



WATER, ENVIRONMENT AND MANAGEMENT

Development of groundwater in Bophuthatswana

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INTRODUCTION

Bophuthatswana gained its independence from South Africa in 1977 and comprises six separate territories. It has become one of the fastest developing countries economically, in the region since then.

According to the population census of 1991 and other analyses, it is estimated that a total of 1,75 million more people in rural areas will have to be provided with reasonable access to safe water up to the year 2000.

Prior to the establishment of the Department of Water Affairs (DWA) in 1987, more emphasis had been placed on urban water supply, whilst an ad-hoc approach was followed for rural supply until 1989. In order to rectify the imbalance, the Bophuthatswana Rural Water Supply Programme (BRWSP) was launched in 1989 with the aim to provide sustainable and adequate water to rural communities, primarily from boreholes.

HYDROGEOLOGY

The country 44500 km² in extent, is underlain by a variety of rocks including crystalline rocks (such as basalt, norite, gabbro, andesite, granite and schist) and sedimentary rocks (dolomite as well as limited sandstone, mudstone and shale).

The dominant vegetation of the region consists of bushes, shrubs and thorn trees typical of the savanna environment in Southern Africa. Topographical relief is very low. Owing to its semi-arid climate with a mean annual rainfall of approximately 500mm, perennial rivers have ceased to exist. The estimated Mean Annual Run-off is 345 Mm³/annum. The economically exploitable groundwater is determined to be 110 Mm³/annum, whilst 65 Mm³/annum is available from the existing dams. Of the present demand of 123 Mm³/annum, 90Mm³/annum is imported, 11Mm³/annum is supplied from dams and the balance of 22Mm³/annum from groundwater. Three types of aquifers are identified and exploited:

1. Fractured and cavernous dolomite.
2. Weathered and fractured igneous rocks.
3. Superficial water-bearing sandy zones.

Quaternary deposits are not significant. Dolomitic aquifers with a 15% outcrop area in the country possess a high potential for water supply in a few areas, as opposed to only 4% outcrop area in South Africa.

Heavy thunderstorms and scattered showers are the main sources of aquifer recharge. Groundwater is of HCO⁻-Ca⁺⁺ and Mg⁺⁺ type. The major point source pollutant encountered is nitrate.

WATER SUPPLY LEGISLATION

There are primarily two acts controlling the supply of water in Bophuthatswana viz:

- * The Water Act, Act 38 of 1988.
- * The Bophuthatswana Water Supply Authority Act, Act 39 of 1988.

Due to its scarcity, water is considered to be a strategic resource therefore water rights are vested in the state. The Water Act empowers the Minister of Water Affairs to grant water rights and prescribes the manner in which such rights are to be administered. The Bophuthatswana Water Supply Authority Act makes provision for the establishment of BWSA, a parastatal, which is responsible for the control, acquisition, supply and distribution of water, as well as for operation and maintenance of water works in Bophuthatswana. BWSA may be regarded as the "operational arm" of DWA, as a parastatal facilitates more flexibility than a government department.

POLICIES AND STRATEGIES

In 1987, 85% of rural villages had no reasonable access to potable water. As a result of this backlog, DWA adopted a strategy for BRWSP which relied on requests from villages for boreholes, rather than attempting to supply water to all areas on a pro-active basis. It was felt that properly verified and prioritized requests would indicate those areas with the

greatest need for water to be supplied within limited funds and time.

In 1987, DWA attempted to satisfy requests for water with departmental plant and personnel. Lack of staff and frequent breakdowns however, soon rendered the operation ineffective. Work output and success rates were low and targets could not be met.

A new approach was adopted in August 1989, when project coordination and private contractors were introduced to the programme on a rational and structured basis.

Prioritization and the introduction of hydro-geological methods improved production to a level where more than 300 boreholes per year were sunk in subsequent financial years. The backlog saw a dramatic reduction as a result of the new approach.

By 31 March 1992, 1356 boreholes were drilled and more than a quarter of a million people benefited from the programme.

(Table 1). The number of requests declined and the nature of requests changed. Applications for not only boreholes but also for reticulation systems were received. The backlog on primary water supply has been substantially erased.

COMMUNITY PARTICIPATION

Rural Communities in Bophuthatswana are organized on a tribal basis and governed mostly by traditional leaders ie. Chiefs, Headmen and Tribal Authorities. It is virtually impossible for rural communities to benefit from BRWSP without co-operation from Tribal Authorities. All personnel involved in fieldwork are instructed to consult with chiefs and headmen about the activities concerned. DWA and Tribal Authorities must co-ordinate matters arising from the Execution phase through regular meetings.

Table 1 : Some Figures of the Programme

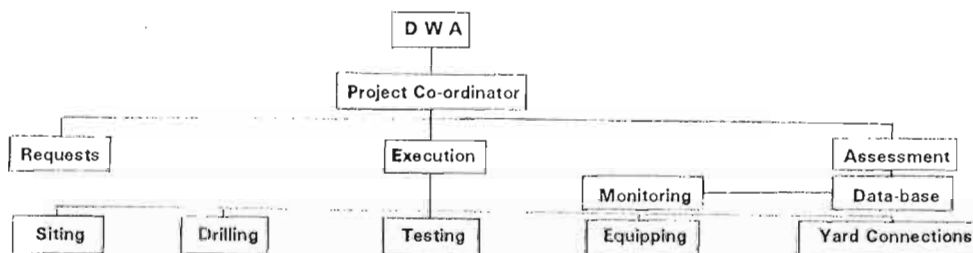
Phase	Financial year	Expenditure	Boreholes	People served	Feature
1	Aug 89 - March 90	\$2.64m (89/90)	508	22100	Privatization
2	April 90-March 91	\$6.54m (90/91)	332	110900	Co-ordination
3	April 91-March 92	\$8.18m (91/92)	516	132900	Sub-programmes
TOTAL		\$17.39m	1356	265900	

Note : * No reliable information available
Rate of exchange : US\$ 1,00 = SA Rand 2,80 (March 1992)

THE MANAGEMENT SYSTEM

Organisational Structure

The functional organisation chart of the programme is as follows:



The Execution Phase is handled by a consulting civil engineer, assisted by geohydrological consultants and DWA geohydrologists, seconded to the programme. Private contractors handle the drilling,

testpumping and equipping of boreholes, as well as installation of yard connections.

Logic Network

A system of flowcharts defines the workflow from receipt of a request, through to hand-over of a completed installation to the users. A standard water supply application form sets the whole process in motion. Various other standard forms and reports are utilized to facilitate workflow, authorization and information exchange. The overall flowchart is given in Figure 1.

Action Lists

The core of the whole management system is the Action List. The Action List summarises the logic network on a single page and traces the progress of all requests from request stage to hand-over. Actual completion dates are entered for those actions which have been completed and target dates for future actions are set in accordance with priorities. The Action List is a powerful scheduling tool and forms the basis of monthly works meetings where lists are updated and the work co-ordinated. Appendix A shows a typical action list.

Financial Control

From the Action Lists and monthly payment certificates, the following financial information may be derived:

- * Value of total work in hand
- * Actual expenditure to date, against budget.
- * Projected expenditure to the end of the financial year, against budget.
- * Unit costs for work performed.

The financial model also determines the required monthly production rates to completion, for drilling, testing and equipping, so that the average time between drilling and equipping of a borehole is minimized.

GROUNDWATER DATABASE

Upon completion of the work related to a particular request, all pertinent information is recorded in a locally developed computerized database. Borehole number, borehole construction details, pumping test results and equipment details are some of the items provided for in the database. The database programme can interact with CAD and GIS programmes to facilitate mapping and plotting.

Apart from borehole information generated as part of BRWSP, information concerning existing public and private boreholes is constantly being collected in a national borehole census. This information is also entered into the database to render a "complete picture" of groundwater in

Bophuthatswana. The use of Global Position System (GPS) receivers has greatly reduced the time and effort required to obtain accurate co-ordinates for boreholes.

EVALUATION

A programme of the magnitude of BRWSP generates a mass of information and statistics which has to be carefully processed and analyzed before any conclusions are to be drawn. Certain key parameters have been identified whereby the programme may be evaluated on an ongoing basis, as given in Table 2. Programme averages are given, but as can be expected from a region with varied geology and an erratic climate, variations around the averages are quite extreme in cases.

TABLE 2 KEY PARAMETERS

ITEM	UNIT	VALUE
Drilling		
Unit Cost	\$/m	25.71
Unit cost	\$/borehole	2316.50
Success rate	l/s 100m	1.47
Testing		
Unit cost	\$/borehole	1149.09
Equipping*		
Motor pump unit cost	\$/borehole	15312.14
Handpumps unit costs	\$/borehole	2027.14
Windmills unit cost	\$/borehole	9197.50
Solar pumps unit cost	\$/borehole	8675.36
Overall cost of water supply (1992)	\$/capita	61.78

***Note:** Cost of equipping includes storage tanks and limited reticulation systems.

Due to the relative uniqueness of BRWSP in Southern Africa, comparative evaluations are not possible, therefore these parameters can only be evaluated over time in order to establish trends, and to compare results between regions within Bophuthatswana.

AQUIFER MANAGEMENT

By the year 2000, at least 41.9% of the population in the country will rely on boreholes. Aquifer management based on the groundwater database must be implemented on a full scale. It is an independent programme which monitors the wellfields and individual boreholes, mostly resulting from BRWSP. Its scope covers three aspects:

- 1) Maintenance of boreholes
- 2) Regulation of pumpage and

3) Aquifer protection

Maintenance of boreholes is done by Bophuthatswana Water Supply Authority, a para-statal body under jurisdiction of DWA.

It is essential that the exploitation of wellfields be done on a sustainable basis. The most important wellfields in the country are in dolomitic compartments delineated by less permeable dykes. Most of the boreholes in weathered crystalline rocks yield less than one litre per second but they are vital to scattered rural communities. Because of their secondary aquifer nature, the production yield based on initial pumping tests is verified from time to time. Regulation of pumpage is implemented based on management recommendations formulated from the Assessment subprogramme.

To protect a groundwater resource while exploiting it, a comprehensive aquifer protection policy is being compiled. This includes: Wellfield Monitoring, Vulnerability Mapping and Delineation of Borehole Protection Zones.

CONCLUSIONS

The following conclusions can be drawn from the experience on BRWSP.

- * The development of groundwater resources in Bophuthatswana has successfully contributed to the alleviation of water supply problems in rural areas.
- * The implementation of a structural and disciplined management system for a programme of this magnitude is a necessary condition for the success of the programme, but such a system should not compromise on flexibility and speedy action.
- * Assessment is a vital action as a follow up to short term actions and as a tool for long term planning of water resources.

ACKNOWLEDGEMENT

We would like to express our gratitude to Mr T M Thlabane, the Minister of Water Affairs, for his great leadership behind the whole programme. The programme would not have developed to its current stage without input from Mr G Croucamp, the Secretary of Water Affairs. We are grateful to his encouragement and permission for this paper.

FURTHER READINGS

Xu, Y., Marais S, & McCaffrey L. (1991) A preliminary Discussion of Aquifer Protection Strategies for some areas in Bophuthatswana, Groundwater Quality and Pollution, ISBN-0-620-15829-8, Biennial Ground Water Convention, South Africa, 21-13 August 1991.

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FIGURE 1 : OVERALL PROJECT FLOWCHART

