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# GROUND WATER MONITORING SYSTEM

# CYBERNAPTICS LTD

# EVALUATION OF TECHNICAL AND FINANCIAL REPORTS (FINAL)

**To**

**AFRINIC Ltd.**

**Patricia SENGHOR – Cooperation & Project Development Manager**

**By**

**SANVI & Co.**

**Kenneth SANVI, PMP – Consultant in International Development**

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# EXECUTIVE SUMMARY

## *I. CONTEXT AND DESCRIPTION*

FIRE is a Grant and Awards program designed by AFRINIC in order to support and encourage the development of solutions to information and communication needs in the Africa Region. It places particular emphasis on the role of the Internet in the social and economic development for the benefit of the African community.

Launched in May 2012, the program is partly funded by two donors: IDRC and SIDA International Development Agencies. In 2013, AFRINIC selected eleven grant recipients which received 10 000 USD each for their project.

The grantees are bound by several obligations, which are among other things:

- Implementation and use of the project funds solely to perform the objectives and activities of their project
- Use the funds in accordance with the budget set out in their application
- Submission of an Interim and a Final Report in accordance with AFRINIC's report guidelines outlined in the Memorandum of Grant Conditions.

## *II. PURPOSE AND EXPECTED USE*

AFRINIC required this evaluation in order to confirm that the project is run in accordance with the following criteria:

- Quality and reliance of design
- Effectiveness
- Efficiency of implementation
- Impact and potential of sustainability
- Replicability

AFRINIC also requires this evaluation to be run on the basis of the Interim and Financial Reports sent by the project in accordance with their obligations.

## *III. OBJECTIVES*

AFRINIC requires this evaluation to ensure of the following:

- The project meets identified objectives;
- Enhance the Design and the implementation of FIRE programme;
- Demonstrate and Improve the impact of the various projects on the local community;
- Develop recommendations to improve the implementation and the monitoring of future projects;
- Ensure that funds allocated to the various projects are used efficiently and within the initial identified scope.

## *IV. FINDINGS AND CONCLUSIONS*

The aim of this project was to build a proof of concept for a low cost underground water monitoring system. Project team collaborated with specialists in the area of research to carry out successfully the mission. Despite few set backs and difficulties locating viable suppliers and components, project team has demonstrated the feasibility of such system as a viable candidate for mass deployment in developing countries. Although the main goal was achieved, we would like to point out that project team did not provide sufficient insight on the collected data analysis process so as to clearly evaluate the quality of results. Moreover, the report fails to provide information regarding data archiving and leaves us to infer that said process was part of the strategy and implemented during the course of the project. Furthermore, discrepancies were identified in the financial report, which ought to be addressed by project team.

## *V. KEY RECOMMENDATIONS*

We would recommend that as part of implementation strategy, project team ensures to clearly articulate results analysis process. This will ensure that proper evaluation of the result is done and ensure that the quality of results is acceptable. Furthermore, it is important that data archiving mechanisms are put in place and documented.

# THE EVALUATION

## 1. BACKGROUND INFORMATION

### *1.1. PURPOSE*

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- Ensure that funds allocated to the various projects are used efficiently and within the initial identified scope.

This evaluation is also required by AFRINIC in order to help the project in its implementation in accordance with the Memorandum of Grant Conditions.

### *1.2. AUDIENCE AND USE*

The stakeholders who will make use of the evaluation reports are:

1. FIRE programme – AFRINIC
2. International Development Research Center (IDRC)

3. Swedish International Development Agency (SIDA)
4. The grantees
5. Prospective applicants to FIRE program

### *1.3. OBJECTIVES*

AFRINIC requires this evaluation to ensure of the following:

- The project meets identified objectives;
- Enhance the Design and the implementation of FIRE programme;
- Demonstrate and Improve the impact of the various projects on the local community;
- Develop recommendations to improve the implementation and the monitoring of future projects;
- Ensure that funds allocated to the various projects are used efficiently and within the initial identified scope.

### *1.4. METHODOLOGY*

The evaluation methodology is linked with the objectives, the evaluation questions and the type of evaluation.

| **Evaluation criteria** | **Key Results Areas** | **Evaluation questions** | **Data sources** |
|---|---|---|---|
| **Design** | Assess the extent to which the project responds to priority issues and identified objectives. | • Are the project objectives still valid?<br>• Has the project team put in place the appropriate strategies?<br>• Are there major risks that have not been taken into account? | • Design documentation.<br>• Project objectives.<br>• Interim and final technical reports. |
| **Effectiveness** | Assess the project major key results. | • Are the obtained results aligned with planed | • Interim and final technical reports. |

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|---|---|---|---|
| | | objectives?<br>• Are the results in acceptable both in terms of the quantity and their quality? | • Project management plan.<br>• Result monitoring report. |
| **Efficiency** | Assess the extent to which:<br>- Project plan has been followed;<br>- Project reports are up to date. | • To which percentage has project plan been achieved to date?<br>• Are expenses aligned with established budget?<br>• Have data collected archived for future use? | • Project management plan.<br>• Monitoring and control reports.<br>• Financial reports.<br>• Interim and final technical reports. |
| **Impact** | Assess to which extent the project will have a long-term positive impact on local community. | To which extent has the project's general objectives and final goals been achieved? | • Project objectives<br>• Interim and final technical reports.<br>• FIRE programme objectives |
| **Sustainability** | Assess to which extent the project has been socially and politically adopted by the local community. | • Will the project contribute to long-term benefits?<br>• Would the long-term benefits be materialized by the implementation of an organization?<br>• What are the costs implications for scaling up impact?<br>• Are there savings that could be made without compromising delivery? | • Project benefits report.<br>• Project cost report.<br>• Project monitoring report. |

### *1.5. TEAM*

**M. Kenneth SANVI, PMP**, is a Canadian Consultant in International Development, specialized in all areas of project management. M. SANVI is a seasoned expert with many audits and evaluations projects in several countries in Africa. He is also a trainer in many areas among which, monitoring and evaluation.

**Ms. Rebecca GIDEON, CISA** will perform the evaluation of Information Technology aspects of the reports. Ms. Gideon is an experienced Information Technology professional with over seven years of diversified experience.

## 2. THE PROJECT

### *2.1. CONTEXT*

Ground water is a vital natural resource, which requires careful monitoring and management for sustainable development. This applies equally to both developed and developing countries alike. Recent studies in the SADC region (IGRAC, 2013) have shown that at least 70% of the population in the member countries relies on ground water. However, while developed countries have implemented extensive monitoring systems to manage their underground water resources effectively, this still remain a challenge in the case of many developing countries (Hansen, 2011). Furthermore, ground water is a renewable resource whereby the aquifer (underground water reservoir) gets replenished from rainwater percolating through the soil and rocks. For sustainable development, the rate of extraction should not exceed the rate of replenishment, which would, otherwise, lead to over abstraction of underground water. Over abstraction can lead to various kinds of environmental problems such as drying up of surrounding rivers and springs and subsidence (K. M. Hiscock, 2002).

The purpose of this project is to develop a low cost underground water monitoring system that can be readily deployed anywhere with relative ease. This would make it a viable candidate for mass deployment in developing countries. One of the key aspects of the project is that the measurements of ground water level is relayed to a web server by a telemetry system running over the GPRS network. The cellular network is the most pervasive telecommunication network in Africa and, by using the lowest bandwidth GPRS over GSM or 3G, the project team ensured universal connectivity across a wide range of signal quality. By using readily available components and open source software, we have aimed to reduce costs even further. The scope of the project is limited to the development of a proof of concept and, therefore, a large component of the cost went towards the research and development linked to the project.

### *2.2. UNDERLYNG RATIONALE*

The objectives of the project are listed below:

1. Data Collection Unit (DCU)

The data collection unit will consist of the ground water level sensor, analogue/digital signal conversion, data storage and processing device and data transmission device using the cellular network. The DCU will also include the solar panels, charger and batteries for power the devices.

2. The Data Collection Server (DCS)

The data collection server will consist of a rugged industrial rack mounted Linux or FreeBSD server that will collect all the data from the DCU into a central database. It will compile the data into reports and present them to monitoring staff via an Internet based web server.

## *2.3. STAKEHOLDERS AND BENEFICIARIES*

### 2.3.1. Stakeholders

a. FIRE programme – AFRINIC

b. International Development Research Center (IDRC)

c. Swedish International Development Agency (SIDA)

d. The grantees

e. Prospective applicants to FIRE program

f. Government

g. Farming community

h. Industry

i. Private Individuals

### 2.3.2. Users & Beneficiaries

a. Government

The department in charge of water resource management will find this solution extremely useful to monitor their reserves, usage and replenishment of underground water. Its low cost and design for remote and isolated locations make it a good candidate for mass deployment.

b. Farming community

The farming industry is a major user of underground water for irrigation and animal husbandry. They will find our monitoring solution very useful to monitor their reserves from their own borehole.

c. Industry

Several industries like beverage, food processing, manufacturing etc. relies on bore holes. Therefore, they too will find a monitoring tool very useful.

d. Private Individuals

In some countries where the national water distribution network is not well developed or reliable, individuals resort to their own private boreholes. The system should be useful to them too.

## *2.4. CONCEPTUAL MODEL*

### 2.4.1. Resources and activities

The project lead by Cybernaptics Ltd. has been developed in association with Water Research Ltd.

Project team projects to hold below activities:

a. Selection of bore hole, site preparation and general advice on the project.
b. Installation and Calibration of probe
c. Installation and testing of telemetry device
d. Data streaming control software
e. Securing the electronics components in an IP65 enclosure and tidying all cables and power supply.
f. Stabilising the power supply with a UPS
g. Development of a web site to collect and display the ground water level data
h. Data Collection
i. Installation of solar powered energy source and modification of device electronics to function on same

### 2.4.2. Expected results

Expected results from this project are listed below:

a. Bore hole selection and site preparation
b. Water level probe calibration
c. Telemetry Activation
d. Data Streaming Control software

e. Securing Equipment

f. Web site creation

g. Historical Data

h. Switching to Solar Power

### *2.5. RESULT CHAIN AND LOGICAL FRAMEWORK*

To implement this project, the team collaborated with Water Research Ltd, which specializes in borehole drilling and maintenance. The initial milestone consisted in the selection of boreholes, and the preparation of sites. Following that measuring probes and various equipment were acquired, calibrated and installed successfully. To facilitate the monitoring and data collection process, software was developed and deployed successfully as well as a website to display results.

### *2.6. PROJECT MONITORING SYSTEM*

A key milestone of this project was the successful development of a Data Streaming Control software. This software enabled the team to remotely collect data for analysis. To minimize communication cost, the software makes use of UDP protocol, which efficiently minimizes transmission overhead. Collected data are transmitted to a central station and displayed on a website thus making it easy for users to visualise and interact with the monitoring system.

### *2.7. EVALUATION FINDINGS*

#### 2.7.1. DESIGN

- Valid objectives

The project objectives remain valid. As highlighted by the team, the successful use of low cost hardware and open source software to implement a monitoring system of ground water was clearly demonstrated.

- Appropriate strategies

The project team worked in collaboration with Water Research and this allowed them to draw on their pool of labour for the site installation works and calibration. From the concept paper and initial objective, the team had to research the most cost effective and, yet, the most appropriate design to solve the problem. The design work cut across various disciplines such as electronic and software engineering and underground water drilling and management. The skills acquired on this project will certainly be of value for similar projects that may be undertaken by the company in the future.

When we refer to all the information above, it appears that there was a well-planed strategy initiated by the project team.

- Major risks not accounted for

Procurement was challenging on the project for the following reasons:

a. Lead time: Most of the parts are ordered from Europe, US and Asia (Hong Kong and China) which are all far from Mauritius leading to long lead time.

b. Experimental nature of the project: Being a new and experimental project, most of the parts and equipment were being purchased for the first time. Therefore, there was no history of suppliers' reliability or even the reliability of their parts. Sometimes, due to wrong decision on design we had to back track and reorder different parts hence delaying the project.

In addition, power consumption remains problematic due to the demanding aspect of data transmission activity and in most countries in Africa, power supply remains a challenge.

### 2.7.2. EFFECTIVENESS

- Results aligned with planed objectives

Results are aligned with the planed objectives. Project team has been able to demonstrate that low cost equipment and an open source development could be used to implement an efficient monitoring system for ground water level.

- Results acceptability

As mentioned in the report, the proof of concept has successfully established the key functionalities the project team set out to demonstrate at the project onset. Nevertheless, the team did not provide sufficient insight on the collected data analysis process so as to clearly evaluate the quality of results.

### 2.7.3. EFFICIENCY OF PLANNING AND IMPLEMENTATION

- Percentage of achieved project plan

Based on final report submitted, all activities of project plan have been fully executed with the exception of the acquisition of a solar cells charger and battery. Various trials were conducted with different suppliers and project team is confident to have identified the right components.

- Expenses aligned with budget

We wish to point out some discrepancies in the reporting of financial expenses. Based on the financial report, the total expenditure of the project is **Rs 771,485** while the approved grant is **Rs 320,000**. Expenditure is thus over twice the budget. The report shows a variance of **Rs 103,985** on salaries and equipment cost which does not add up to the total expenditure reported.

- Archive of collected data

The project has been conceived on the monitoring of data collected. Based on the report and as highlighted, there have been many monitoring activities and we can infer that many data were collected. A website was deployed to facilitate the monitoring of the system. Nonetheless, the report failed to provide information regarding the archiving process of data.

### 2.7.3. IMPACT

- General objectives and final goals achieved

The impact of the ground water monitoring project is best described in terms of impact areas:

a. Development Impact

Water is an essential resource for any government. Therefore, good management practices of that resource is critical for development. Monitoring of ground water is therefore, bound to become more and more integrated to the overall water resource management policy of developing countries. We are therefore confident that our solution will be able to attract the attention of governments, development agencies and other organisations directly or indirectly linked to water resource management.

b. Social Impact

Boreholes are, very often, the only source of water for domestic and agricultural usage in rural areas. Therefore, we expect our solution to be of practical importance to those communities in helping them to better manage their water resources. Hence the social impact of our project will help to create a need for it and, hence, ensures its sustainability.

c. Economic impact

Various sectors of the economy such as agriculture, manufacturing, hospitality and food industry are dependent on a regular supply of potable water. In many cases, this water comes from underground. These stakeholders may have a direct interest to install and use their own monitoring system and our solution may provide them with an affordable alternative.

- Long-term benefits contribution

Although the initial cost of the project itself is relatively high, one has to remember that most of that cost got sunk into the research and development effort that went into designing the solution. Scaling up the proof of concept from a prototype status to a fully commercial solution should result in bringing down the cost significantly.

The sustainability of the project is ensured by the fact that the project fulfils a very basic and critical function, which is ground water resource monitoring. The project team has increased its sustainability even further by taking the following considerations into account:

- Cost:

The project has been implemented using readily available and low cost components and using open source software throughout the project.

- Ruggedness:

The whole installation is mounted in an IP65 Weather-Proof enclosure to prevent water and insect ingress, tampering and vandalism.

- Use of cellular network:

The cellular network is the most pervasive telecommunication network in Africa (Mbiti, 2010). Therefore, rather than adding radio transmission capabilities for telemetry, we have preferred to use the GPRS/GSM network instead. Therefore, this has allowed us to keep costs down while ensuring an almost universal deployment foot-print in most countries. However, it is true that if there is no cellular network coverage, the telemetry functionality will not work.

- Off grid functionality:

Although the current prototype is still dependent on the electricity mains, the final design will allow the system to power itself from a 12V DC battery supply, which will be continuously recharged via solar panels.

There is an important aspect of replicability in this project. In effect, there are many other areas in which the project outcomes can be replicate. The project by itself cannot allow achieving the impact, which should be to resolve the water problem in Africa. The project team made a first

effort in its intention to approach the SADC chapter of the International Ground Water Resource Assessment Centre (IGRAC).

### *2.8. RECOMMENDATIONS*

The aim of this project was to build a proof of concept for a low cost underground water monitoring system. Despite few set backs and difficulties locating viable suppliers and components, project team has demonstrated the feasibility of such system as a viable candidate for mass deployment in developing countries. Although the main goal was achieved, we would like to point out that project team did not provide sufficient insight on the collected data analysis process so as to clearly evaluate the quality of results. Moreover, the report fails to provide information regarding data archiving and leaves us to infer that said process was part of the strategy and implemented during the course of the project.

We would recommend that as part of implementation strategy, project team ensures to clearly articulate results analysis process. This will ensure that proper evaluation of the result is done and ensure that the quality of results is acceptable. Furthermore, it is important that data archiving mechanisms are put in place and documented.