

## EXECUTIVE SUMMARY

- This project report describes the **hydrogeological conditions** observed in the Yumbe/Bidibidi and Rhino Camp project areas where refugees are being resettled.
- The assignment includes logging and data collection on inventories of existing and new **boreholes** in both project areas for a new UNHCR database and on other water sources being used to supply the refugee camps. The project further includes information on siting, drilling, and test pumping operations and an analysis of the hydrogeological information collected.
- The study has established that **bedrock geology** in the two project areas consists of Precambrian metamorphic rocks, primarily banded gneisses.
- The study finds that **deep groundwater resources** (aquifers) occur in **Bidibidi** predominantly in two zones: 1. The lower regolith and upper weathered basement; 2. Joint/fracture/eroded crevice systems within the fresh bedrock.
- The study finds that **deep groundwater resources** occur within the **Rhino Camp** project area predominantly in three zones: 1. The lower regolith and upper weathered basement; 2. Joint/fracture/eroded crevice systems within the fresh bedrock; 3. Alluvial sand layers within thicker surficial formations closer to the River Nile.
- Hydrogeological field investigations in both project areas have established that an **adequate groundwater resource exists** to supply the refugee settlements, provided that the resource is properly managed.
- This study shows the **success indicator for high yielding boreholes** in this area is that they are located on drainage lines that follow or intersect lineaments representing significant basement fractures. No strong indications have yet been found for a correlation between high yielding boreholes with a specific drilled depth or range of depths.
- The survey has established that **existing water supplies** from all available sources still fall short of refugee settlements requirements in both project areas.
- In Rhino Camp the short term main priority should be to **drill more high yielding boreholes** to increase the water supply. In Bidibidi already a significant number of potentially high yielding boreholes have been drilled but **need to be equipped urgently** with motor pumps of sufficient capacity to actually supply the water. In Bidibidi this already could triple the daily water supply even without drilling any new boreholes.
- The current daily water supply in Bidibidi is calculated to be on average 9 litres per person per day (assuming a population number of 250,000). This could be increased to **>30 litres per person per day** if all existing boreholes were equipped appropriately. In Rhino Camp the daily water supply could not be identified from the limited amount of reliable information provided and collected.
- The study finds that the water supply provided by low-yield boreholes with handpumps can never be sufficient as a water supply. More **high-yielding boreholes** equipped with motor pumps are required. An inventory of the water supply in Bidibidi shows that in the current situation as many as 30 boreholes with handpumps provide the same amount of water as 1 borehole with an electric submersible pump.
- From the results of this study **sites favourable to the siting of new high-yield boreholes** have been suggested for both Bidibidi and Rhino Camp.

- A simplified regional water balance suggests that the overall increased water abstraction due to the refugee population in Bidibidi and Rhino Camp is unlikely to have a major negative impact on the regional water balance. However, **groundwater can become locally depleted, even in an overall sustainable context**. Monitoring and evaluation of groundwater levels and abstraction rates are the only way to anticipate this.
- To evaluate the long-term sustainability of the groundwater exploitation and to avoid unanticipated drying up of boreholes due to over-pumping, **monitoring of groundwater levels and pumping rates** is urgently required. This demands the construction of secured openings in existing high yielding boreholes to access the water, the installation of a piezometer and a flow meter in all new high-yielding boreholes, and the start of manual or automatic monitoring. During this study it just proved possible to initiate this. Extended monitoring in both Bidibidi and Rhino Camp is required.
- The study has found that most NGO partners engaged in siting, drilling, testing, and recording of boreholes in the two project areas have not been carrying out their work in an entirely professional manner. This has caused **errors, limitations, confusion, and delays in the construction and exploiting of boreholes**. Attempts have been made to correct these short-comings through meetings, field guidance, requests for advice, and information dissemination.
- There is a **critical lack of qualified and experienced staff in the field** at most NGO partners and at UNHCR to adequately manage and supervise the siting, drilling, testing, and recording of boreholes. Better supervision may have improved the yield of many boreholes, and will do in the future.
- Drilling contractors need to be more financially incentivized in their **drilling contracts** to increase the yield of a borehole (ie. by deeper drilling or longer development of a borehole). The end result of the current type of contract specifications is inadequate development times for boreholes and a preponderance of relatively shallow low-yield holes suitable only for hand-pumps: drillers have no incentive to drill deeper into hard basement in which more productive fracture aquifers may occur.
- The survey has found that borehole **water quality** within the projects areas is generally good, but with occasional verbal reports from users of an iron-like taste. Some boreholes with hand-pumps have been reported to periodically run dry.
- **Faecal contamination** of water by human and animal excrement is considered a significant health risk and requires the highest attention. In several sites in Bidibidi and Rhino Camp used open pit latrines or livestock have been observed too close to boreholes. Also defecating into streams occurs, which constitutes a high risk of faecal coliform pollution for water lower down the same drainage and for nearby boreholes. These cases have been reported immediately.
- **Maintenance and repair** is crucial to guarantee a long-term sustainable water supply for Bidibidi and Rhino Camp. Clearer agreements must be made between UNHCR, NGO partners, and the local authorities (DWO) about who is responsible for maintenance and repair of the borehole and how this is carried out in practice.