	0.2	3	9.5
Total[b]	19	49 3	3	39 1	4	8.2	5	3.5	5	100

Source: Water Points Household Survey, October - November 1979

a May not add to 100 percent due to rounding errors. Total "Use" is defined as the sum of the number of times each water point was used for at least one month by the sample households. A household or a water point may be counted more than once in calculating "total use".

TABLE 4 Twelve Survey Sites: Percent of Sample Households Using Water Point Types When They are in Residence in the Village

Type of Water Points	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points	
	Number of Households	Percent of Households	Number of Households	Percent of Households	Number of Households	Percent of Households	Number of Households	Percent of Households
Dam	-	-	1	0.3	10	3.2	-	-
Haffir Dam	2	0.6	-	-	-	-	17	5.4
Haffir	-	-	15	4.8	1	0.3	-	-
River	-	-	-	-	6	1.9	-	-
Pan	-	-	-	-	-	-	-	-
Borehole	240	76.7	13	4.2	-	-	-	-
Open Well	-	-	93	29.7	-	-	1	0.3
Sand River Well	-	-	37	11.8	28	8.9	-	-
Sand River Extractor	20	6.4	-	-	-	-	-	-
Seep Well	-	-	37	11.8	3	0.9	1	0.3

Source: Water Points Household Survey October - November 1979

Sample = 313 Households

Sums to more than 100 percent since households use more than one water point.

TABLE 5 Twelve Survey Sites: Water Points Used by Sample Households When They are in Residence at the Lands

Type of Water Point	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points		Total[a]	
	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points
Dam	3	1.8	1	0.6	3	1.8	-	-	7	4.3
Haffir Dam	5	3.1	-	-	1	0.6	3	1.8	9	5.6
Haffir	-	-	43	26.5	3	1.8	2	1.2	48	29.6
River	-	-	-	-	6	3.7	-	-	6	3.7
Pan	-	-	1	0.6	10	6.2	-	-	11	6.8
Borehole	5	3.1	4	2.5	-	-	7	4.3	16	9.9
Open Well	-	-	32	19.7	-	-	-	-	32	19.7
Sand River Well	-	-	16	9.9	1	0.6	-	-	17	10.5
Seep Well	-	-	16	9.9	-	-	-	-	16	9.9
Total[a]	13	8.0	113	69.7	24	14.8	12	7.4	162	100

Source: Water Points Household Survey, October - November 1979

a May not sum to 100 percent due to rounding error

TABLE 6 Twelve Survey Sites: Average Number of Households per Water Point Type and Percent of "Use"[a] at each Water Point Type when Sample Households are in Residence at the Lands

Type of Water Point	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points		Total	
	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]
Dam	2	1.7	1	0.3	3	2.5	-	-	2	4.4
Haffir Dam	2	2.5	-	-	1	0.3	1	0.8	1	3.6
Haffir	-	-	2	21.0	1	1.1	1	0.5	2	22.7
River	-	-	-	-	5	8.3	-	-	5	8.3
Pan	-	-	2	0.5	2	5.5	-	-	2	6.0
Borehole	4	5.2	2	2.5	-	-	5	8.8	4	16.6
Open Well	-	-	3	24.9	-	-	-		3	24.9
Sand River Well	-	-	1	4.7	2	0.5	-	-	1	5.2
Seep Well	-	-	2	8.3	-	-	-	-	2	8.3
Total[a]	3	9.4	2	62.2	3	18.2	3	10.2	2	100

Source: Water Points Household Survey, October - November 1979

a May not add to 100 percent due to rounding errors. Total "Use" is defined as the sum of the number of times each water point was used for at least one month by the sample households. A household or a water point may be counted more than once in calculating "total use".

TABLE 7 Twelve Survey Sites: Percent of Sample Households Using Water Point Types When They are in Residence at the Lands

Type of Water Points	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points	
	Number of Households	Percent of Households	Number of Households	Percent of Households	Number of Households	Percent of Households	Number of Households	Percent of Households
Dam	6	2.5	1	0.4	10	4.2	-	-
Haffir Dam	8	3.4	-	-	1	0.4	3	12.7
Haffir	-	-	70	29.5	4	1.7	2	0.8
River	-	-	-	-	25	10.6	-	-
Pan	-	-	2	0.8	18	7.6	-	-
Borehole	20	8.4	9	3.8	-	-	30	12.7
Open Well	-	-	86	36.3	-	-	-	-
Sand River Well	-	-	17	7.2	2	0.8	-	-
Seep Wells	-	-	33	13.9	-	-	-	-

Source: Water Points Household Survey October - November 1979

Sample = 237 Households

Sums to more than 100 percent since households use more than one water point.

Table 8 Twelve Survey Sites: Water Points Used by Sample Households When They are in Residence at the Cattle Post

Type of Water Point	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points		Total[a]	
	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points	Number of Water Points	Percent of Water Points
Dam	1	1.4	1	1.4	1	1.4	-	-	3	4.1
Haffir Dam	1	1.4	-	-	1	1.4	-	-	2	2.7
Haffir	-	-	7	9.6	-	-	-	-	7	9.6
River	-	-	-	-	5	6.8	-	-	5	6.8
Pan	-	-	-	-	-	-	-	-	-	-
Borehole	5	6.8	9	12.3	-	-	2	2.7	16	21.9
Open Well	-	-	25	34.3	-	-	-	-	25	34.3
Sand River Well	-	-	8	10.9	1	1.4	-	-	9	12.3
Seep Well	-	-	6	8.2	-	-	-	-	6	8.2
Total[a]	7	9.6	56	76.7	8	10.9	2	2.7	73	100

Source: Water Points Household Survey, October - November 1979

a May not sum to 100 percent due to rounding error

TABLE 9 Twelve Survey Sites: Average Number of Households per Water Point Type and Percent of "Use"[a] at each Water Point Type when Sample Households are in Residence at the Cattle Post

Type of Water Point	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points		Total	
	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]	Average Number of Households per Water Point	Percent of Total Use[a]
Dam	2	2.0	1	1.0	1	1.0	-	-	1	4.1
Haffir Dam	1	1.0	-	-	1	1.0	-	-	1	2.0
Haffir	-	-	1	9.2	-	-	-	-	1	9.2
River	-	-	-	-	1	6.1	-	-	1	6.1
Pan	-	-	-	-	-	-	-	-	-	-
Borehole	2	8.2	1	9.2	-	-	2	3.1	1	20.4
Open Well	-	-	2	41.8	-	-	-	-	2	41.8
Sand River Well	-	-	1	8.2	1	1.0	-	-	1	9.2
Seep Well	-	-	1	7.1	-	-	-	-	1	7.1
Total[a]	2	11.2	1	76.5	1	9.2	2	3.1	1	100

Source: Water Points Household Survey, October - November 1979

a May not add to 100 percent due to rounding errors. Total "Use" is defined as the sum of the number of times each water point was used for at least one month by the sample households. A household or a water point may be counted more than once in calculating "total use"

TABLE 10 Twelve Survey Sites: Percent of Sample Households Using Water Point Types When They are in Residence at the Cattlepost

Type of Water Points	Council Owned Water Points		Privately Owned Water Points		Public or Community Water Points		Group Owned or Managed Water Points	
	Number of Households	Percent of Households	Number of Households	Percent of Households	Number of Households	Percent of Households	Number of Households	Percent of Households
Dam	2	2.8	1	1.4	1	1.4	-	-
Haffir Dam	1	1.4	-	-	1	1.4	-	-
Haffir	-	-	9	12.7	-	-	-	-
River	-	-	-	-	6	8.5	-	-
Dam	-	-	-	-	-	-	-	-
Borehole	9	12.7	10	14.1	-	-	2	2.8
Open Well	-	-	33	46.5	-	-	-	-
Sand River Well	-	-	8	11.3	1	1.4	-	-
Seep Well	-	-	5	7.0	-	-	-	-

Source: Water Points Household Survey October - November 1979

Sample = 71 Households

Sums to more than 100 percent because households use more than one water point.

TABLE 11 Average Daily Livestock Units (and Domestic Users) at Water Points by Physical Type and Month (446 Water Point Diaries)

Physical Type	October 1979	November	December	January 1980	February	March	April	May	June	July	Daily Average Per Month
Spring								584(0) N = 2	491.5(1.5) N = 6	24(0) N = 2	416.5(0.9) N = 10
Dam		21.3(0) N = 8		88.8(0) N = 8		73.5(0) N = 4	332.5(0.3) N = 4	318(0.8) N = 6	344.3(0) N = 6	197.5(0) N = 2	180.9(0.2) N = 38
Haffir Dam		41.4(2.6) N = 20	104(7) N = 2	46.2(3.1) N = 21		62.3(1.0) N = 3	51.7(2.6) N = 20	147.6(9.3) N = 27	268.1(4.1) N = 14	73.1(3.6) N = 12	99.5(4.5) N = 119
Haffir		0(0) N = 2		0(0) N=2 (147.8(1)) N=4	17(0) N = 1		97.5(0.3) N=4 (215.8(2.2)) N=6	121.4(0) N=7 (203.6(0.9)) N=9	56.1(13,2) N=9 (156.0(10.8)) N=11	(372.5(0.5)) N = 2	177.0(4.1) N = 35
River		83.5(0.5) N = 2		76.0(0) N = 2		165(0) N = 2	123.5(0) N = 2	168.5(0) N = 2	58.7(4.3) N = 3	164.5(3.5) N = 2	115.9(1.4) N = 15
Borehole and Eq. Well		107.6(5.8) N = 20	0(4) N = 1	103.3(6.7) N = 20			111.3(3.0) N = 21	302.3(6.9) N = 14	241.8(6.8) N = 15	258.8(0) N = 6	164.6(5.3)* N = 97
Open Well	0(0) N=1	25.6(15.8) N = 18	67.5 N = 2	12.0(4.5) N = 28	37.5(1) N = 4		16.6(4.4) N = 17	61.4(3.2) N = 25	66.1(3.5) N = 20		36.7(5.6) N = 115
Sand River Well	9(28) N = 1			128(3) N = 1							68.5(15.5) N = 2
Seep Well	0(12) N = 2			1.7(15.3) N = 6			0.7(16.3) N = 3	7(33.5) N = 2	2(8.5) N = 2		2(9.9) N = 15
	N = 4	N = 70	N = 5	N = 90	N = 5	N = 9	N = 73	N = 87	N = 77	N = 26	N = 446

* The averages for boreholes and equipped wells are 168.0 and 149.8 LSU, respectively.

Table 12 Lower Layer Species Counts by Village and Region

	Dry Season 1979				Wet Season 1979-80				Dry Season 1980			
	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4
Mokatako	26.0	31.5	33.1	32.1	21.9	26.0	25.2	30.4	15.0	16.9	21.9	28.7
Ntlhantlhe	13.1	16.6	15.4	13.0	14.9	19.7	23.0	26.8				
Gamodubu	20.6	17.8	15.0	9.9	28.8	30.1	28.8	34.0				
Lentsweletau	21.2	16.1	22.2	18.1	27.8	22.6	29.0	17.8				
Matebele	16.0	16.8	7.3	16.8	16.5	18.4	15.1	21.7				
Dikgonnye	20.5	16.2	21.1	21.0	20.1	20.7	29.1	28.8				
Mmaphashalala	10.7	10.6	9.1	9.3	11.8	12.8	11.6	14.5				
SOUTH AVERAGE*	18.5 (N=27)	18.0 (N=27)	17.6 (N=27)	18.3 (N=22)	20.4 (N=27)	21.5 (N=27)	23.1 (N=27)	24.0 (N=22)				
Mosolotshane	7.0	14.7	17.6	17.9	35.6	54.0	51.5	58.1	11.4	27.8	30.6	24.2
Ramokgonami	10.2	9.1	10.8	12.2	16.1	13.7	18.3	17.3	4.5	3.7	8.1	11.7
Motongolong	9.4	10.2	10.8	8.8	1.5	6.4	4.7	1.1	0.2	0.7	0.8	0.3
Phokoje	18.9	20.8	21.4	8.5	24.3	18.5	18.8	19.2	16.0	20.9	13.8	8.3
Makaleng	16.6	17.9	18.1	17.4	12.6	13.5	9.5	9.0	8.0	6.9	6.8	7.7
NORTH AVERAGE*	12.1 (N=19)	14.2 (N=19)	15.1 (N=18)	14.2 (N=15)	17.7 (N=19)	21.3 (N=19)	20.7 (N=18)	22.6 (N=16)	7.6 (N=19)	11.5 (N=19)	11.8 (N=18)	11.2 (N=16)
TOTAL*	15.8 (N=46)	16.4 (N=46)	16.6 (N=45)	16.6 (N=37)	19.3 (N=46)	21.4 (N=46)	22.1 (N=45)	23.4 (N=38)				

* Computed on the basis of totalling individual water point scores by water point and village.
D1 is the nearest and D4 the furthest interval scored from the water point (see Appendix F for the actual distances involved).

Table 13 Selected Grazing Scores by Region in the Eastern Communal Area

Transect Interval		Lower Layer Species (%)			Average Tree and Shrubs (Per Hectare)			Total Grazing Score*		
		North	South	ECA	North	South	ECA	North	South	ECA
D1	Dry	12.1	18.5	15.8	681.0	317.0	467.4	33.9	52.2	44.7
	Wet	17.7	20.4	19.3	528.3	256.8	368.9	37.0	52.0	45.8
D2	Dry	14.2	18.0	16.4	688.6	344.9	486.9	36.1	53.9	46.6
	Wet	21.3	21.5	21.4	631.7	247.2	406.0	38.4	53.1	47.0
D3	Dry	15.1	17.6	16.6	640.1	341.7	461.1	36.6	53.4	46.6
	Wet	20.7	23.1	22.1	602.1	269.3	402.4	38.8	52.5	47.0
D4	Dry	14.2	18.3	16.6	685.6	385.7	510.7	36.0	53.8	46.6
	Wet	22.6	24.0	23.4	582.4	280.3	407.5	40.3	54.0	48.2

* Ranges from 0 (low) to 100 (high)

Table 14 The Unit Cost of Water for Cattle

Water Point Builder	Owner/Manager	Annual Cost per Cubic Metre of Water (P)
MoA Small Dam Unit	Group Haffir-Dam	0.98
Brigades Dam Building Unit	Group Haffir-Dam	0.59
Private Contractor	Group Haffir-Dam	0.54
Water Affairs - Schramm Rig	Government Borehole	1.43
Water Affairs - Percussion Rig	Government Borehole	1.50
Large Private Contractor	Government Borehole	1.45
Large Private Contractor	Syndicate Borehole	2.79
Large Private Contractor	Private Borehole	3.32
Small Private Driller	Syndicate Borehole	2.07
Small Private Driller	Private Borehole	2.41
Open Wells - Private Sector	Private Open Well	1.55

Note: See Charles Bailey, 1980, Keeping Cattle and the Cost of Water in Eastern Botswana for calculations and more details.

TABLE 15 Management of SDU Dams

Dam Name and Code Number	Group	Use[a]	Maintenance	Regulation	Fees[b]	Average Daily Counts* (LSU/Domestic) Users	Condition of Fence	Comments
Makaleng Haffir Dam 11201	VDC	L D	None	Gate is locked when village cattle watering borehole is operating	None	289/0 (Dry Season)	Good	
Mambo Haffir Dam 11204	None	L	None	Occasional exhortation by headman	None	-	Knocked down in places	
Sechele Haffir	VDC	L	Fence reinforced with thorns	Locked until Sechele Haffir Dam goes dry	None	-	Good reinforced	
Sechele Haffir Dam	VDC	L	None	See Sechele Haffir above	None	-	-	
Toteng Haffir 11302	Toteng Ward	D	None	Domestic only	None		Good	
Bosudi Haffir 11303	None	L D	None	Occasional exhortation by Chief	None	148/1 (Jan, 1980) 237/4 (April-July 1980)	Gate knocked down	A group has been formed but was told by MOA that they must wait until the dam has been handed over to Council
Lekurwana Haffir Dam 23201	Dam Group	L D	Fence reinforced with thorns	Non members excluded	None	41/2 (Wet season) 60/0 (Dry Season)	Good reinforced with thorns	Hand pump does not work charge for not working on maintenance
Mmadithota 23202	Dam Group	L D		Non members intended to be excluded	None	99/7 (Wet Season) 86/14 (Dry Season)	Thorns only	Cannot exclude community members from use
Dinokaneng 23203	Dam Group	L D	Fence reinforced with thorns	Non members domestic use only	Members - none Non-members domestic use only 25t/drum (limit one drum per day)50t/month(buckets only 1 - not collected regularly	94/4 (Wet Season) 28/1 (Dry Season)	Good	Hand pump not used some have paid fine for not working on maintenance

TABLE 15 Management of SDU Dams Cont.....2

Dam Name and Code Number	Group	Use[a]	Maintenance	Regulation	Fees[b]	Average Daily Counts* (LSU/Domestic) Users	Condition of Fence	Comments
Sekerepa 23204	Dam Group	L D	Fence reinforced and thorns built fence as a group	If dam going dry, tell non-members not to come	Said to be members Domestic P1.20/ household/year; cattle 72t/beast Non members: Domestic P2.00/ household/year Smallstock 1t/4 head/ day cattle 1t/beast/ day - not collected regularly		-	Hand pump not used Have collected fines for not working on maintenance
Belabela Haffir Dam 32201	Dam Group	L D		No non-members said to use haffir-dam	P6.00 membership fee	0/0 (Wet season) 0/4 (Dry season)	Good	Apparently little used
Segomotlhaba Haffir Dam 41200	Dam Group	Primarily D	None	Livestock excluded often because of lack of sufficient dam water	None	4/13 (Wet season) 0/19 (Dry season)	Good	Hand pump not on order
Galetlhokwane Haffir Dam 41201	Dam Group	L D (Primarily L)	None	Used for domestic only when dam water is low; some non-members use dam	None	218/0 (Wet season) 375/1 (Dry season)	Good	Hand pump not working; major lands cattle watering source
Letswatswe Haffir dam 41202	None	D			None		Good	Rarely used because of poor water holding capacity
Ngotshwale Haffir Dam 41205	Dam Group	Primarily D & SS	Users have placed metal trough outside fence for calf watering	Galetlhokwane non-community members excluded	None		Good	Proximity of village cattle watering boreholes allows group to restrict dam to domestic only
Mannyelanong Haffir dam 41206	Dam Group	D		Gate locked to stop livestock water, water rationed primarily for domestic use only	None	14/10 (May 1980)	Good	Said to be seepage and poor holding capacity

TABLE 15 Management of SDU Dams Cont.....3

Dam Name and Code Number	Group	Use[a]	Maintenance	Regulation	Fees[b]	Average Daily Counts* (LSU/Domestic) Users	Condition of Fence	Comments
Kgope 41207	Dam group	D		Gate often locked to prohibit livestock watering; scarcity of water led to rationing for domestic use only	None	7/28 (May 1980)	Good	Reports of people "forcing" their way into dam for livestock watering have been made recently
Mmanoko Haffir Dam 42200	Dam group (said do be associated with Mmakanke VDC)	D L	Bush fencing within dam area and reservoir pit to exclude livestock walking into water	Caretaker hired. Users have placed a metal trough for watering outside pit; users form "bucket brigade" from pit to trough when watering cattle	Varies: 10t/beast/ dry season(1980); P1.00/year 1978/79)	601/1 (June 1980)	Good	Used by and restricted to residents around dam
Motloletse tshega Haffir dam 42201	Sub committee of Mmakanke VDC	D L	Caretaker maintains fence; however, cattle enter dam & trample spillway as outside hand pump not working	Caretakers hired; users have placed a metal trough outside reservoir pit for watering; herders bucket water to trough; rationed for domestic water only in dry season	Varies:10t/ beast/dry season(1980); P100/hh/yr (1978). In past, fees were self-help levies on residents of area. P67 collected since 1977	2/1 (Wet Season) 240/16 (Dry Season)	Good	Hand pump not working; VDC complaining of people failing to make contributions. Fees collected go into general VDC treasury
Mmamohiko Haffir Dam 42202	"Dam Group"/ Communal	D L	Volunteer caretaker once said to maintain dam, but no longer; new caretaker said to be identified (5/80)	Users have placed water trough outside reservoir pit, with herders bucketing water to trough	Said to be 10t/ beast/dry season, but apparently no one paid as of 10/80	4/4 (Wet Season) 36/9 (Dry Season)	Good	When Chairman of original dam group died, group effectively disbanded; hand pump not working
Rapalana Haffir Dam 42203	Dam Group(said to be associated with Mmakanke VDC)	D L	Caretaker herding activities away from dam fencing	Have used outside hand pump and trough in past to ensure no pollution of water for domestic use; caretaker said to be hired	10t/beast/dry season, but varies from time to time	485/21 (June 1980)	Good	Hand pump recently was working; history of disputes with Mmakanke VDC
Mehane Haffir Dam 51200	Dam Group	D L	None	Gate once said to be locked, excluding Chairman of Dam Group from using it. (Vice chairman had key)	None	7/0 (Wet Season) 105/1 (Dry Season)	Good	Serious disagreements between Dam Group Chairman and Vice Chairman, both of whom are from different communities but farm the same lands area around dam

TABLE 15 Management of SDU Dams Cont.....4

Dam Name and Code Number	Group	Use[a]	Maintenance	Regulation	Fees[b]	Average Daily Counts* (LSU/Domestic) Users	Condition of Fence	Comments
Mmamonkge Haffir Dam 51201	Dam Group	D L	Considerable bush fencing for goat-proofing, cow dung collected for grassing of wall around rill erosion areas	Have bye-laws for members and non-members, meetings held; gate often locked, said to have rationed water in dry season for ss purposes; caretaker said to have volunteered at one time.	50t/hh/dry season (covers D & L Uses); said to have collected P150 so far, fees vary yearly for members and non-members	9/0 (Wet Season) 108/0 (Dry Season)	Good	Group has had fund raising parties and projects for dam
Magolthwane Haffir-Dam 51202	Dam Group	Primarily L (Late 1980)	None	Has not been managed or used since just after construction to mid 1980; availability of domestic village borehole and nearby river has lessened need for dam	Inconsistent reports on fee collections; some P6 - P11 collected in the past	12/0 (Wet Season) 139/0 (Dry Season)	Good	Hand pump does not work; people want Government to fix pump
24 Dams	21 Groups	83% dams used for domestic water. 25% dams used for domestic only	48% of the groups do some maintenance	All the groups try to regulate the use of their dams	43 percent of the groups say they charge fees			

* 1979/80 Counts from Water Points Diaries; see Chapter Four for more details

a. D = Domestic, L = Livestock, SS = smallstock

b. hh = household

APPENDIX C: The Busy Policy Maker's Guide to the Literature on Water Use in Rural Eastern Botswana

The Busy Policy Maker's Guide To the Literature on Water Use in Rural Eastern Botswana

Government officials in Botswana find it increasingly difficult, if not already impossible, to keep up with the research industry in the country. In a few cases, projects and policy suffer as officials continually ask those same questions which, unbeknownst to them, have already been dealt with in some fact-finding report or consultancy.

There is a need for a guide to the literature on those water-related topics which many government officials commonly discuss today. This appendix is designed for those who want more detail than is given in Brian Wilson's excellent Mini-Guide to the Water Resources of Botswana (1979:59-70). We have selected for discussion the research material which we consider to be of the most policy interest today. No attempt has been made to summarize all the research referred to.

The discussion topics are those covered by the Water Points Survey's terms of reference,as well as those additional issues which have been raised on a number of occasions by officials during the course of this Survey. While we have relied almost exclusively on published research material, some of the most useful information on water-related topics exists in government files.

This literature review is about rural eastern Botswana. For introductory information on water usage in other areas of the country, the reader can start with: Potten (1975), Astle (1977) and The Ngamiland Arable Agriculture Survey of 1978 for information on northwest Botswana (Odell, 1980: A54-A74); Hitchcock (Volume 1, 1978: Chapters 3,6,7), Kramer and Odell(1979: 9-37) and Vierich (1979) for the Kgalagadi; and the National Development Plan 1979-85 (1980: Chapter 7) for urban and mining water consumption figures. The bibliographies of these works,as well as those mentioned below,should be consulted for additional sources of information.

For those expatriate policy makers who know little about rural eastern Botswana, we have found the UN/FAO study of agricultural constraints in eastern Botswana to be the most useful single work for giving an overview of the rural economy (Ministry of Agriculture, Reprint, 1980:14-75). Less integrated, but more comprehensive and up-to-date, is Cooper's review of the literature relating to lands and cattlepost production in eastern Botswana (1980: Chapter 2). Although lengthy and not always policy-oriented, the area-specific studies of Gulbrandsen (1980) and Vierich (1979) provide fairly recent information on aspects of communal hardveld production systems in south eastern Botswana. Research on freehold farming in the Tuli Block is scant in comparison to that for the tribal areas, but the interested reader should consult the freehold farm survey of the Central Statistics Office(1972), De Rafols (1979) and Sigwele (1979) for information on arable and livestock production there, while Nchunga (1978) provides data on wildlife utilization in the northeastern Tuli Block area. A short, but very informative, article on the economy of Botswana with reference to agriculture production can be found in the ILCA Bulletin of September, 1979 (pp.10-15). Finally, a number of other area-specific socioeconomic studies of eastern Botswana are discussed by M.J. Odell (1980),who reviewed the research undertaken through the Ministry of Agriculture's Rural Sociology Unit.

The topics to be reviewed here are:

I. Tradition, History and the Law Relating to Water Use in the Eastern Communal Areas

II. Water-Related Pollution and Disease: Does Anyone Believe the Bilharzia Signs?

III. Rechargeability of Groundwater: Are Boreholes Drying Up in the East?

IV. Improved Water Supplies: Changes in Household Water Consumption and Time Use

V. Differences Between Hardveld and Sandveld Water Usage

VI. Water and Permanent Settlement at the Lands: How Villagers, But Not Townspeople, are Stopped From Living Permanently in the Bush

VII. The Perennial Water Recommendations: Development of Sand Rivers and Open Wells in Eastern Botswana

VIII. Gardening and Small-Scale Irrigation

IX. "Directions in Future Water Research" or "Is There Really Need for <u>More</u> Water Research in Botswana?"

I. Tradition, History and the Law Relating to Water Use in the Eastern Communal Areas

A. Tradition. The authoritative account of traditional water use patterns and customs in eastern Botswana remains Schapera's Native Land Tenure in the Bechuanaland Protectorate (1943: Chapter 13). Roberts' rendering of the Kgatla customary law provides a concise statement of one tribe's traditional attitudes toward the use of water resources in the east (1969?:25-27). Both Roberts and Fosbrooke (UNDP/FAO.a., 1972: Volume 1, pp. 63-66) discuss how traditional water controls have been altered with legal developments since Independence.

While traditional structures have been subject to considerable change over time, some traditional water sharing practises still remain. For example, the Water Points Survey found that a number of people still believe that surface water is free for use, that no one should have to pay for domestic water and that a person in extreme need (say, in a drought) or just passing through an area should not be denied water for his or her cattle. Such practises are changing though, and it is widely accepted that private owners of water points they constructed, inherited or purchased have the right to charge fees for the use of these points. Both Copperman's study of village water use (1978:38-39) and Peters' study of Kgatleng borehole syndicates (1980: passim) found similar traditional practices and pressures for change in attitudes toward water use.

B. History. A short history of borehole, well and dam development in Botswana up to Independence is provided in Roe (1980:17-27, 42-43). Frank Taylor's fine history on the Mogobane Dam and Irrigation Scheme(s) deserves wider circulation and reading than it has gotten (1977), while a history of the equally important irrigation schemes at Bathoen Dam in Kanye has yet to be written (old District Commissioner files in Kanye shed considerable light on those latter schemes). A very interesting case study of how the changing water supply of an area affected one village's history is recounted by Syson in her work on Shoshong (UNDP/FAO.a., 1972: Volume 2, Appendix 6). The history of the Kgatleng borehole syndicates is sketched by Peters (1980:1-8); forthcoming work by Wynne is expected to provide some information on Kweneng borehole syndicates, though many of these syndicates lie in the sand-veld area of the District. No comprehensive inventory exists of boreholes, dams and wells built over time in the east, though work by Roe (1975) and Wynne (1979) provide borehole information for Southern and Kweneng Districts, respectively.

A history of water development in eastern Botswana since Independence has yet to be written. Some themes of a future history of government water development in the east are already clear, however: Ministry of Agriculture soil and water conservation projects focussing on small dam construction in the late 1960s (see Appendix N of the main Report for a short history of these activities); the UNDP/FAO Shoshong Project; rural water pricing policies; expansion of both village water supplies construction and government borehole maintenance capacity; increasing concern over groundwater rechargeability; identification of large dam and irrigation sites; water consumption demands made by mining and urban activities in the east; rising emphasis on hydro-chemical and bacterial pollution of domestic and livestock water supplies in major eastern villages; preoccupation of local government planning authorities with sandveld water and grazing development; increased government research on and monitoring of drought; and expanded interest in the provision of small-scale and intermediate technology water supplies in the communal areas. A highly selective list of major consultancies and reports, specifically about or affecting water use in eastern Botswana since Independence, would include the following, given in chronological order:

1964: B.G. Lund, The Surface Water Sources of Bechuanaland

1969: M. Upton, Irrigation in Botswana

1971: M. Sekgoma and D. Eding, "Attitudes Toward the FFHC Dams in the Metsemotlhaba"

J.G. Pike, Rainfall and Evaporation in Botswana

1972: UNDP/FAO, Botswana: The Water Resources of Eastern and Northern Botswana and Their Development.

UNDP/FAO, The Human, Land and Water Resources of the Shoshong Area - Eastern Botswana (Volumes 1 and 2)

E.G. Thomas and L.W. Hyde, Water Storage in the Sand Rivers of Eastern Botswana With Particular Reference to Storage on the Mahalapshwe River

1973: SIDA, Population and Water Usage at Mahalapye and Palapye (1972)

1974: C. Howe, Recommendations and Observations on Water Resource Planning in Botswana

C.E.W. Simkins and H. Maddux, "The Kgatleng Pilot Water Survey"

1975: C.E.W. Simkins, "Ministry of Mineral Resources and Water Affairs' Review of Rural Water Prices"

Department of Water Affairs, Borehole Preventative Maintenance Scheme Consultancy

1976: Sir Alexander Gibb and Partners, A Reconnaissance Study of Major Surface Water Schemes in Eastern Botswana (Phase I Report)

A.J.B. Mitchell, Land Resources Study 7: The Irrigation Potential of Soils Along the Main Rivers of Eastern Botswana - A Reconnaissance Assessment

1977: Sir Alexander Gibb and Partners, A Reconnaissance Study of Major Surface Water Schemes in Eastern Botswana (Phase II Report)

Sir Alexander Gibb and Partners, Preinvestment Study for Water Development of North East Botswana (Preliminary Report)

B.G. Lund and Partner, Water Resource Reconnaissance of Lower Metsemotlhaba and Lower Ngotwane Rivers

W. Pitman, Hydrogeology of the Upper Limpopo River

S. Sandford, Dealing With Drought and Livestock in Botswana.

SWECO, Draft Final Report: Botswana Rural Water Supply - Evaluation of Existing Rural Water Schemes and Preparation of Guidelines for Nitrate Reduction of Contaminated Boreholes

1978: J. Copperman, The Impact of Village Water Supplies in Botswana

1979: R. Ashford and J. Miller, SIDA Report on Needs to Improve District Councils' Capacity to Maintain and Operate Village Water Supplies

The drought-related reports of McGowan, Vierich, Austin and Sheppard/Clement-Jones

1980: H. Vierich and C. Sheppard, Drought in Botswana: Socioeconomic Impact and Government Policy

Water Points Survey, Key to the Water Points Survey Maps

E.B. Egner and I. Martin, Draft Report: Horticulture in Botswana - A Social and Economic Analysis

M.R. Hall Drilling Ltd./CIDA, Evaluation of Private Borehole Drilling Capabilities

G.A. Classen/ALDEP, Consultant's Report on Small Scale Rural Water Supplies

J. MacDonald and J. Austin, A Human Drought Relief Programme for Botswana

P. Peters, "Preliminary Findings and Observations on Borehole Syndicates in Kgatleng District"

1981: (Jan) D. Sims, Agroclimatological Information, Crop Requirements and Agricultural Zones for Botswana

In addition, Jennings' (1974) massive work on the hydrogeology of Botswana provides a detailed description and a bibliography on the work and activities of the Department of Geological Survey during the 1960s and early 1970s.

C. Law. There is no comprehensive publication which systematically describes all the laws relating to water use in Botswana. Both Roberts (1969?: 25-27) and Fosbrooke (UNDP/FAO.a., 1972: 63-66) discuss how laws immediately after Independence affected traditional water customs, while Jennings (1974:819-822) briefly describes some aspects of the Borehole Proclamation of 1956 and the Water Act of 1967. The Department of Water Affairs is presently (January, 1981) seeking a Water Legislation Consultancy to make sense of the some 20 pieces or more of legislation that affect water development and utilization in Botswana.

II. Water-Related Pollution and Disease: Does Anyone Believe the Bilharzia Signs?

Prior to the mid-1970s, purity of groundwater supplies was analyzed largely in terms of the levels of total dissolved solids (TDS) in these supplies. Judgments were made primarily as to whether or not water was too saline or hard for human and livestock consumption (see Jennings, 1974: 825-850).

In 1976, however, the Department of Geological Survey published a report which found higher than maximum WHO allowable levels of nitrate in selected water points used as part of the major village water supplies in Serowe, Kanye, Molepolole, Mochudi, Thamaga and Ramotswa (Hutton, Lewis and Skinner). In 1977, the SWECO consultancy found nitrate pollution in water supplies at smaller settlements such as Bobonong and Mabalane/Sikwane (pages 4.3:4-10), though most villages surveyed did not have higher than allowable nitrate values (p.6.3.). In 1978, several studies were completed showing not only nitrate pollution, but also bacterial contamination, in selected water points of the major village water supplies of Serowe, Kanye, Molepolole, Mochudi, Mahalapye, Palapye and Ramotswa (Lewis; Thomson, a; Thomson, b; Lewis, Farr and Foster). (Bacterial contamination had been found in Mahalapye as early as 1972 (SIDA, 1973:26).) In addition, Copperman reported bacterial pollution in some small village water schemes (1978:49). Both Lewis and the SWECO consultants concluded that there was little correlation between nitrate and bacterial contamination (Lewis, 1978: 3; SWECO, 1977:6.3), though the SWECO consultants suggested that low nitrate levels may be correlated with low TDS values (1977:6.2). The Senior Water Engineer (Pollution) in the Department of Water Affairs has an ongoing monitoring programme of such pollution at selected village water points in Botswana.

The evidence on such pollution of surface water sources is scant and mixed. Lewis (1978:4) attributes much of the bacterial contamination of groundwater in Palapye to the infiltration of the water table by highly polluted dam water. Mochudi dam was found to have high levels of bacterial pollution in 1978 (Thomson, a.,4),though little nitrate contamination in 1976 (Hutton, Lewis and Skinner, Table 5). In 1976, Moshupa village dam also had low nitrate levels (Ibid, p.12). There appears to be a widespread impression, however, on the part of villagers that dam water is often polluted, e.g., less than half of some 300 households using dams in the Metsemotlhaba catchment area thought the dam water they used was clean (Sekgoma and Eding, 1971: Table 3). Of the 40 households in the Water Points Survey who said they did not use dams, 29 (73%) gave "dirty water" as the reason for doing so. Less research has been done on river water pollution, except in Mochudi, and results there are not straightforward (Thomson, 1978:4; Lewis, Farr and Foster, 1978). It is evident, though, that due to high permeability some sand rivers are susceptible to considerably high levels of contamination. For example, high bacterial counts have been found in sections of the Motloutse River (Sir Alexander Gibb and Partners, 1977: 58,67). Of the 28 households in the Water Points Survey who did not use rivers or sand river wells, 26 (93%) said it was because of "dirty water".

Rain water catchment tanks, sponsored by ALDEP and pioneered by IFPP at Pelotshetlha, have been sporadically tested for water pollution. Preliminary results indicate possible low nitrate contamination, but high bacterial pollution (Classen, 1980: 27; Group Development Officer, Serowe, personal communication).

Yet, for all this research showing high levels of nitrate and/or bacterial pollution of water supplies, the clinical evidence that these levels actually harm human or livestock health is not overwhelming. Some villagers have long maintained a link between water quality, poor health or specific ailments but there has been little research in this area. In fact, what studies that have been done suggest no apparent harm to humans as a result of certain kinds of pollution. In particular, the Swedish Nitrate Group assigned to study the connection between nitrate contamination and suspected shortage of hemoglobin in humans concluded in 1978:

> "We therefore believe that already this pre-study has produced evidence that methemoglobinema is not a major problem in Botswana and that further studies are not indicated at present."

Both the Group and the SWECO consultants noted, however, that the most susceptible population to this nitrate-related deficiency in hemoglobin are babies and that an increase in bottle feeding may also lead to an increase in this disease in the future (Swedish Nitrate Group, 1978; SWECO, 1977:6.1). Concern over such findings, as well as over the methodology used in some of the reports on water pollution,has prompted proposals for more detailed village water supply contamination studies. The most pressing research need at this time appears to be less for more hydrochemical and bacterial studies of water points,than for clinical research establishing the causal connection between contamination and disease and loss in human productivity.

There are other research findings pertinent to water-related diseases. Approximately one-third of the randomly selected households surveyed in Mahalapye and Palapye in 1972 suffered from sore eyes, blood in the urine, diarrhoea or skin diseases,which health officials commonly attributed to water-related causes (SIDA, 1973: 39-40). There was some indication in the survey results that the incidence of these ailments increased with household distance from the nearest water point (Ibid. p.43). In addition, these SIDA consultants found some 46% of the 194 students at three primary schools in Palapye were "suffering from bilharzia" on the basis of analysis of urine specimens (Ibid. pp. 40-41).[1]

In the large nationwide bilharzia survey undertaken between 1976 and 1978 in Botswana, Rudo saw an important connection between the percentage of people who were infected with bilharzia (i.e.,its prevalence in a locality) and the water sources these people used,

> "A trend was detected which suggests that localities with prevalence figures greater than 9 percent [of the sampled population] are often characterized by water sources which are rivers and the pools formed by rivers. These water sources also tend to be more permanent and more accessible than water sources of localities with prevalence figures less than 9 percent. Those localities with less prevalence are often characterized by non-perennial rivers which dry out for long periods of the year, and the presence of [dispersed] small dams." (Rudo, undated:13).

Rudo also pointed out that, ironically, the greater the surface water pollution by cattle, the less the incidence of the small hosts for bilharzia. (Ibid. p.7). It is important to note that while Rudo found these snails in large and small dams, rivers, pools, haffirs and other natural catchment areas, the vast majority of localities surveyed had less than 9 percent of their sampled population infected (Ibid. p.8).

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1. Rudo also found in Palapye that "two schools which are situated near to the river had 94 percent more [bilharzia] infections than the school on the opposite side of the river". (undated, p.9).

A survey of some 105 households in Tlhabala and Moiyabana concluded that households which perceived themselves lacking sufficient water at the lands were more likely to be malnourished than those households who felt water was no problem at the lands. Namely, the lack of timely access to draft oxen in association with the lack of water were seen as contributing factors to poverty and malnourishment at the lands (German Development Institute, 1979: 68,76,81).

One might expect that variation in the geographical incidence of water-related disease and pollution would be affected by differing patterns of fallback water points in these areas. To our knowledge, no study has systematically analyzed the correlation between seasonal incidence of certain water-related diseases and shifting water points use over time (see Chambers et. al., 1979, for discussion of similar research in other countries of Africa; Rudo, undated: 7).

III. Rechargeability of Groundwater: Are Boreholes Drying Up in the East?

One of the most frequent questions asked of water consultants in Botswana is: "What's happening to the groundwater levels in Botswana - are we using up more water than is being recharged into the overall supply?" No definitive answer to this question exists but what research has been done indicates that, on nett, rural domestic and livestock water consumption in eastern Botswana is not depleting groundwater reserves there.

There is some evidence that urban water consumption may be exceeding recharge in certain areas, e.g., in Francistown (Sir Alexander Gibb and Partner, 1977:43). There is also an indication that some major village water supplies may be "mining" groundwater reserves. Jennings provides figures suggesting that water consumption in Serowe may be at equilibrium with or presently exceeding groundwater recharge there: in 1974 groundwater recharge was set at an average 30,000m^3 per month, while in 1979/80 monthly abstraction at the village water supply was set at nearly 35,000m^3 (Jennings, 1974:411-419; Department of Water Affairs, 1980:53). In addition, water requirements of major mining activities in eastern Botswana clearly exceed groundwater storage and recharge capabilities in those areas where they are located (Foster and Farr, 1976, paragraphs 2.4.1-2.5.1).

However, in aggregate terms, the estimated 1 percent to 4 percent of annual runoff that is attributed to recharging groundwater in eastern Botswana is seen as sufficient in covering rural domestic and livestock water consumption requirements in the intermediate term (UNDP/FAO,b., 1972:3; Jennings, 1974: Abstract; Foster and Farr, 1976: paragraph 2.2.3). Needless to say, there is local variation in groundwater reserves and the methodology of measuring recharge is not fail-safe.

Perhaps the best summary of systematically collected evidence on this matter of recharge of groundwater has been made by Jennings and deserves to be quoted in full for wider circulation:

> "ARE BOTSWANA'S GROUNDWATER RESOURCES DRYING UP?
>
> Since the commencement of drilling by government in Botswana in 1929, 124 boreholes, for which reliable records are available, have been worked on subsequent to their being drilled. Reasons for this are generally because of a reported drying up or reduction in yield; because the hole has collapsed due to insufficient lining; because it was considered on geological or geophysical grounds that deepening the borehole would result in further water supplies being encountered; or because local 'basimane' (young boys) have filled the unequipped borehole with rocks and other objects.
>
> In [Jenning's] experience most reported cases of a borehole drying up are due to mechanical failure of one sort or other - generally worn pump cylinder, leather washers or rod failures. Careful examination of the records of government boreholes which have been subsequently worked on by a drilling rig... has shown that only 21 out of the 2000 odd successful holes drilled in Botswana have in fact dried up or shown reduced yields. Of the 21 boreholes only two dried up completely while of the two, one was subsequently found to have a yield of 7.6

litres per minute. The total initial tested yield of these 21 boreholes was 1715.3 litres per minute while their final tested yield was 448.8 litres per minute - 73 percent less than original yield. It is concluded that less than one percent of boreholes drilled in Botswana have shown reduced yields with the passage of time. It would appear therefore that no marked drying up of boreholes is taking place in Botswana" (1974:562).

IV. Improved Water Supplies: Changes in Household Water Consumption and Time Use

Questions: 1. "Do people consume more water when their water supplies are brought nearer to them or improved?"

2. "What does a household do with the time saved fetching water by bringing water points nearer to its lolwapa?"

1. Accurate household water consumption figures are notoriously difficult to get in Botswana. Households vary in terms of not only the containers they use to transport water, but also the frequency with which they collect water over time. Copperman points this out with respect to household water consumption:

> "Water was collected in metal buckets, old oil cans, plastic paint buckets and other plastic containers. Children were sent to the standpipe with anything from a teapot (very small children) to a wheelbarrow full of jerry cans.... It was difficult to specify the exact number of trips made in any one day by one household. As interviewees themselves pointed out, the number of trips depended on activities going on in the lolwapa which vary from day to day and time of year" (1978:16-17).

In addition, livestock watering counts done during the Water Points Survey over a number of two day periods at selected water points show the substantial variation in daily water numbers (see Table 82 of main Report also illustrating seasonal, inter-village and intra-village variation in daily counts).

Table 1 gives figures compiled from the Department of Water Affairs' on water abstraction and consumption levels at the SIDA-funded water schemes in the major villages of eastern Botswana. These figures suggest that on average in these villages, daily per capita and standpipe consumption have been increasing since 1976/77.[2] Per capita consumption was said to have increased from a daily 22 litres to 28 litres between 1977 and 1980, while individual standpipe consumption increased from 2,400 litres to 3,100 litres per day between 1976 and 1980. Substantial inter-village variation is evident. Data collected in the 1972 SIDA water use survey at Mahalapye and Palapye indicate that average per capita water consumption levels are considerably higher after the installation of the improved water schemes than before: in 1972, per capita daily water consumption was set at roughly 9 litres in Palapye and 11 litres in Mahalapye, as compared to 24 litres and 26 litres, respectively, in 1979/80 (SIDA, 1973:31; Table 1). Copperman indicated that water consumption in areas other than these major villages may be lower: she estimated an average daily per capita consumption of 10-12 litres of water in 1978 at her surveyed small villages, as compared to 24 litres recorded in the major villages that year (1978:19; Table 1).

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2. The figures for Serowe are dubious. Not only were water losses high and individual standpipe consumption low, but the increase in monthly water abstraction between 1972 and 1979/80 (30,000 to 35,000), when averaged on a per capita basis, is probably less than the rate of population increase for that period (Jennings, 1974:412 ff.; Department of Water Affairs, 1980:53).

TABLE 1 EASTERN BOTSWANA MAJOR VILLAGE WATER SUPPLIES: AVERAGE WATER CONSUMED DAILY PER STANDPIPE AND PER CAPITA (LITRES)*

	1976/77		1977/78		1978/79		1979/80		1979/80 Losses as % of Consumption (Annual)***	Increase (%)	
	Standpipe**	Capita	Standpipe**	Capita	Standpipe**	Capita	Standpipe**	Capita		Standpipe**	Capita
Kanye	2,500	N/A	3,500	18	2,900	17	4,200	20	N/A	68% (76/80)	11%(77/80)
Ramotswa	2,500	N/A	2,600	22	2,900	29	2,900	29	20%	16 (76/80)	32 (77/80)
Tlokweng	1,400	N/A	1,700	32	1,800	36	1,700	37	10	21 (76/80)	16 (77/80)
Moshupa	1,900	N/A	2,400	19	2,700	23	3,200	30	10	68 (76/80)	58 (77/80)
Tonota/Shashe	2,500	N/A	3,400	23	3,000	23	2,500	33	30	0 (76/80)	44 (77/80)
Mahalapye	3,700	N/A	3,700	26	3,200	23	3,900	26	20	5 (76/80)	0 (77/80)
Mochudi	-	-	1,800	16	2,600	24	2,000	23	60	11 (77/80)	44 (77/80)
Thamaga	-	-	2,000	17	2,500	23	2,900	24	50	45 (77/80)	29 (77/80)
Palapye	-	-	-	-	4,400	19	4,900	24	40	11 (78/80)	26 (78/80)
Molepolole	-	-	-	-	4,800	24	4,800	30	20	0 (78/80)	25 (78/80)
Serowe	-	-	-	-	2,600	22	1,600	27	70	-39 (78/80)	23 (78/80)
Ave Per Capita (Litres)	N/A		22		24		28			+ 27% (77/80)	
Ave. Per Standpipe (Litres)	2,400		2,600		3,000		3,100			+ 29% (76/80)	

* Figures obtained from the Department of Water Affairs Annual Reports for the operation of major village water supplies.

** Does not include figures for private connections.

*** Because of computation problems in the Annual Reports, these figures must be regarded as approximate.

It must be stressed that such figures and comparisons are tentative, given the methods used in estimating consumption levels and the use of average, rather than median, values for these levels.

Such research evidence suggest that there is an inverse relationship between water consumption and distance from a water point. That is, the further away a household is from a water point, the less water it consumes. However, the little evidence available on this issue is mixed. The 1972 SIDA study of water use at Mahalapye and Palapye found "no clear relationship between distance and water consumption" (1973:44). Copperman's survey sample figures indicated "a slight decline in water consumption as distance increases" and she concluded on the basis of personal observations that "households living within 50 metres of a standpipe seemed to use significantly more water" (1978:19).

In 1974, the Kgatleng Pilot Water Survey project was carried out in an attempt to assess whether or not human and livestock water demand exceeded supply capabilities in 10 out of the 57 Census enumeration areas of Kgatleng District (which included villages, lands and cattlepost areas). A number fairly stringent assumptions were made in the analysis (not least of which was a daily requirement of 25 litres per person and per beast), but the Survey concluded that between 75% and 90% of the people in these areas had "access to an adequate water supply" (Simkins and Maddux, 1974:4).

2. While the research evidence directly linking distance and water consumption is weak, the data tying distance and time spent in collecting water is somewhat stronger. Both the Copperman study of four small villages and the SIDA study of two major villages, indicate an average of some four trips per household per day in order to fetch water for lolwapa consumption (Copperman, 1978: 45; SIDA, 1973:33). Consistent with this was the research finding of a Molepolole study that households collected an average of six buckets of water per day (Report on Village Studies, 1972:221). Again, daily and seasonal variation in such figures are enormous.

Consolidating Copperman and SIDA figures suggests an average of between 1 - 2 hours is spent daily by a household fetching water in a reticulated village, as compared to 2 - 3 hours in villages without water reticulation, and even more time spent when at the lands (Copperman, 1978:18, 45; SIDA, 1973:33). Figures provided in the pilot Rural Income Distribution Survey indicate approximately an hour a day is spent in fetching village water (RIDS, 1976: 280). Fetching domestic water is typically a female activity in Botswana (Bond, 1974:33); data from the Activities Survey indicate that men and young boys are likely to spend as much time each day watering livestock (2 - 4 hours), as women and young girls do in fetching domestic water (see Kerven, 1979:7-10 for herd watering figures). Not all households have livestock, of course.

Copperman concludes that people at the lands and cattleposts spend considerably more time collecting water than do people in villages, a finding that is consistent with a number of surveys which have shown that more people typically live further away from their primary water point when at the lands, as compared to when at the village (Copperman, 1978:45: Shoshong Survey, 1972: unpublished data; Report on Village Studies, 1972: 195; Moshupa Catchment Survey, undated: Table 4-2; Kweneng Resource Survey, 1972:81-83). The Water Points Survey found 26 percent of the cases of use in villages were within a 10 minute round trip of the lolwapa, compared to 16 percent of the cases of use at the lands and 12 percent at the cattleposts. (See Table 27, main Report).

Survey evidence to date indicates that the increased accessibility of rural households to water supplies is not likely to release household time for more production or additional economic activities. Rather, it is probable that such released time, by having water points nearer, will be used to increase water-related household maintenance or leisure activities. Since this is an important finding, both Copperman and the SIDA consultants will be quoted at length:

> "The households were asked to state some gains they would get if they had their own water-tap...In general, the direct gains like more washing and cleaning, building and improving facilities, drinking, gardening etc. were mentioned. The more indirect gains, like taking more care of children and taking cash-jobs were not so frequent... It is ...more likely that any time released from this tiresome work [of fetching water] will produce social benefits instead of direct economic benefits..." (SIDA, 1973:35-36,53).

> "When asked about the benefits of the [reticulated] water most respondents remarked that they were able to wash and smear more often. Sometimes more beer brewing was mentioned in addition. One clear difference that did emerge, however, was that respondents in Mmathethe [a reticulated village] were doing the main rebuilding of the compound twice a year, whilst those in Modipane [an unreticulated village] were doing it only once... Respondents said that they used the extra time [released from having nearer standpipes] for relaxation. They pointed out that it was difficult to specify exactly what they did with the time, but that life was generally easier for them. Given the more important other factors which enter into whether a household decides to plough, it seems unlikely that time saved will necessarily be spent on productive agricultural work" (Copperman, 1978: 23,46).

While not completely consistent with some prior findings concerning the relationship between distance from water point and water consumption levels, these two surveys support the conclusion that released time from fetching water will likely be put into either directly water-related activities for household maintenance or relaxation. Apart from beer-brewing and brick-making, the direct economic benefit of nearer water seems less significant.

V. Differences Between Hardveld and Sandveld Water Usage

One of the major obstacles to a better understanding of how people use water in the eastern communal areas of Botswana is the pervasive assumption that solitary boreholes play the major role in the provision of livestock and domestic water supplies in the country. The number of people in Botswana who think boreholes are the answer to almost any domestic or livestock watering shortage is staggering. For example, District-village consultations repeatedly focus on village demands for improved borehole supplies (see Rural Industries Innovation Centre/ Southern District Council, 1977; Kramer and Odell, 1979:24). There are a number of reasons for this operating assumption, not least of which continues to be the construction of borehole-based village water schemes and the perceptions of boreholes as more reliable, higher volume and cleaner water sources than their next best alternative.

But surely the primary reason people equate "real" water development with borehole construction lies in Botswana's long preoccupation with sandveld water and grazing development from the earliest of colonial times with Ghanzi Boer trekkers up to the present Tribal Grazing Lands Programme. Many people still think that there are parallel water needs for sandveld and hardveld. An anecdote illustrates this quite nicely. After having explained how the Water Points Survey results showed that a number of lands households wanted more convenient domestic water supplies and having recommended the construction of more small scale open wells in such areas, the first question asked of us at a Kgatleng planning meeting was: "But where are the thousands of cattle going to water?" This was asked in all seriousness, although there may be 6 times as many boreholes per square kilometre in the east as there are in the sandveld.[2]

At the superficial level, cattle water usage in the sandveld and hardveld appear similar: wet season dispersal of cattle to better grazing and natural water sources, followed by dry season concentration of cattle around boreholes (compare Vierich, 1979:23-24, 70-72 on the sandveld with Gulbrandsen, 1980:196-198 on the hardveld). Yet there are substantial differences between hardveld and sandveld domestic and livestock watering. At the risk of overgeneralizing this dichotomy, three of the more important differences are:

(1) The combination of typically greater rainfall, more runoff and better groundwater recharge in eastern Botswana has literally shaped one of the major regional differences in water use: unlike in the sandveld, a number of seasonally flowing rivers etch the hardveld and play a substantially more critical role in rural surface and groundwater usage than in the western sandveld (for comparative rainfall, runoff and recharge figures, see:

2. Figures supplied by Kramer and Odell for the western Kweneng and by Hitchcock for the western sandveld region of Central District indicate approximately 5 boreholes per 1,000 square kilometres as compared to some 3 boreholes per 100 square kilometres at eleven of the Water Points Survey sites (Kramer and Odell, 1979:pp. 2 & 12, 35 boreholes for approximately 7,500 km^2; Hitchcock, 1978: Volume 1. pp.62 & 153, 131 boreholes for 28,064 km^2; Water Points Survey, 48 boreholes for 1,512 km^2). If one argues that it is the mal-distribution of boreholes in the east that is a problem, thereby justifying more borehole drilling, then the implications of such an argument for promoting increased sandveld borehole drilling is devastating!

UNDP/FAO. b., 1972:1-3; Pike, 1971:15-25; Jennings, 1974:65,125). While rivers are not uniformly present in eastern Botswana nor, where present, are they always as significant as some other sources, a number of past surveys have shown rivers to provide a substantial percentage of water use, especially in the communal lands and cattleposts. For example, in the late 1960s and early 1970s, 21% of all water sources used at the Moshupa lands and 17% of the sources used in the lands of southeastern Kweneng were rivers (these figures would have been higher had sand river wells been included; Report on Village Studies, 1972:195; Moshupa Catchment Survey, undated: Table 4.1; Kweneng Resource Survey, 1972:81). The 1978 Arable Lands Survey lists rivers and sand river wells as accounting for 13% to 37% of the water points used in four of its eight eastern lands areas (Odell, 1980:67). Between 34% and 38% of wet and dry season water points used by cattle owners in the Losilakgokong lands area were attributed to rivers (Rural Sociology Unit 1977, unpublished data). Similarly, published data from Pelotshetlha and unpublished information from Shoshong, Tlhabala and Tsetsejwe indicate some river usage by households in these areas (Rural Sociology Unit files). In terms of evidence from the Water Points Survey, Tables 17,23 and 27 in Chapter II show that on average 23% of the water points used by sample households at the village, lands and cattleposts are attributed to the surface water in or shallow well water of rivers. Rivers and sand river wells accounted for 10% of all the water points mapped in the Water Points Survey. Moreover, 22% of the estimated monthly cattle water usage at those points used by respondents in the 12 Survey sites was at rivers and sand river wells, as compared to 26% and 17% of total monthly cattle usage at boreholes and open wells, respectively, between April,1979 and March,1980.(see Charles Bailey's Keeping Cattle and the Cost of Water in Eastern Botswana). While there are some fossil rivers in the sandveld, it is doubtful that,except for a few localities, rivers have an important role in water usage there.

Not only do rainfall and runoff lead to river formation but when overutilization of the land is added into this equation in the east, a higher incidence of sheet and donga erosion becomes another factor distinguishing water utilization in the hardveld from that of the sandveld (Rigby/ALDEP, 1980:23-24).

(2) Fifteen percent of the water points mapped in the Water Points Survey and 14 percent of those used by the Survey's sample households were boreholes,as compared to 83 percent of the water points mapped in the western sandveld of the Central District (Hitchcock, 1978: Volume 1, p.153; Tables 17, 23 and 27 in main Report). While comparable figures do not exist for western sandveld areas, it is probable that considerably more than 26 percent of the western sandveld's monthly cattle water usage was at boreholes between April,1979 and March,1980. Similarly, it appears that many sandveld livestock boreholes water substantially more cattle than the typical livestock borehole in the east. Average counts for dry season daily livestock watering at monitored boreholes in the Water Points Survey were around 165 LSU per day. In the sandveld, figures of 300-500 cattle watering at boreholes are not uncommon (Kramer and Odell, 1979:12; also Hitchcock, 1978: Volume 1, pp.276-278).

While boreholes typically dominate water usage in the sandveld, variety of physical and management types is the hallmark of much of the eastern communal area water use. In addition to rivers, surface water sources such as dams, haffir-dams and haffirs account for 35 percent of all the water points mapped in the Water Points Survey, while Hitchcock, Kramer and Odell scarcely note any such sources in their surveyed areas. Twenty percent of the water points mapped and 22 percent of the water points used by sample households in the Water Points Survey were open wells as compared to 10% in Central District's western sandveld (Hitchcock, 1978: Volume 1, p.153; Tables 17, 23 and 27 in main Report). A number of past surveys also have found a variety of physical water point types used in the eastern lands and cattle posts, such as boreholes, haffirs, pans, dams, rivers, open wells, shallow river wells and springs (Odell/ALDEP, 1980:67; Opschoor, 1980:37; Report on Village Studies, 1972:195; Moshupa Catchment Survey, undated; Table 4-1; Kweneng Resource Survey, 1972: 81-83; Pelotshetlha Survey/Rural Sociology Unit, 1975; 5; unpublished data in the Rural Sociology Unit from surveys at Shoshong, Tlhabala, Tsetsejwe and Losilakgokong).

Differences in water point ownership patterns seem to be present between the hardveld and the sandveld as well, with the east probably having more communal and natural water points and less private ones:

Table 2: Comparison of Sandveld and Hardveld Ownership of Water Points

	Western Sandveld Central District[a]	Water Points Survey 12 Eastern Sites[a]
Private	86%	58%
Council/Government	4	9
Syndicate/Group	2	3
Communal/Natural	2	25
Others/Unknown	6	5
	100%	100%

a. Based on mapped water points for Hitchcock (1978:Volume 1, 1978,p.181) and the Water Points Survey (Table 13 in main Report).

In fact, approximately 34 percent of the estimated monthly cattle water usage at points used by respondents in the Survey's 12 sites was at natural and communal water points (see Charles Bailey's Keeping Cattle and the Cost of Water in Eastern Botswana).

Moreover,a higher percentage of residents of the sandveld are apparently dependent on privately-owned borehole water supplies than is the case for hardveld village areas (Kramer and Odell, 1979: 14,19; Hitchcock, 1978: Volume 1, passim; Table 18 of main Report).

(3) While there are similarities in the hardveld and sandveld fallback systems, there are differences as well. What is comparable are both the broad pattern of seasonal dispersal and concentration of livestock and the more specific drought response of many livestock holders who resettle themselves and their livestock at their major village of allegiance ("the cattlepost of last resort"; see Vierich, 1979:17). In addition, smaller stockholders in each veld are probably less able to herd their livestock very far from their malwapa, whatever the season or location of settlement (see Gulbrandsen, 1980:196). The dissimilarities between these two veld water systems are primarily three:

(a) Because of the variety of water points in the east, fallback strategies there appear to include more types of water points than in the sandveld. One has the impression from reading some of the sandveld literature that many (richer) cattle owners typically move their cattle out to pans or other natural surface water sources in the wet season and back to boreholes and wells in the dry season (with the dry season usually longer in the west than in the east). However, in the mixed lands and cattleposts of southeastern Botswana, it is not uncommon to find cattle moving from wet season lands haffirs and rivers to large dams, after which to open wells, sand river wells and the odd communal area borehole in the dry season. The importance to the smallholder of the variety of communal and natural water points in the eastern fallback strategies cannot be overestimated, even if grazing condition may be poorer around many of them.

(b) Village settlement and cattle watering boreholes and wells are more closely allied in the sandveld than in many hardveld settlements today. Much of the sandveld literature suggests that people and their cattle move back into their villages to take advantage of the permanent water there during the period between the ephemeral water sources drying up in the grazing areas and harvesting completed at their sandveld lands. While such a pattern exists in some hardveld villages and certainly existed to a large extent in the past, many eastern villages no longer support large cattle watering and grazing populations, save in extreme drought periods.

(c) Some hunting and gathering groups in the Kgalagadi effectively reverse the wet season-dispersal/dry season-concentration fallback strategy: they concentrate around several natural watering holes in the wet season and are forced to forage further outward or migrate to new areas in the dry season (Silberbauer, 1972: 294-304; Tanaka, 1976:99-116).[3]

A number of other water related differences doubtless exist between hardveld and sandveld water use systems, some of which may be: the type and frequency of fee payments for cattle watering; perceptions of whether grazing or water is the limiting factor to cattle production; borehole syndicate organizational structures; groundwater hydrochemistry and borehole drilling success rates; and the role of pans in the sandveld and springs in the hardveld in early population settlement and expansion. This is a topic which deserves much more study and it is expected that the findings of the EDF Evaluation Unit at Ramatlabama and of Charles Bailey,on behalf of the Water Points Survey, will throw further light on some of these important differences.

This discussion suggests a moral of sorts for planners: a district or central government official who has spent almost all of his or her time in planning sandveld water and grazing projects probably needs to be much more sensitive and cautious when undertaking such projects in the hardveld. Since livestock holders typically have many more("free")options for water point use in the east than in the western sandveld, simply drilling boreholes becomes less a viable option for solving hardveld grazing problems.

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3. We owe this point and references to Robert Hitchcock.

VI. Water and Permanent Settlement at the Lands: How Villagers, But Not Townspeople, Are Stopped From Living Permanently in the Bush[4].

A number of studies have argued that the lack of adequate water supplies seriously retards lands settlement and agricultural production in eastern Botswana. Fosbrooke and Syson concluded on the basis of their extensive research in Shoshong that the shortage of water supplies was "a major limiting factor" on livestock and arable production, constraining ploughing activities by discouraging movement to the lands until late in the cropping season (UNDP/FAO a. 1972:69; Syson, 1973:34). Approximately 41 percent of Bond's 1974 sample of some 200 households in southeastern Botswana gave the lack of water at the lands as the reason explaining why they did not live there all the year (Bond, 1974:XXIV). Twenty percent of Silitshena's village sample in eastern Kweneng (N = 180) said it was the lack of water at the lands which explained why they returned to the village after harvesting (Silitshena, 1979:133, Figure 6.6). Thirty eight percent of the 105 households sampled in the 1979 study of Tlhabala and Moiyabana gave "no water" as the main reason for not staying year-round at the lands (German Development Institute, 1979: 159). Similarly, both Kooijman and Copperman point out in their research that the shortage of water points at many lands is the primary reason why there is still substantial seasonal migration (Kooijman, 1978:86; Copperman, 1978:69). Further it is this lack of water points at the lands that the ALDEP team has recently focussed on as "one of the biggest constraints to arable production", requiring solution if such production is to increase (ALDEP Team (Water Development), 1978:1).

There are problems, though, in understanding in what sense water is short at the lands and how this insufficiency inhibits settlement. For example, while one-fifth of the Silitshena village sample gave lack of water supplies as the reason for not permanently settling at the lands, only 2.1 percent of the settler sample gave availability of dry season (i.e.,reliable) water as the major reason explaining their permanent residence at the lands (Silitshena, 1979:111). In fact, only 4.2 percent of this settler sample gave the reason of lack of water at the lands in explaining why they did not settle at the lands before they did (Ibid.,p.127). Similarly,only 1.3 percent of the respondents in the Water Points Survey who said they lived permanently at the lands mentioned the availability of sufficient water as a reason for this settlement, whereas 26.1 percent of those who said they did not live permanently at the lands gave as a reason the lack of permanent domestic and livestock water. Water is clearly a necessary condition for permanent settlement but under what circumstances is it a sufficient condition?

It appears from Water Points Survey information that people who consider themselves permanent lands residents are willing to sacrifice nearby water in order to benefit from the production advantages of living there permanently. These permanent lands dwellers are willing to go further for water than they would if they lived in the villages or lived only seasonally at the lands. They also accept the inconvenience and expense of maintaining their own water point rather than having the government maintain a water point

4. This topic is discussed in much more detail in a forthcoming paper by Fortmann and Roe entitled "Settlement on Tap: The Role of Water in Permanent Settlement at the Lands" in Settlement in Botswana: The Historical Development of a Human Landscape, (R. Renee Hitchcock and Mary Smith, editors), Heinemann (in press).

for them. Year-round water is necessary for living at the lands but it may not have to be as nearby as water which is provided in the village. Such permanent lands residents seem to be making a tradeoff of less convenient water for more production.[5]

Thus, there are at least two water policy issues involved in permanent settlement at the lands. The provision of convenient water supplies at the lands may encourage not only earlier arrivals and later departures among seasonal residents, but also a labour and time shift from fetching water to other activities among those who are already permanent lands dwellers. This would require the development of a number of water points in an area of dispersed settlement. In addition, it is the lack of year-round reliable water supply that keeps some people from living permanently at the lands, making the provision of permanent water sources another issue in increasing agricultural production at the lands.

However, the provision of water is not an easy policy solution to the problem of encouraging permanent settlement and expanded agricultural production at the lands. The village provides a pull away from the lands in the form of social amenities, alternative economic opportunities and other amenities. This pull may be strong enough to overcome the attraction of even the most convenient and reliable lands water supply. Further, for a segment of the population the more basic problems of access to the means of production means that settlement at the lands may not even be feasible. For them ,the economic opportunities of the village provide an irresistible pull. There is also a push from the lands into the village in the form of inconvenient water which a water policy might well address. These factors discourage permanent lands settlement.

A push-pull dynamic, separate from availability of water supplies, also operates to encourage permanent lands settlers. There is a push out of the village towards the lands in the form of insufficient land for grazing around the village, insufficient household labour and the expenses involved in maintaining two homes. For some ,the lands provides a strong pull in the form of production opportunities associated with permanent residence there. This pull may overcome even the most inconvenient water supply at the lands.

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5. This is not to say that residents of lands areas do not want more convenient water. Quite the contrary. Only 6.7 percent of those who said they lived permenently at the lands felt no need for an additional water point,compared to 35.4 percent of the seasonal residents.

VII. The Perennial Water Recommendations: Development of Sand River and Open Wells in Eastern Botswana

In recommending the expanded utilization of sand rivers and open wells in eastern Botswana, the Water Points Survey joins an ever-growing line of consultants and reports making similar observations, though not with much success in the past (UNDP/FAO.b., 1972:86-106; UNDP/FAO.a., 1972: Volume 2, Appendix 9; Jennings, 1974:446-465; Flood, 1974:236; Sir Alexander Gibb and Partners, 1977:53-59; Copperman, 1978:6; Classen/ALDEP,1980:8-14; National Development Plan, 1980: 171). There has been some government activity in these areas and the most recent National Development Plan indicates funding of two projects (WB 29: Sand Rivers Project and WB 35: Rural Water Extraction) which should go some way in identifying sand river extraction points and open well sources for village water supplies. It is not clear to what extent such research and funding under these projects will be appropriate for the development of similar water sources at the mixed lands and cattle-posts of eastern Botswana.

Much of the government's present water development effort is still preoccupied with borehole solutions to settlement water needs and in no way matches the great potential that exists in many areas of eastern Botswana for sand river and well exploitation (especially for domestic puposes). Technology for such exploitation has been long known in Botswana. Research has been going on in identifying sand river sites for nearly 10 years now. If funding was once a problem, it appears to be much less a constraint than before, especially for providing small-scale water systems.

It is unfortunate, but probably true, that within five years time, at least one more consultant will recommend the expanded utilization of sand rivers and wells to no avail. This will occur largely because of the lack of committment on behalf of the government in identifying a person or department responsible for a large-scale programme to exploit these resources.

It is hoped that the Ministry of Agriculture will expand the operation of its Small Dam Unit to include such activities for future water development in the mixed lands and cattleposts of eastern Botswana.

VIII. Gardening and Small-Scale Irrigation

The survey evidence on the extent of gardening and small-scale irrigation activities in Botswana is mixed. No family in the RIDS sample used irrigation for crop farming (Lucas, 1979:8). Copperman estimated that 9 percent of a household's weekly consumption went to activities such as gardening and building (1978:21). Some 35 percent of Bond households in southeastern Botswana did some kind of vegetable gardening when they were at the lands. Some kind of fruit and vegetable gardening was done by 18 percent of the households when they were in the village. Twelve percent of the households in the Water Points Survey used water for agricultural purposes such as gardening.

Small-scale irrigation schemes have not been popular or common in some areas of the country. While one of the original aims of the dam building exercise in the Metsemotlhaba catchment area was to provide irrigation water, at best 10% of the villagers in Moshupa suggested using their dam for irrigation purposes in 1971 (Report on Village Studies, 1972:196,215). Similarly, some 80 percent of the arable farmers in a 1978 Ngamiland survey stated that they did not intend growing vegetables in the near future (Odell/ALDEP, 1980:A.71). A case study of one brigade's problems in promoting economic small-scale horticulture in a populated rural area of southeastern Botswana has been described in a recent evaluation of a project under the Kweneng Rural Development Association (Egner, Eustice and Grant, 1980:93-99). However, whatever the economic problems of small-scale irrigation, a number of gardening schemes, often at schools and around water points, have been observed during field work in the Water Points Survey.

It is one of the recurring district enthusiasms, especially of expatriate development officers, to propose irrigation schemes at dams which appear to them to have year-round water capacity. For example, at least four separate irrigation projects have been proposed by as many government officials over a twelve year period for one dam in the Southern District. While some such schemes doubtless have the potential for success - especially if initiated at the local level without prior government intervention - a full dam is not necessarily an "underutilized" dam. Making dams less reliable water sources by adding new water uses will have a serious impact on those fallback water points which users will have to utilize when dam water becomes scarce or dries up. The resulting scenario is not difficult to imagine: both livestock users and irrigation farmers at this dam will demand a back-upborehole to ensure reliability of water supply throughout the year in their area, especially since security of water supply has long been shown to be an important factor in farmer participation in irrigation schemes (Bromley et al, 1980: 368ff).

An optimistic assessment of small-scale irrigation potential for Botswana is given by Michael Lipton in his "Economies of Irrigated Farming in Botswana", (Botswana: Employment and Labour in Botswana, Vol. II, Appendix 7.4.)

The reader should consult the Egner-Martin report on horticulture and the Ministry of Agriculture's horticulture officer for more information.

IX. "Directions in Future Water Research" or "Is There Really Need For More Water Research in Botswana?"

With the survey and research industry growing considerably faster than government's ability to integrate much of the information gathered, calls for further research on topics already surveyed deserve special justification and scrutiny. The gaps in our knowledge about rural water use are pretty clear by now and indicate very specific studies for future consideration:

(1) First and foremost, there is a need to undertake the promised post-development survey of the SIDA-funded water schemes in Mahalapye and Palapye. The 1972 pre-development survey provided excellent baseline information on water use in thse two major villages and it would be useful to know how the subsequent improvement in the water supply has affected water use over time. In particular, this post-development survey should give special attention to three areas:

(a) A careful calculation of the change in per capita water consumption in the villages since 1972.

(b) Investigation of what households have done with the time released (if any) by improving the village water sources.

(c) A careful study of the hydrochemical, bacterial and clinical effects of water use in Mahalapye and Palapye, taking as a starting point, but considerably expanding upon, the baseline information collected in 1972. It may be necessary to select control groups from unreticulated villages in order to get a better understanding of the net affects on health attributable to such improved water supplies.

(2) A recurring question asked about the utilization of livestock watering points has been: to what extent has the past operation of any one cattle watering source increased the number of livestock staying in an area over and above what would have been the likely stocking rate without this water point? This is an extremely difficult question to answer, in part, because livestock watering counts have not been routinely kept at individual watering points over time in any given area. Two sources of pertinent information became available to the Water Points Survey which, although too late to be of any use to us, should be the starting point for a more specialized study on the relationship between increases in numbers of water points and increases in stocking rates:

(a) In the early 1960s, Livestock Industry Development Teams within the Department of Agriculture began operating in regions of the country. Files found in the office of the District Commissioner, Kanye (now kept by the District Officer, Lands) show that one of the activities of the Livestock Industry Development Team (South) was undertaking livestock watering counts at selected boreholes, many of which were in the sandveld. There is a pressing need to return to these boreholes still in operation and, at comparable periods of time, physically count the livestock now watering there. Reports of the Livestock Industry Development Team (South) were also found in the Molepolole Veterinary office storeroom and more reports could be found in other districts with a little effort, unless wholesale burning of old files (as in North East District) has become a major past-time of civil servants who have nothing better to do.

(b) Table 3 gives figures for livestock watering counts taken at selected FFHC dams in the Southern District in 1968. It is important that up-to-date counts be taken in August in order to determine the rate of increase in numbers over the last decade or so. In addition, a small survey of dam users should be undertaken to see how attitudes about dam use in the Metsemotlhaba catchment area have changed since the early 1970s. Efforts should be made through informal interviews to determine how dam management and access to these dams over time have affected (if at all) the levels of livestock numbers watering there.

Such a project seems especially suitable for joint cooperation between the Small Dam Unit and the Rural Sociology Unit,on one hand,and the District Officers Development and Lands in the Southern District,on the other.

(c) In order to assist future estimation of changes in livestock watering counts at water points, we have listed all 446 water point diaries with domestic and livestock counts used in Chapter Four of main Report in Appendix M.

(3) A thorough study should be undertaken on the regional differences in water usage for both domestic and livestock purposes by comparing systems in the east, western sandveld and in the northwest. Much of this could be done through a literature and file search, with selected key informant interviews in the field. There is a clear need for some government officials to be more sensitive to the regional differences and similarities in water use when planning water projects.

(4) In the future, survey questions about water usage and needs should be more specific than those asked in the past. In particular, the questionnaire response "Not enough water" is really a catch-all for a variety of possible respondent concerns covering, among others, the lack of sufficient rainfall, a shortage of livestock watering points as distinct from domestic ones (or vice versa), a perceived shortage of free communal water supplies, lack of reliable or convenient water sources, problems with water quality and so on. (See Appendix J for examples of more detailed questions about the water needs.)

(5) Finally, there is a need to replicate parts of either the Kweneng Resource Survey or the UNDP/FAO Shoshong Survey of the early 1970s. These two studies seem to have been undertaken and executed with a concern for accuracy and thoroughness and appear suitable for a follow up study designed to investigate the degree of change in rural society in the last decade. What has happened to the distribution of cattle holdings? Have crop yields gone up or down? Has off-farm employment increased over the last ten years? Answers to these and other timely questions are more likely to come from replicating earlier studies than by undertaking new studies in new areas. Only after such a study is done can we begin to understand the forces of change working on village communal area water use, both in the past and for the future.

Table 3 Dam Census Livestock Counts - Moshupa Catchment Area

Date of Census: 12/8/68 - 16/8/68

Dam No.		Distance Trekked to Dam By Livestock (Miles)	Livestock Units
1		0-2	330
		2-5	2905
		5-10	2500
		10+	402
	Daily Average:		1427
	No. of Owners Daily:		53
2		0-2	920
		2-5	1904
		5-10	376
		10+	-
	Daily Average:		640
	No. of Owners Daily:		32
5		0-2	2060
		2-5	1260
		5-10	33
		10+	-
	Daily Average:		670
	No. of Owners Daily:		37
9		0-2	2628
		2-5	15
		5-10	-
		10+	-
	Daily Average:		530
	No. of Owners Daily:		45

Average size of Herd/Family:

Dam No. 1	27 L.U.
Dam No. 2	20
Dam No. 5	22
Dam No. 9	15

Average size of Herd for Area: 21 L.U.

All figures are approximate.

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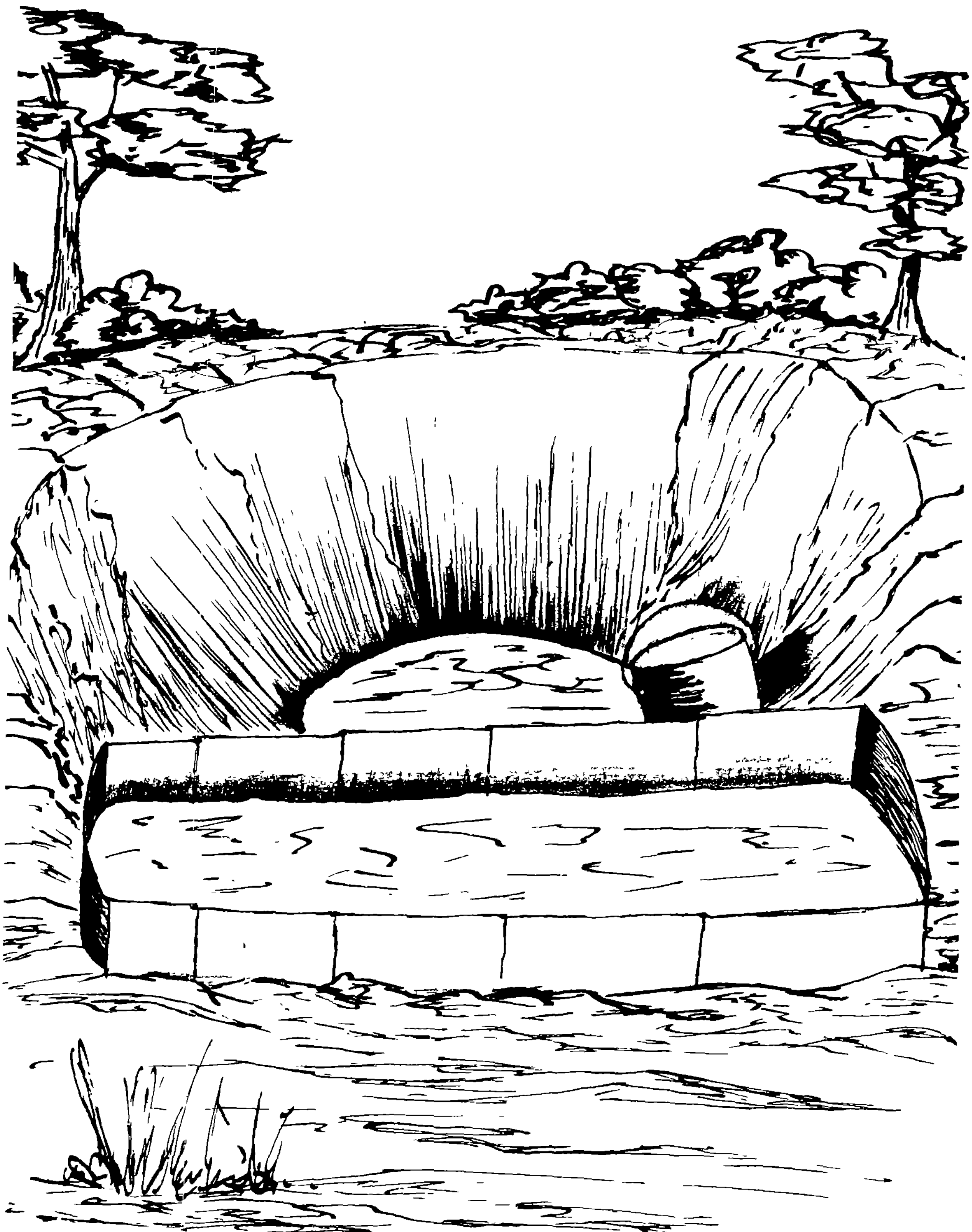

APPENDIX D: Consultancy Documents

PROPOSED WATER POINTS SURVEY

CONSULTANCY

1. SUMMARY

At the request of the Land Development Committee and the Natural Resources Technical Committee, the Ministry of Agriculture will conduct a survey of small dams and boreholes in communal areas, used predominantly for cattle watering. The aim will be to provide policy guidance for the future planning and implementation of both dam construction and water development under the Tribal Grazing Land and Arable Lands Development Programme.[1]

The success/failure of present government programmes will be judged by:

(a) success in providing watering facilities to those least able to pay for private facilities;

(b) effects on the country's range resources and indicate factors which would improve performance of these programmes according to the same criteria;

(c) costs/effectiveness in providing facilities.

The cost of the project, costing in all staff and equipment at local prices, whether or not seconded from Government, at local rates, would be P100 000. Of this, P55 000 would have to come from projected funds, and the remaining P45 000 would be absorbed in the normal recurrent budgets of Central Statistical Office (Agricultural Statistics) and Ministry of Agriculture.

A survey team will be assembled under a Project Coordinator who will form part of the team. The Project Coordinator will report to the Permanent Secretary of the Ministry of Agriculture, through the Chief Agricultural Economist, and to the Director of Water Affairs.

2. Background

Government-provided water facilities include:

(i) direct provision of small dams to be managed by District Councils;

(ii) direct provision of small dams to be managed by groups;

(iii) provision of small dams through the Serowe Dam Building Unit to be managed by groups (this is more labour intensive and involves use of local labour contribution which is not required in cases (i) and (ii) above;

(iv) provision of council owned and operated boreholes for livestock watering on a watering fee basis.

1. As defined in Government Paper No. 2 of 1975 on the National Policy on Tribal Grazing Land, i.e., areas where individuals would not be given exclusive tenure rights over grazing land.

These can be compared with:

(v) privately owned dams;

(vi) individually managed boreholes;

(vii) syndicated boreholes.

3. <u>Hypotheses to be tested</u>:

(A) Publicly provided facilities (i), (ii), (iii), (iv) do not cause more ecological damage than privately provided alternatives (v), (vi), (vii). (This should be tested both with and without controlling for comparability of livestock numbers).

(B) Facilities controlled by a group (ii), (iii), (vii) are managed worse than those controlled by:

(a) individuals (v), (vi)

(b) public authorities (i), (iv)

The investigation should cover three aspects of management;

1. Ecological

2. Maintenance of equipment/structures

3. Financial

(C) Publicly provided facilities (i), (ii), (iii), (iv) benefit poorer sections of the livestock-holding population more than privately provided facilities (v), (vi) and (vii). In assessing the benefits to the poorer holders, account should be taken not only of the proportion of such holders using the different types of facility but also the security of their rights as users (e.g.,whether they can be refused water at times of shortage) and the costs of using the facility.

(D) Water points with well-defined user rights lead better management than those with loosely defined user rights.

(E) Use of local labour on a labour intensive basis in Serowe Unit dams (iii) leads to better management.

(F) Establishment of dam groups before dams are applied for leads to improved management (i), (ii), (iii), (v).

(G) Regular payment of fees leads to improved management.

(H) Existence of written accounts leads to improved management.

4. <u>Costs and Effectiveness in Providing Facilities</u>

The aim here is to determine costs to government and to the economy of providing and maintaining in use different types of watering facility taking into account the constraints on government (skilled and unskilled labour, management capacity etc.).

This would mainly concern publicly provided facilities (i), (ii), (iii), (iv). Comparison with syndicated boreholes (vii) may also be appropriate, as it may be possible to use public funds to stimulate such development. It would involve costing a sample of such facilities; estimating expected life (from siltation rate, etc.), evaluating employment creating effects, calculating of costs to government per holder/livestock unit served. Reliability of the facility (e.g.,likelihood of dams being dry in certain years or for some portion of the year), and associated costs/benefits to stock owners, and in terms of effects on grazing. Consideration should be given to design and siting criteria in relation to costs.

5. Other Questions

The study should also try and reach some conclusions on the hypothesis that the beneficial effect of small dams (i), (ii), (iii) in breaking up concentrations of livestock around existing water points in densely populated areas outweighs any deleterious effect in increasing stocking rates.

The study can also be used to obtain information on a limited number of other questions, such as reliability of water source, tendency of publicly provided facilities and syndicated boreholes to be dominated by wealthier or more influential members and costs and benefits of such domination. Such information can be obtained both by questionnaire and by in-depth study of individual cases encountered during the survey.

6. Reporting

The survey should result in a report which:

(i) presents statistically meaningful data on the questions and hypotheses listed;

(ii) analyse these data to derive policy implications;

(iii) reports on other issues and conclusions relevant to policy on watering facilities which have emerged in the course of the survey, even if these cannot be statistically verified by the survey (the statistical hypotheses must be based on enlightened guesses as to the main problems and issues, which may well turn out to be only partially right).

The indicators listed below are a preliminary listing to help guage the scale of the work. The survey team should revise and refine these.

(A) Indicators relevant to hypothesis (A) will include:

  (a) measurement of range conditions (species composition, ground cover) at specified distances from the watering point;

  (b) number of livestock units using the watering point;

  (c) presence or absence of such management factors as seasonal movement of stock to other areas.

In view of the different ages of different watering points (most small dams managed by groups are less than three years old), and concentration of certain types of watering points in areas with specific characteristics (e.g. syndicates in the Kgatleng), standardisation for such factors affecting ecological conditions will be important.

(B) Indicators relevant to hypothesis (B) will include:

(d) (dams) condition of dam wall, siltation, condition of (and existence of) fence; frequency with which dam dries up;

(e) (boreholes) recent breakdowns, condition of reservoir, availability of spare parts/spare fuel.

Indicators relevant to hypothesis (C) will include:

(f) number of livestock units per holder using the water point (frequency distribution):

(g) arrangements for paying;

(h) relationship of responsibility for payment to income/cattle wealth of holders.

Relevant indicators for hypotheses D to H are fairly self evident.

7. Data, size of sample, sampling frame

At this stage it is not possible to indicate the minimum sample size or the likely sampling frame because of data deficiencies which will have to be rectified within the study.

All that can be done is to give an order of magnitude.

This means that some uncertainty must attach to the cost and size of the survey. The survey can, however, be limited to communal areas in Southern, South East, Kgatleng, Kweneng, Central and North East Districts, since these contain almost all publicly provided water points.

Annex 1 summarizes preliminary data on water points in these districts, and concludes that on the order of 172 dams and boreholes will need to be fully surveyed.

8. Method of Proceeding

The main investigation will have to be preceded by three months of professional work searching aerial photographs, data already collected by the Department of Water Affairs and Geological Surveys, and data collected at district level for the Tribal Grazing Land Policy, to establish populations of different types of livestock watering facilities. Collection of this data will be a very valuable by-product of the survey. The person doing this work should have photo interpretation skills.

Thereafter, the investigation should involve a period of research and design to draw up a sample frame and questionnaires, and a reconnaissance survey to further develop the hypotheses to be tested, and field test the questionnaire. This should take up one and a half months and be followed by the full survey and, lastly, by processing and writing up of results.

At least two different types of survey questionnaire will be needed, one to provide a description of the systems to be evaluated, and the second to do the evaluation.

Professional staff inputs will consist of a photo-interpreter to do the preliminary data search, a statistician to design the sample, a civil engineer to examine structures (dams, boreholes,etc.) and train range ecology assistants in this work, an economist to do the assessment of costs, employment effects, etc., a rural sociologist to assist in sociological design of the survey and survey work and a range ecologist to assist in range ecology aspects of survey design, and survey work. The survey team will be assembled partly from personnel already employed by Government, and partly from personnel specially recruited or obtained under technical cooperation.

9. Time and Resources Budgeting

The limiting factor for the main survey is the sociological survey work. Given difficulties in tracing owners, users, etc., each dam or borehole surveyed may be expected to take about 2.5 enumerator working days. This work thus amounts to 344 enumerator workdays, or about 14 enumerator man months. Some extra time should be allowed for travelling/contingencies and training,raising the total to 20 enumerator man months. This could be managed by 2 teams of 4 enumerators, in just over two months, plus a supervisor, a vehicle and a driver per team. The two supervisors would be needed also for the reconnaissance survey and a total of 8 man months of their time should be budgeted for.

The range ecology field assistants (locally recruited) should be able also to carry out such work as evaluation of dam wall condition, siltation,etc.

To minimize friction with users/owners, and to ensure the same coverage, these should cover the same water points as the enumerators on the same days. One two man team should accompany each team of enumerators. A summary of resource needs is given at (10) below, and followed at (11) by an outline budget at local costs. Where possible, local resources will be used.

10. Summary of Resource Needs

Staff

I Professional Input (Probably Expatriate)

(a) Statistician PR3

One required for 3 man months for the design, tabulation and writing up of the survey results. Available from Government (Agricultural Statistics Department).

(b) Civil Engineer PR3

One required for 1 man month to examine dam structures, borehole structures,etc., instruct range ecology assistants in survey assessment, and assist in the writing up. Assumed available from Government.

(c) Economist PR3

One required for 3 man months to examine costs, employment effects,etc., of different construction options for samples of dams, boreholes, and assist in writing up.

(d) Rural Sociologist (Project Coordinator)

One required for 7 man months for data collection, questionnaire design and will take part in the full survey and the analysing of data and writing up of the findings. This will take about 5 man months. An extra 2 months are being written in for work involved as Project Coordinator.

(e) Range Ecologist

One required for 5 man months for the survey design, reconnaissance survey, full survey, analysing and writing up of the findings. Available from Government (Land Utilisation Department of Ministry of Agriculture).

(f) Photo-Interpreter/Research Assistants

One required for 3 man months to locate dams and water points from air photographs and previously collected data with district and central government.

II Non Professional Staff, Local Recruitment

(a) Four Range Ecology Assistants will be required for 10 man months. They will carry on such work as the evaluation of dam wall condition, siltation, etc., and species/ground cover work. Two will be required to accompany each team of 4 enumerators and a supervisor. Available from Government (Land Utilisation Department).

(b) Supervisors T3

Two Supervisors will be required to a total of 7 man months. One supervisor will be assigned to each team of enumerators for supervision and guidance purposes. They will also be required to carry out the reconnaissance survey. Available within Government (Agricultural Statistics).

(c) Clerks GA4

One will be required for 5 man months for coding and tabulation work. Available within Government (Agricultural Statistics).

(d) Enumerators Group 3

Nine Enumerators will be required for a total of 20 man months, including training, travelling/contingencies. Available within Government (Agricultural Statistics).

Drivers Group 3

One driver will be required for 9 months (for the professional staff during the preliminary data search and the remainder of the project). One driver will be required for 5 months (for the professional staff throughout the main period of the project). Three drivers will be required for two and a half months(for the three survey teams). The latter three drivers will be available within Government (Agricultural Statistics/ Land Utilisation). Total seven and a half man months paid through normal budget; 14 man months paid through project.

III Vehicles

(a) 5 x $1\frac{1}{2}$ ton 4 wheel vehicles will be required for transportation purposes, one for 9 months, one for 5 months and three for two and a half months (as for drivers). The latter three available from Government Pool (Agriculture Statistics and/or Department of Land Utilisation).

(b) Camping Equipment

Enough equipment will be required for the entire survey staff. (Equipment for staff from Government available from Government).

(c) Equipment Contingency

A sum of P10 000 to be allowed for miscellaneous equipment at discretion of Project Coordinator.

II Outline Budget (Local Prices)

I Personnel Emoluments

A. Professional Staff (Expatriate)

Post	Man Months	Grade	Salaries and Allowances	Government Recurrent Budget	Project Costs
Statistician	3	PR3	1 623 + 812	2 435	-
Civil Engineer	1	PR3	541 + 271	812	-
Economist	3	PR3	1 623 + 812	-	2 435
Rural Sociologist/ Project Coordinator	7	PR3	2 705 +1353	-	5 681
Range Ecologist	5	PR3	2 705 +1353	4 058	-
Photo Interpreter	3	PR3	1 623 + 812		2 435
				7 305	10 551

B. Non Professional Staff (Local)

Post	Man Months	Grade	Salaries and Allowances	Government Recurrent Budget	Project Costs
4 Range Ecology Assistants	10	T3	3 100 + 1 550	4 650	-
2 Supervisors	8	T3	2 480 + 1 240	3 720	-
1 Clerk	5	GA4	970 + 485	1 455	-
8 Enumerators	20	Group 3	1 860 + 930	2 790	-
2 Drivers, project vehicles	14	Group 3	1 302 + 651	-	1 953
3 Drivers, Government vehicles	$7\frac{1}{2}$	Group 3	698 + 349	1 046	-
				13 661	1 953

			Government Recurrent Budget	Project Costs
II	Vehicles			
	(i)	2 x $1\frac{1}{2}$ ton 4 wheel drive Ford @ P9 690 each for project (9 months and five months use)	-	19 380
	(ii)	Vehicle Running Costs at 30t/km for 20 000 km per vehicle for vehicles provided by donar	-	12 000
	(iii)	3 x $1\frac{1}{2}$ ton 4 wheel drive vehicles assigned to project by Government Pool (running costs only at 30t/km for 20 000 km per vehicle	18 000	-
			18 000	31 380
III	(A)	Camping Equipment		
	(i)	Camping equipment for 22 personnel provided from Government at P282.80 per person	6 221	-
	(ii)	Camping equipment for 3 personnel provided from Project at P282.80 per person	-	848
			6 221	848
IV		Contingencies	-	10 000
		Grand Total	45 187	54 732

Annex 1

Probable Sample Size

There is not a good or interregionally consistent inventory of dams and boreholes, although much data has been collected and mapped in connection with the Tribal Grazing Land Programme (TGLP). The TGLP maps show borehole locations, but usually fail to distinguish different types of boreholes (iv), (vi), (vii) and for some districts, they fail to distinguish equipped from non-equipped,functioning from non-functioning, etc. The location of dams built by the Ministry of Agriculture are well mapped, but not those of private dams including those built under self help in the 1960's.

The data given below is therefore, incomplete, but is intended to give an indication of the work required.

N.E. District

D.L.U. dams run by Councils	37
Other dams	6
Boreholes	36
(Of which council operated)	(10)

Central District

D.L.U. dams run by groups	28
D.L.U. dams run by Councils	7

Kweneng District

D.L.U. dams run by groups	17
D.L.U. dams runs by councils	7
Other dams	7
Boreholes (with pumps)	129
(Of which council operated)	(18)
(Of which council owned, syndicated)	(38)

Kgatleng District

D.L.U. dams run by groups	9
"Successful" boreholes	102
(Of which council operated)	(4)

S.E. District

D.L.U. dams run by groups	8
Other dams	93*
Boreholes	19
(Of which council operated)	(9)

* includes many dams on freehold farms, irrelevant to survey

Southern District

D.L.U. dams run by groups	14
D.L.U. dams run by Council	12
Boreholes	136
(Of which council operated)	(6)
(Of which council owned, syndicated)	(54)

Totals

D.L.U. dams run by groups	76
D.L.U. dams run by councils	57
Serowe Dam Unit dams	7
Other dams	106
Boreholes	422**
(Of which council operated)	(47)
(Of which council owned, syndicated)	(92)

Sample Size Indicators

(i) Small dams managed by Councils - a large proportion of the total will need to be surveyed because the total population is small. Say,50% sample + 25 dams.

(ii) Small dams managed by Groups - same considerations apply as for (i). Dams less than a year old - about 25 - will be of little interest for any purpose except to study costing/effectiveness, and need not be covered by full survey. Say,50% survey sample of remainder = 25 dams.

(iii) Serowe Dam Unit dams - there is no chance of having a statistically satisfactory sample of seven dams. All will probably have to be visited, although several will be too new to be of much interest except to study costing/effectiveness. Say, full survey sample = 7 dams.

(iv) Council operated boreholes for livestock - unless number greatly exceeds preliminary estimate of 47, the majority of those in the Communal areas will have to be visited, say 30 boreholes.

(v) Privately owned dams - there are probably gaps in the data, but many dams counted are on freehold farms and therefore of no interest. Say,33% sample = 35 dams.

(vi) Individually managed boreholes - total number unclear. Assume sample one for each sampled dam managed by groups = 25 boreholes.

** excludes Central District

(vii) Syndicated boreholes - number unclear. Aim to sample one for each sampled dam managed by groups = 25 boreholes.

Total to be surveyed 172 dams and boreholes (plus some dams to be visited for cost/effectiveness of provision assessment).

David Jones,
Ministry of Agriculture.

20th December, 1978.

Memorandum of Agreement: Water Points Consultancy, Ministry of Agriculture, Republic of Botswana

1. This memorandum of agreement outlines the services and conditions under which the Rural Development Committee (RDC) of Cornell University will render technical consultancy and training for a water points consultancy in the Eastern Communal Areas for the Republic of Botswana, Ministry of Agriculture. AID Contract AID/DSAN-C-0060.

2. The goals of the consultancy are:

(a) To identify current water point locations, evaluate water point construction and participation in use and management practices, and suggest ways to provide additional facilities which reduce monetary costs and limit adverse environmental impact.

(b) To analyse livestock production in the communal areas in terms of its demands on water and range resources, and indicate patterns of more efficient resource use.

(c) To determine the reasons and conditions under which some rural households have access to various types of water points, while others do not, as well as understand the nature of participation in water point management and construction.

(d) The overall objective of the Water Point Consultancy is to provide policy guidance for the planning and implementation of both dam construction and water development under the Tribal Grazing Land Programme (TGLP) and the proposed Arable Lands Development Programme (ALDEP).

3. The RDC agrees to fulfill the terms of the consultancy by undertaking survey research under the terms of its cooperative agreement with USAID.

4. The RDC proposes to provide the Republic of Botswana Ministry of Agriculture the following consultative and staff training services to be undertaken in a spirit of cooperation, with the staff of the Ministry:

<u>Phase I: The Long-Term Survey (LTS) - 12 months</u>

The long-term survey will provide the data for an in-depth analysis of a small representative sample of water points and their encompassing water use systems, and endeavour to explain the process that leads to the pattern of water, and range use around a given water point. The survey is intended to achieve:

(a) Recommendations for improved water management systems.

(b) Provide guidelines for what can be done in times of stress on the water resource, should the drought continue.

(c) Improved local capacity to communicate water needs to the government, particularly to the LUPAGS, through involvement of the LUPAGS and local people in the research process.

(d) Develop animal productivity index which can be used in the field to give an indication of the current condition of cattle.

(e) Provide a physical and economic assessment of selected dam and boreholes structures.

Using the framework previously described, these broader issues will be examined in the LTS:-

- Conditions which lead to over-utilization of resources (both water and range) at and around the watering point surveyed.
- Institutional arrangements which might better align the social and private interests involved in the pattern of utilization of resources at the watering point.
- Structural factors which differentiate household patterns of water utilization.

Six groups of respondents will be interviewed:

1. Rural household heads.
2. Livestock owners/managers.
3. Water point diary: pumpers; herders; enumerator observations.
4. Water point owners: Councilors, sundicate members, private owners.
5. Land Board members (current and past).
6. Other Key Informants: DOL's, headmen, cattle traders, BMC staff, etc.

Phase II: The Point-in-Time Survey (PITS) - 1 1/2 months

Drawing on experience gained with the LTS, the point-in-time survey will sample a large number of different types of water points throughout the communal area of eastern Botswana. The PITS is intended to gather information on the utilization and management of a cross section of water points at a given time. A detailed plan for the PITS will be worked out once the LTS is in operation.

5. The consultancy will have the following outputs:

(a) An examination of livestock production systems in communal areas with the intent of ascertaining more efficient uses of water and range resources for such production.

(b) Guidelines for Water Point Management systems.

(c) An evaluation of present dam and borehole physical structures and recommendations for their improvement.

(d) An updated map of water points in the eastern communal areas.

(e) Development of simple livestock productivity index.

(f) Cooperation with LUPAGS in order to facilitate information transfer and local planning capacity.

6. To fulfill these objectives Cornell University agrees to provide the following personnel:

(a) Rural Sociologist for 18 months.

(b) Policy Planner for 12 months.

(c) Resource Economist for 9 months.

(d) Air photo interpreter for 2 months.

(e) Animal Production Specialist 6 weeks.

(f) Agricultural Economist 6 weeks.

(g) Civil Engineer 6 weeks

7. If local data processing is not possible, Cornell University will undertake the analysis of project generated data in Ithaca.

8. To fulfill the consultancy objectives, the Government of the Republic of Botswana agrees to the following:

(a) To undertake translation of the questionnaires.

(b) To provide survey enumerators or funds .

(c) To provide transport (including petrol) and drivers for interviewers.

(d) To duplicate questionnaires and reports.

(e) To provide assistance for pretesting the questionnaires.

(f) To provide office accomodation, secretarial, statistical and clerical assistance for all Cornell University staff during their stay in Gaborone.

(g) To provide 10 work months of a range ecologist and field assistants.

(h) To provide two weeks of staff time of the Animal Production Research Units.

(i) To provide maps and air photos to a limit of P150.

9. The provisions of this Memorandum of understanding may be modified, changed, replaced and amended if mutually agreed upon by all parties involved.

Signed

Milton J. Esman, Director
Center for International Studies
Cornell University

Dated:Nov. 2. 1979

Date

Signed

Acting Permanent Secretary
Ministry of Finance and
Development Planning
Government of Botswana.

Dated: Nov. 2 1979

Date

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