The spring-box solution — choosing the right water-supply technology for Southern KwaZulu Natal
by Antony Lenehan

What is the quickest, most effective method of providing drought-stricken communities with a primary water supply? One W&S engineer's experience in South Africa throws into sharp relief the economic and practical contrast between installing handpumps on boreholes and protecting springs. Can the cheaper option really be better value?

SOUTHERN KWAZULU NATAL (SKZN), 5500km^2 of rugged land along South Africa's south-east coast, dominated by the valleys and gorges of several major rivers, is blessed with a high concentration of natural springs, on which people have traditionally relied for their water supply.

Antony Lenehan

A KwaZulu woman collects water from an unprotected spring.

The demography of the region is complex. While formal settlements are concentrated along the coastal strip, the hinterland is settled by underdeveloped rural communities in what was formerly the KwaZulu 'homeland'. These families, whose homes or *imizi* are scattered along ridge lines, are served by a limited infrastructure, and rely on subsistence agriculture.

Crisis

In early 1994, the whole of rural South Africa faced a water crisis after a prolonged drought. Reacting to overwhelming requests from communities nationwide, the Minister of Water Affairs, Professor Kadar Asmal, launched a special drought-relief programme in June 1994: the Crisis Intervention Programme (CIP).

Once the Department of Water Affairs and Forestry (DWAF) staff had assessed these appeals for help in the field, they made suitable recommendations. The programme proper, which began in November 1994 encompassed:

- machine-drilling conventional boreholes and installing handpumps;
- mending existing handpumps; and
- spring protection.

Constructing boreholes

Boreholes were drilled to depths of up to 100m at sites chosen by geo-hydrologists using ground magnetic and electromagnetic methods. As the area is dominated by complex geology with minimal hydrogeological mapping, the team was limited to areas of fractured hardrock and geological contacts.

The drilling was done using air percussion drilling rigs — heavy technologies that often experienced difficulty gaining access to the sites because of a combination of difficult terrain and lack of roads. In several cases, a bulldozer was necessary.

A borehole was judged to be successful when water was struck and the water discharge displaced by drilling (blow yield) was greater than 0.1 litres per second (l/s). Successful boreholes were tested to establish their sustainable yield, and then installed with positive displacement handpumps (piston pumps, whose rate of delivery is almost independent of lift). A total of 147 holes were drilled, 63 being successful. Unsuccessful holes were capped and abandoned.

Proper communication between agency staff and the community must be an integral part of any development project. During the CIP borehole construction, villagers' involvement was limited to confirming each site, a role which fell to the local *induna* (headman). He visited the proposed site, and was able to tell the DWAF team whether it was acceptable to the community. Failure to take his opinion into account could lead to compensation payments for ruining a beanfield, or upsetting the descendants of those whose graves had been disturbed.

More substantial community involvement was not possible because of the disparity between the technology of borehole construction and the capacity within the communities.

Antony Lenehan

Constructing lids for the 5000-litre capacity tanks.

Handpump maintenance

Approximately 300 existing handpumps were in need of some degree of rehabilitation. None was designed for VLOM (village level operation and

Antony Lenehan

Protection means purity.

maintenance), so all the work had to be carried out by a private contractor.

Most of these handpumps were in place before the start of the programme, but approximately 10 out of a total of the 63 installed during the programme were also soon in need of some maintenance. These handpumps were installed on particularly deep holes and so were subjected to high loads.

Spring protection

This technology involves the construction of a box around the spring outlet to collect the water which is piped to a storage tank (see Figure 1, below). People can then pour water from a tap connected to the tank. There are three fundamental objectives in protecting springs:

❒ to prevent pollution of the spring water by humans, animals, insects, and surface-water runoff;

❒ to increase the infiltration rate at the spring outlet; and

❒ to store overnight flow from the spring for use during the day.

Over the 16 months' duration of the CIP, seven contractors undertook 176 spring protections. Although their construction methodologies varied slightly, DWAF management ensured that the work met agreed standards.

Community involvement

The spring-protection construction was a labour-intensive effort, providing jobs for each community. Between 5 and 15 people — mainly women — were employed at each spring construction to transport materials which were supplied by the contractor, who was also responsible for supervising construction, and for training local workers on site.

The number of people given work depended on the proximity of the spring to the road. Only five or so —

Constructing a spring protection

The basics of a spring protection construction are shown in Figure 1 (right).

● ***Spring box*** The spring box collects water direct from the spring outlet, and protects it against damage and contamination. It is the most important component of the system, and the most difficult to construct properly. If the spring box does not enclose the spring outlet completely, allowing water to drain freely, there is a danger that the spring outlet will move elsewhere; this happened at two CIP spring protections. It is also important to locate and protect the spring's primary outlet, as some springs have a number of secondary outlets.

In SKZN, the spring boxes were either box or wall concrete construction depending on their location. Each was filled with locally available coarse to fine stone layers, graded material and covered with concrete, or plastic sheeting and earth backfill. Slotted pipes covered with geotextile material — permeable, non-biodegradable fabric such as plastic mesh — were placed in the spring boxes to collect the water. Access was provided by a manhole, so that blockages could be cleaned out.

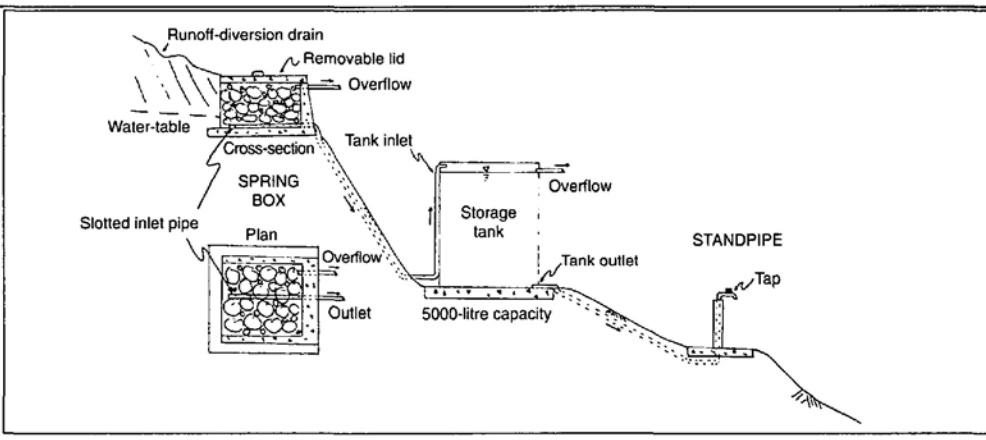


Figure 1. The components of the SKZN spring protection.

● ***Storage tank***

Each storage tank can store up to approximately 5000 litres of water. They were constructed from: ferro-cement around a reusable corrugated-iron mould; mortar rendering over a prefabricated plastic or fibreglass tank; or the traditional slab and wall concrete, using timber formwork. Again, covered manholes at the top of the tanks allow for cleaning and maintenance.

● ***Standpipe***

Standpipes were slotted inside 100mm-diameter PVC pipes filled with concrete to increase durability, and fitted with standard outdoor taps. The taps were positioned between 1m and 1.3m off the ground so that a 25l plastic container could be placed underneath with the minimum of water wastage. The standpipes were positioned on concrete slabs with drainage channels, to reduce pollution at the water-collection areas.

● ***Pipes***

Plastic pipes of 400mm in diameter were used for water collection, conveyance, and overflow. Valves were placed in the pipes so that components of the spring protection could be isolated for easier maintenance. Several contractors also installed silt traps upstream of the tanks.

Overflows were provided at the spring boxes and tanks to avoid a build-up of pressure at the spring outlet. They were directed to either the original watercourse, or into secondary water facilities, such as animal troughs or clothes-washing basins.

To reduce blockages and ensure efficient operation of the spring protection, CIP staff had to be careful to avoid points at which water lay stagnant. They did this by levelling inlets and outlets within the system accurately: the outlet of the spring box had to be at least half a metre above the inlet to the tank, and the bottom of the tank had to be higher than the outlet of the standpipe. In flatter areas, this called for longer sections of pipe.

usually men — were employed to dig trenches and excavate foundations. Wages — at the locally agreed rate for unskilled labour: R10 to R25 (between £1.50 and £3.50) per day — were paid in cash at the end of the week.

Not only did this instill within the community a sense of ownership of the final installation, it also ensured that, in the future, the community would not have to look outside for their maintenance needs.

Management and maintenance

The sustainability of spring-protection systems depends on good management. Latrines, cattle *kraals*, and other contamination sources must be excluded from at least 100m upstream of the spring source, while people must be discouraged from grazing cattle and washing clothes in the immediate vicinity. Native vegetation around the spring source must be maintained, but exotics, such as eucalyptus, must be uprooted so that nothing restricts the flow into the spring box. Since this has been explained to the communities in SKZN, some people have built fences around the spring box and appointed caretakers.

Yield sustainability

Communities were consulted about the sustainability of the springs in their area, particularly during the dry season. But there is still the risk of a spring drying up after an extended dry period. This risk is increased for a project such as the CIP, whose planning had to be done quickly, without the benefit of long-term observation of the spring yield.

Successful, properly tested boreholes should have adequate yield to sustain a handpump. In SKZN, however, there are fewer of these, and more sustainable springs. The problem of handpump maintenance outlined above is also a critical variable.

Truly appropriate

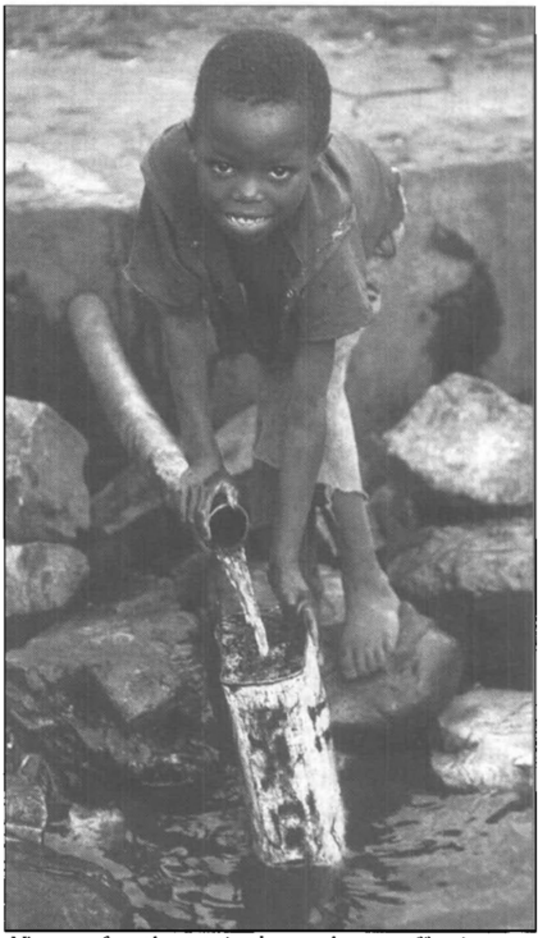
Properly executed spring protections were found to be highly favourable for primary water supply in SKZN's rural communities. This was largely because of the high concentration of strong springs in the region, and the low cost of installation and maintenance. Spring protection was also compatible with the level of development within rural communities. In contrast, handpumps were generally found to be less favourable because of their expense, combined with their unsuitability to the local geography and geology, and because they present most problems to communities at the existing level of development.

References

1. CSIR, 'Guidelines on the Cost Effectiveness of Rural Water Supply and Sanitation Projects', Division of Water Technology, Water Research Commission, Pretoria, 1991.

2. UNHCR, *Water Manual for Refugee Situations*, United Nations, Geneva, 1992.

Antony Lenehan is Senior Engineer, Community Water Supply and Sanitation, Department of Water Affairs and Forestry (DWAF), PO Box 39952, Ramsgate 4285, South Africa. Fax: +27 3931 73329. E-mail: alenehan@ilink.nis.za



Heldur Netocny/Panos Pictures

Victory for the springbox: cheap, effective, and sustainable — if well-managed.

Handpumps or spring protection? How they compared in Southern KwaZulu Natal's Crisis Intervention Programme

• *Costs*

For the CIP, spring protection provded to be a significantly cheaper option than handpump installation on boreholes. The average, initial total cost of a spring protection was R7800 (£1200), compared with the R34 000 (£5230) cost for installing a handpump on a borehole — taking into account the money wasted on unsuccessful drilling. Assuming a supply of 10l/person/day, the average unit cost of spring protection was R20/person, less than a fifth of the average unit cost of R110/person for handpumps on boreholes.

• *Maintenance*

Spring protection also was cheaper to maintain. The average amount spent by the CIP on maintaining one handpump was R1000 (£154), with each pump requiring some attention once or twice every year. In sharp contrast, a well-constructed spring protection can be maintained — within the community — at minimal or no cost.

• *Community involvement*

The experience of the CIP illustrates how the construction of spring-protection systems can raise capacity within communities with respect to development issues in general, and water development specifically. An increased skills-base results in community empowerment, as local people operate and maintain their own water supply.

Not all communities welcomed spring protection with open arms. Villagers in some areas preferred handpumps, as they believed these installations could be located closer to the centre of their community; a preference which was not always feasible, because of geological factors. Other communities rejected the option outright because they had higher expectations of service.

As handpump installation and maintenance required technological capacity not generally available within the communities, it was not possible to utiliize local labour, and the transfer of skills to villagers was minimal. Less capacity was developed, therefore, within the communities to ensure the sustainability of these installations and any other future water development.