



## Reconstruction in Sierra Leone

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AFTER A CIVIL war lasting five years, the democratically elected Sierra Leone government signed a peace treaty with the rebel faction in November 1996 and the country intensified the reconstruction of its infrastructure.

This paper describes the aims, the existing situation, the various stages and the main conclusions of the World Bank financed Master Plan study for the water supply of the three provincial capitals (Bo, Kenema and Makeni). The study was undertaken by Howard Humphreys (HH) as lead consultant, in association with Dutch consultant IWACO, and local consultants ENGCON and Techsult.

### Aims of the study

In October 1995, whilst the civil war was still severely restricting activities outside Freetown, the capital city, Brown and Root Consulting Arm, Howard Humphreys (HH) were commissioned by the Department of Energy and Power, on behalf of the Sierra Leone Water Company, to carry out a Master Plan study. Its aim is to provide a flexible staged development framework to the year 2020 for the water supply to the three towns. From the Master Plan, the first phase works will be determined to satisfy the needs in 2005. A parallel study by management consultants, also financed by the World Bank, considers the institutional and financial aspects of the Sierra Leone Water Company, with a particular emphasis on sustainability.

### Existing situation

Bo, Kenema and Makeni are situated inland between 180km and 300km east of Freetown (Figure 1). All three

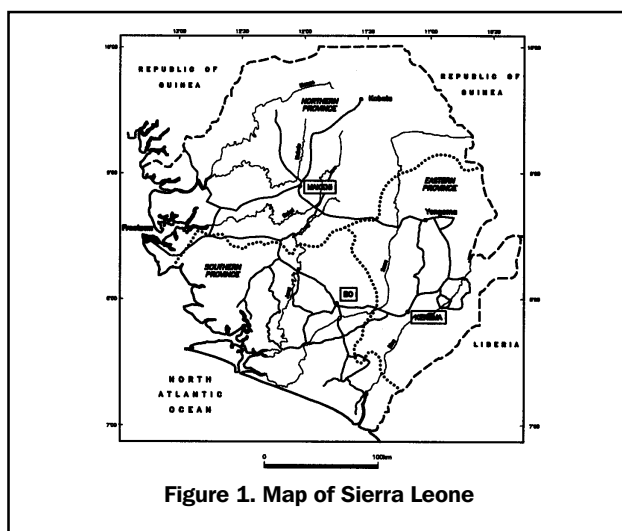


Figure 1. Map of Sierra Leone

towns have a piped water supply infrastructure but experience an acute water shortage for a number of reasons:

- population explosion: due to the insecurity in the countryside, large numbers of displaced persons moved into the towns;
- poor maintenance: the existing systems suffered from years of under-investment;
- shortages in the power supply leading to lengthy interruptions of the system.

As a result, current per capita consumption for most of the population in the three towns has been estimated at a bare minimum of 10 to 15 litres per day, out of which water supplied from the distribution system forms only a small proportion. None of the towns has a waterborne sanitation system.

### Bo

Bo is the second largest town of Sierra Leone and the capital of the Southern Province. In 1996, the population was estimated at 245,000 out of which 158,000 were persons displaced by the hostilities. The only industry is baby food manufacturing. Water supply is obtained mainly from two sources: the public water system and private water wells. The first public water system was constructed in the 1950's with an intake on the Sewa River 10km south of the town. Treatment works with flocculation, sedimentation, filtration and disinfection were built close to the intake, with an output of 2,700m<sup>3</sup>/d. In the early 1980's the original system was augmented by the construction of a new intake, treatment works and transmission mains to deliver 8,600m<sup>3</sup>/d into supply. The original treatment works were abandoned and are now beyond rehabilitation. The current system suffers from lack of maintenance and cannot deliver the design output. The main problem in Bo is linked to failures of the electrical and mechanical equipment. When both duty and standby intake pumps broke down in 1996, no water was distributed in the town for several weeks. Consequently, the population became more and more reliant on shallow wells. The capacity of the wells decreases in the dry season, many dry out completely at the end of the dry season.

### Kenema

Kenema is the provincial capital of the Eastern Province. In 1996, the estimated population was 196,000 of which 114,000 were persons displaced by the hostilities. Kenema is the centre of the diamond trade and agricultural produc-



Photo 1. Kenema – filter beds

tion of coffee, cocoa, palm oil and other cash crops. Since forest industries ceased to operate, there are no industrial activities in Kenema. The first public water supply system was installed in the 1950's based on gravity supply from two intakes in the nearby Kambui Hills. In the early 1980's the supply was augmented by a pumped supply from the Moa River, 8km south of the town. The treatment plant had a capacity of 11,000 m<sup>3</sup>/d. The works were operational for only six months due to electrical problems and lack of spare parts. The works were abandoned, became derelict and served as an army base during the war. The intake, clarifiers, filters, buildings and some of the pumps and pipework are still in place but in extremely poor state of repair.

Currently, the gravity system provides the only pipe borne water supply. It can satisfy less than 10 per cent of the needs of the existing population who now relies mainly on shallow dug wells. On the gravity system, lack of spare parts has led to emergency repairs using inappropriate materials, for instance, it is not uncommon to see leaking joints held together by plastic bags. The water receives no treatment before entering the system.

### Makeni

Makeni is the provincial capital of the Northern Region. In 1996, the population was estimated at 104,000 out of which 39,000 were displaced. There are few commercial

and industrial activities in Makeni, the main industry being tobacco. The first public supply was constructed in the 1950's for a population of 15,000. An intake was constructed on the Mabole River 9km away from the town. Water was pumped to a small impoundment (8000 m<sup>3</sup>) on the Wusum Hill from where water could gravitate to the treatment works further down the hillside. The impoundment also acted as sedimentation tank upstream of the treatment works. During the rainy season, the impoundment captures the waters from the Wusum stream, which significantly reduces the need for pumping. It is grossly insufficient during the dry season. In the 1980's the original intake and treatment works were augmented by a new system capable of delivering 9,600 m<sup>3</sup>/d. However, shortages of fuel mean that in the dry season, the intake works are operated for only a few hours every two or three days. Supply to the town is insufficient and the population now relies mainly on shallow wells which tend to dry up in the dry season.

### Stages of the study

HH as lead consultant with overall responsibility for the study provided the team leader and water treatment, hydraulic, water supply and mechanical/electrical specialists. IWACO provided the water resources, socio-economic (including water demand) and environmental specialists. Local knowledge, which is essential for such a study, came from its local consultants who provided counterpart socio-economist, hydrologist, environmentalist and mechanical/electrical engineer as well as surveyors and technicians and logistical support.

Due to the prevailing security situation, the planned study approach and programme were completely revised in consultation with the client. The socio-economists visited two out of the three towns in January 1996 to carry out a survey on water use and willingness and ability to pay. The water resources specialist carried out a comprehensive desk study based on documentation collected in Freetown and world-wide. In May 96, a second attempt was made to visit all three towns. This was successful. Unfortunately, access was still not possible outside the towns. This became possible only after signature of the peace treaty. A third visit took place in February and March 1997.

Close cooperation with the client was involved at all stages, both at headquarters and in the towns. Town maps have not been updated for many years and there are no physical development plans, nor are any being prepared. Development is therefore uncontrolled. One of the first exercises therefore was to produce town maps, albeit crude ones, to indicate the current extent of development and identify those areas which could accommodate future expansion of the towns.

The following documents have been prepared: an Inception Report after the January 96 visit, a draft Water Resources Desk Study in July 96, a Draft Water Supply Master Plan in November 96. Draft bid documents for

drilling to investigate underground water resources and draft bid documents for the first stage works are in preparation.

**Water resources**

Bo is situated on a watershed. The nearest hills are 10km away and with small catchments. Possibilities for gravity fed supply are limited. Various projects started before the war indicated the presence of groundwater near Bo, however the yields were low. The study led to the conclusion that the main reliable water source for Bo is the Sewa River. The Sewa is exploited for gold using traditional panning methods as well as large scale sand excavation by dredging. As a consequence, the river can become heavily silt laden.

In Kenema, a number of spring based sources have been identified in the past. However, this potential supply is limited, especially in the dry season. It is also fragile due to the increasing deforestation of the Kambui Hills. Kenema is situated in a hard rock region. Most aquifer systems are discontinuous with groundwater occurring in the weathered and locally fractured zones of hard rock. The potential for groundwater based supply sufficient for the town is remote. The only reliable supply for Kenema is the Moa River. However with upstream mining activities, the river water contains a high concentration of suspended solids.

Makeni is surrounded by bare rocky hills with high run-off during the rainy season but no run-off during the dry season. Little is known of the groundwater resources but the geology does not appear favourable for sufficient supply to the town. The only reliable source of water supply is the Mabole River.

**Required water production**

Estimating the future demand requires estimates of the population at the various horizons. In all three towns normal population growth was disrupted by an influx of displaced persons. The number of those displaced who intended to remain in the towns after the end of hostilities was estimated from comprehensive surveys by the socio-economists and from discussions with the relevant ministries, with United Nations representatives and with various non-governmental organisations. A sensitivity analysis was carried out to understand the impact of various percentages of people returning to their villages on the estimated population in 2005. Currently, it is anticipated that approximately 30 per cent of the displaced population will not return to their villages. The design of the first stage works is based on this assumption.

There are no domestic meters in any of the towns, and none of the meters at the treatment works or from the storage reservoirs work. As a result there are no historic data on which to base demands. For the purpose of the Master Plan, water demand had been based on the following assumed domestic consumption figures:

|           |          |
|-----------|----------|
| Standpipe | 20 l.c.d |
|-----------|----------|

|                  |           |
|------------------|-----------|
| Single yard tap  | 45 l.c.d  |
| House connection | 120 l.c.d |

An allowance of 10 per cent of the domestic requirements has been taken for non-domestic consumption.

The existing systems have not been fully pressurised for years. Some sections have not received water for decades. It is anticipated that the first commissioning of the systems will show areas with leakages higher than anticipated. For the purposes of the Master Plan, un-accounted for water has been taken at 30 per cent in 2005, falling to 25 per cent in 2020.

The estimate of water requirements is as follows:

|        | 2005        | 2020        |
|--------|-------------|-------------|
| Bo     | 10,700 m3/d | 22,700 m3/d |
| Kenema | 8,600 m3/d  | 17,000 m3/d |
| Makeni | 7,200 m3/d  | 12,500 m3/d |

**Conclusions**

**General**

The main conclusion of the study was that all three towns are already provided with a basic infrastructure comprising intakes, treatment works, transmission mains, reservoirs and distribution mains. In each case, the current source of water is the most reliable source and the infrastructure is almost sufficient to satisfy the needs of the population at 2005.

**First stage works (2005)**

The first stage works aim at rehabilitating this infrastructure and as much as possible simplifying the process. For instance, in two of the three towns, the existing service reservoirs float on the distribution system and receive water only when direct demand on the system allows. This arrangement will be modified so that the transmission systems feed only the reservoirs and the distribution systems will be fed by gravity from the reservoirs. In all the towns, new reservoirs are required to bring storage up to 12 hours.

Use of slow sand filtration has been investigated as an alternative treatment, however the quality of the raw water is poor with high suspended solids (mining activities upstream), thus requiring construction of pre-settlement facilities.

It will be important that suitable training be provided to staff at all levels of the Sierra Leone Water Company. This aspect is being investigated by the management consultants.

**Environmental impacts**

In all three towns, one negative impact of the works will be on sanitation. Currently the population relies on pit latrines, septic tanks and on the storm drainage system to dispose of waste water. It has been often observed that with increased reliability of the water supply, flush toilets are

installed in houses and the existing systems are no longer able to cope with increased water quantity. Mitigation measures will be required in the long run. In the immediate, it is recommended that cleaning of the existing storm drains should be carried out regularly: currently, many are blocked by material washed off the unsurfaced roads.

In Kenema, the impact of diverting streams into the distribution system was examined in detail. To the east of Kenema, one village relies completely on water from one of the streams to be diverted. It is proposed that compensation will be provided by an extension of the distribution network. Of main concern was the possible negative impact on bio-diversity downstream of the hill catchments. After a detailed site visit it was concluded that the problem would not be acute as anticipated as the impounded catchment forms only a small proportion of the overall catchment of the streams.

In Kenema, deforestation on a large scale happened on the Kambui hills during the war, for firewood, agriculture and security reasons. At the current rate the hill-dams catchments could be affected within a few years, thus endangering the gravity supply to the town. The Forestry Commission is well aware of this problem and has embarked on a reforestation programme.

In Makeni, the treatment works are situated at the edge of the town. Until now, it appears that the sludge from the treatment works has been disposed of in a stream crossing

the town. The stream is used for washing and bathing. New disposal areas will be selected.

### **Immediate works**

Although outside the scope of the study, an investigation was carried out of immediate works which would allow regular water supply, even if insufficient, until implementation of the first stage works. A shopping list was prepared which included items such as a new intake pump and a diesel generator for Bo, new ductile iron pipes, and a large number of fittings such as joints. Toolkits and portable water testing kits were included, as well as basic tools such as shovels and screwdrivers. It was proposed that technical assistance be offered at the time of installing the newly purchased equipment. The technical assistance would be one person spending one month in each town to carry out an overhaul of electrical and mechanical equipment as well as on the job training. A source of finance for the immediate works is still being actively pursued. However due to the problems currently faced by Sierra Leone, it is unclear when implementation will start.

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