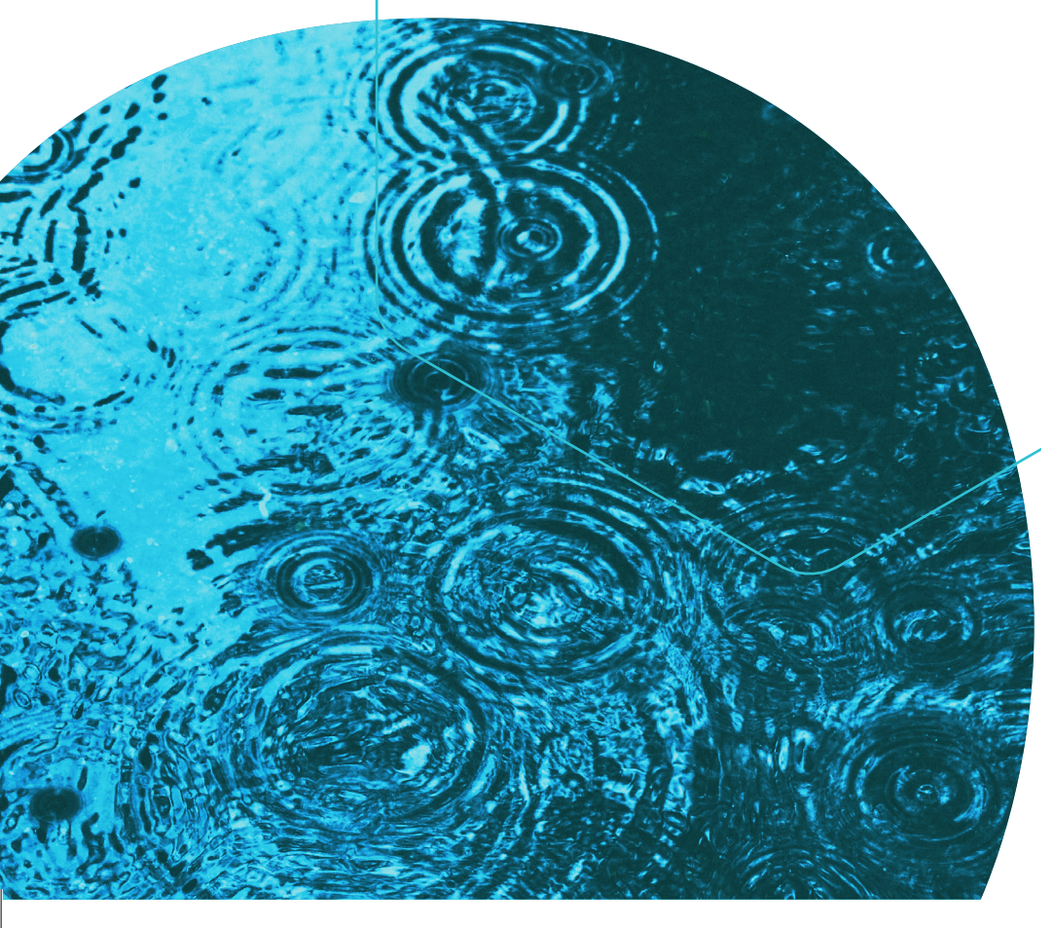
Appropriate Technology Project

Business Plan for the Implementation of Appropriate Technology for Rainwater Harvesting in Uganda



WIPO

Business Plan for the Implementation of Appropriate Technology for Rainwater Harvesting in Uganda

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National Expert Group for the Bilateral Project on Appropriate Technology for Uganda.

Executive summary

The World Intellectual Property Organization (WIPO) in cooperation with the Government of the Republic of Uganda has implemented the Bilateral Project on Appropriate Technology for Uganda. For the project, the Government of Uganda was represented by the National Expert Group (NEG), chaired by the Registrar General of the Uganda Registration Services Bureau (URSB), with members drawn from different Ministries, Agencies, Departments, Research Institutes and Universities. The NEG was assigned with the responsibility of steering the project implementation at the national level, whereas the Uganda Registration Services Bureau (URSB) was tasked with the role of the focal point to coordinate the project on behalf of Uganda.

The purpose was to support Uganda in identifying, managing, administering and utilizing technical and scientific information contained in patents, and in building the national capacity on appropriate technology for development. In particular, it focused on facilitating the use of patents as a source of technological information to address development needs at community level. Identifying two technologies to be so deployed was an important outcome of the project. The patent information search, which was conducted under this bilateral project, has provided the technological solution for a device that purifies rainwater for domestic use. The preparation of the business plans for the identified technologies/technological solutions has been the final stage of the Bilateral Project on Appropriate Technology Uganda with WIPO, which concluded recently.

Thus, this document serves as a business plan for the next project, to be implemented by the Government of Uganda with potential partners and stakeholders, for adopting and developing the technology for rainwater harvesting (RWH), which was identified as the result of the afore-mentioned bilateral project with WIPO.

With most parts of Uganda experiencing good rainfall (900 mm to 2000 mm per year), the identified technology provides the following advantages:

- low-cost water supply;
- reduces water bill;
- reduces need for imported water;
- reduces travel distances in search for water;
- promotes water and energy conservation;
- does not require filtration system for landscape irrigation;
- relatively simple technology, easy to install and operate;
- reduces soil erosion, storm water runoff, flooding and pollution of surface water with fertilizers, pesticides, metals and other sediments; and
- excellent for landscape irrigation, having no chemicals and dissolved salts, and free from all minerals.

Most existing houses have pitched roofs that can act as ideal collection surfaces. All that is required is to add gutters, purification device, pipes and storage tanks. The Project National Expert Group (NEG) reviewed several technologies and shortlisted three technologies. A further review was undertaken and the final technology selected, namely an unpowered rainwater collection, discarding, overflow and purification device (patent No. CN105672445A). This was recommended by the NEG for inclusion in the business plan for adoption and implementation in Uganda.

This technology has the following benefits:

- cost effective;
- simple to install;
- simple to operate and maintain;
- energy saving (power-free technology);
- improved quality of water;
- robust; and
- environmentally friendly.

Specific selected target communities

In order for the project to be successful, practical demonstration of the technology at community level is necessary. The Amazing Grace Primary School (Wakiso district) was recommended and accepted by the NEG, subject to the target beneficiaries submitting expressions of interest in the project.

Technology development

To improve the chances of adaptation, research and development (R&D) in the technology is needed. This will simplify the technology and make it easier to operate and maintain in Amazing Grace Primary School. It is proposed that a research project be commissioned, spearheaded by the School of Engineering at Makerere University. The School of Engineering will need to be provided with patent information and resources for prototypes. It is estimated that the R&D could be completed in six months.

Water quality

Those responsible will carry out routine maintenance on the systems, such as removing large debris from gutters and collection areas after every rain period. Water quality will be maintained through cleaning the system every six months and taking samples for testing at the Uganda National Bureau of Standards every three months.

Governance

URSB/NEG will be the overall authority and will provide all approvals for project activities, including project management, payments and accounting. A project coordinator responsible for

day-to-day project activities, together with a steering committee representing the schools and residents, will assist the NEG. The district water officer will provide backup technical support.

Financial projections

The project proposed in this business plan for adopting and developing the technology for rainwater harvesting (RWH) is estimated to last 12 months with a total budget of 108,474,000 Ugandan shillings. The funds will be sourced from the Government, stakeholders, microfinance and community contributions.

A proposed financing structure is provided in the following table.

Source	*Amount (UGX)*	*Percentage*
Grant	75,931,800	70
Microfinance	16,271,100	15
Contribution community	16,271,100	15
Total	**108,474,000**	**100**

Financial summary

No.	*Particulars*	*Cost (UGX)*	
1	Planning (technology development)	20,000,000	
2	Pre-operating (project management)	26,674,000	
3	Project piloting	61,800,000	
	Total	**108,474,000**	

Source: Author

Project outcomes and impact

The immediate outcomes will be (1) fewer resources (time and cash) spent by the school community to obtain water, (2) increased availability of water, (3) improved sanitation and (4) improved food stuffs, especially vegetables. Implementing the RWH system at Amazing Grace Primary School will generate significant advantages for approximately 1,000 direct beneficiaries at community level. These will include (1) environmental and health improvements, (2) improved food security and (3) school development from money saved.

Conclusion

The project is implementable in the selected communities (Amazing Grace Primary School and surrounding areas), with tangible benefits such as water availability and reduced water bills, and improved livelihoods. The average cost of a RWH system (tank support, gutters, device, pipes, tank) will be 9,337,000 Ugandan shillings for 10,000-liter capacity. The water will be used for irrigating small vegetable gardens, thereby improving food security and nutrition.

Recommendation

It is recommended that the RWH project be implemented in the selected target communities. If successful, it can be rolled out in other communities.

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Abbreviations and acronyms

BOQs	bill of quantities
IRC	International Rescue Committee
JICA	Japan International Cooperation Agency
NEG	National Expert Group
NWSC	National Water and Sewerage Corporation
PTA	parent teacher association
R&D	research and development
RWH	rainwater harvesting
SACCOs	Savings and Credit Cooperative Societies
UBOS	Uganda Bureau of Statistics
UNICEF	United Nations Children's Fund

URSB	Uganda Registration Services Bureau
USAID	United States Agency for International Development
WIPO	World Intellectual Property Organization

1. Introduction

Under the recently completed Bilateral Project on Appropriate Technology for Uganda, the World Intellectual Property Organization (WIPO) commissioned this business plan following a technology landscape report by consultants Dr. Douglas Sanyahumbi and Dr. Charles Mugoya. They worked closely with the National Expert Group (NEG) under the Uganda Registration Services Bureau (URSB)/Government of Uganda.

1.1 Background information

Uganda has a population of 41.6 million, with a growth rate of 3 per cent per annum (UBOS, 2020). There are 7.3 million households, 75 per cent of which are in rural areas. Population growth has triggered significant water demand. Access to clean water is a key driver of social and economic development and critical to both food and national security. It is a fundamental human need and an essential resource for a developing economy. Lack of or poor access to clean water is likely to have a considerable negative impact on health, and agricultural, domestic and industrial activities. More than 21 million people – 51 per cent of the East African country's population – are living without basic access to safe drinking water. Uganda has 135,269 domestic water points that serve 28,078,690 people, 22,986,424 of them in rural areas.

1.2 Water access

Uganda has 1,211 piped schemes. The percentage of people served per technology is as follows:

- protected spring, 21.4 per cent;
- shallow well, 23.9 per cent;
- deep borehole, 45.3 per cent;
- rainwater harvesting (RWH) tank, 0.4 per cent; and
- public tap, 9.1 per cent.

From the listed breakdown of water supply, RWH, surprisingly, contributes a minimum percentage despite being the most abundant water source (Uganda Atlas of Water Sources, 2018). An additional 5,312 sources have been nonfunctional for more than five years and are considered abandoned. The reasons for nonfunctionality include the following:

- low yield, 18.6 per cent;
- tech breakdown, 40.7 per cent;
- water quality, 11.7 per cent;
- water source nonfunctionality, 5.9 per cent;
- silted, 1.2 per cent;
- leaking, 3.3 per cent;
- alternative nearby, 6.3 per cent;

- vandalism, 8 per cent; and
- other, 4.5 per cent.

Type of management includes the following:

- communal, 82.4 per cent;
- private/individual, 7.7 per cent;
- private operator, 1.2 per cent;
- institutional, 8.1 per cent; and
- other, 0.6 per cent.

The challenges associated with water scarcity and the development and application of simple-to-use, affordable, efficient clean water delivery systems in lower income settings are largely unmet. Investment is required for robust technological innovations to meet an ever-growing need that is compounded by population dynamics and climate change.

People in rural areas mostly depend on streams, boreholes and swamp water. This has meant women and children having to travel between 1 km and 5 km to fetch water (Mugumya, 2018). Currently, piped water is distributed in urban areas, with the unit cost per cubic meter approximately 3,516 Ugandan shillings (1 United States dollar) for domestic consumption (NWSC, website). RWH can be an immediate solution given housing in rural areas has mostly pitched corrugated iron roofs conducive to harvesting. The Government of Uganda has no policy regarding harvesting as yet, and people normally use any means available, such as banana leaves with jerry cans to collect water. However, this may not provide sufficient water during dry spells. Traditionally, more than 76 per cent of Ugandans roof their homes with corrugated iron sheets (UBOS, 2020), while buildings in urban areas have gutters and pipes discharging rainwater to the ground.

1.3 Rainwater harvesting

In low to middle-income developing countries with limited infrastructure, rainfall is often the only relatively consistent source of clean water that communities have access to. RWH technology is not a new concept, with roof rainwater harvesting the most widely implemented. In such countries, corrugated iron is a popular material that allows for good runoff and the collection of relatively clean rainwater for domestic use. According to Uganda's Ministry of Water and Environment, rainfall ranges from 400 mm in dry areas to 1,400 mm in the wetter areas. This volume of rainfall, together with the fact that some 75 per cent of Ugandans have galvanized iron roofs, means rural Uganda is well positioned to capture and store rainwater for domestic use, thus increasing access to safe water.

1.4 Advantages of rainwater harvesting

RWH is a sustainable process that helps preserve water for future needs. Water scarcity is a major concern in the present day. The process of harvesting is a good way to conserve water. The benefits of a RWH system include:

- fewer costs;
- reduces water bill;
- reduces need for imported water;
- reduces travel distances in search for water;
- promotes water and energy conservation;
- does not require filtration system for landscape irrigation;
- relatively simple technology, easy to install and operate;
- reduces soil erosion, storm water runoff, flooding and pollution of surface water with fertilizers, pesticides, metals and other sediments; and
- excellent for landscape irrigation, with no chemicals and dissolved salts, and free from minerals.

1.5 Disadvantages of rainwater harvesting

In addition to the pros, there are also cons to RWH, such as unpredictable rainfall and no available storage systems. Other disadvantages include:

1. Limited or no rainfall can limit the supply of water.
2. If not installed correctly, may attract mosquitoes and other waterborne diseases.

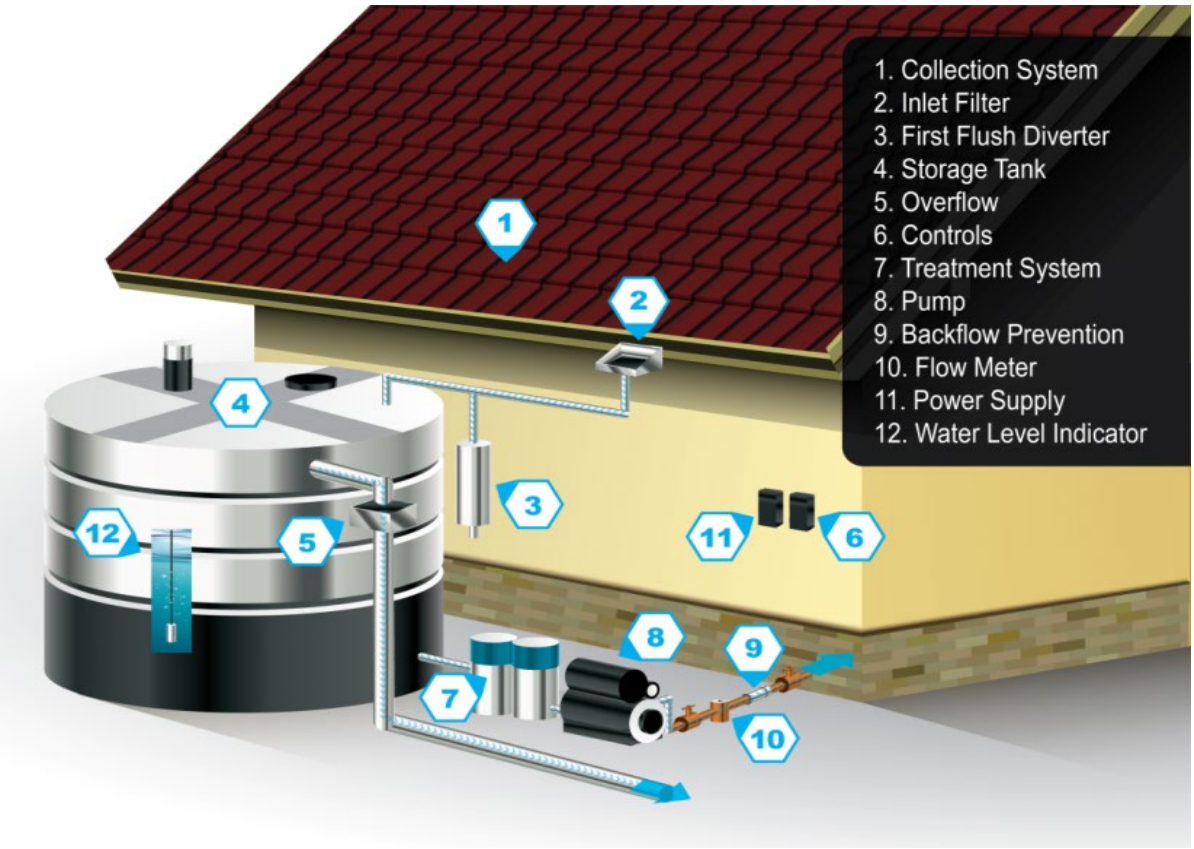
1.6 Current technology

Rainwater capture from rooftops collects relatively clean water for domestic purposes, including drinking. Gutters and pipes are used to guide the rainwater into storage facilities that allow access to the water, usually via taps. RWH systems consist of the following components:

- catchment: to collect and store the captured rainwater;
- conveyance system: to transport harvested water from the catchment to the recharge zone;
- flush: to flush out the first spell of rain;
- filter: for filtering collected rainwater and remove pollutants; and
- tanks and recharge structures: to store filtered water that is ready to use.

The process of harvesting involves the collection and storage of rainwater through artificially designed systems that run off naturally, or man-made catchment areas such as the rooftop, compounds, rock surface, hill slopes or repaired impervious or semipervious land surface. Figure 1 illustrates an installation applicable to high, raised buildings. The pumps and treatment systems may not be applicable for rural RWH requirements due to affordability.

Figure 1 **Components of a typical rainwater harvesting system**



Source: Author.

RWH components and associated maintenance actions are shown in table 1.

Table 1 **Rainwater harvesting components and associated maintenance**

No.	*Component*	*Description*	*Maintenance actions*	*Suggested frequency*
1	Collection system	Roof surface and gutters to capture rainwater and send it to storage system	Keep clean and clear of excessive debris, especially after prolonged dry periods or storms Inspect roof surface and ensure water flows and drains as intended	Weekly
2	Inlet filter	Screen filter to catch large debris	Clean filter and replace at regular manufacturer-specified intervals	Weekly and replace at manufacturer-specified intervals
3	First flush diverter	Removes debris not captured by the inlet filter	Keep clean and clear of excessive debris, especially	Monthly and after prolonged storms

		from the initial stream of rainwater	after prolonged dry periods or storms Ensure diverter is functioning as intended, diverting only the initial flush of water during rainfall	
4	Storage tank	Composed of *FDA-approved, food-grade polyester resin material that is green in color, which helps reduce bacterial growth	Inspect tank for cracks or leakage Infrequent blowdown may be required to remove sediment from bottom of tank. If filters are regularly maintained, accrual should be minimal (2 mm to 50 mm per year)	Annually
5	Overflow	Drainage spout that allows for overflow if storage tank gets full	Visually inspect overflow spout to ensure it is clear of debris	Monthly
6	Controls	System that monitors water level and filtration system	Ensure controls operate as intended. Visually confirm response to control commands. Request manufacturer maintenance as required Check wiring is in good condition	Monthly
7	Treatment system	Filtration and disinfection system that treats water to nonpotable or potable standards	Clean and replace filters at manufacturer-specified intervals Ensure treatment system dosing intervals are sufficient to meet water quality requirements in the system	Manufacturer-specified intervals
8	Pump	Move water through the system to end use	Check motor condition, and investigate excessive vibration, noise or temperature Perform pump maintenance such as bearing lubrication in accordance with manufacturer specifications	Monthly and maintenance at manufacturer-specified intervals

9	Backflow prevention	Ensures water cannot flow under instances of negative pressure	Conduct approved professional test annually or at frequency required by local regulations	Annually
10	Flow meter	Meter (with data logger) to measure water production	Ensure meter is calibrated per meter to manufacturer instructions Track water use regularly through meter readings, automatically (with data logger) or manually with log book	Monthly
11	Power supply	Systems may use conventional power sources, or, to improve off-grid capabilities, alternative sources such as stand-alone or grid-tied solar systems	Check power supply and equipment after power outages and ensure no damage to components Follow manufacturer operation and maintenance guidelines for alternative stand-alone power supplies such as solar photovoltaic panels	As required, and for stand-alone supplies at manufacturer-specified intervals
12	Water level indicator	Monitors level in storage tank	Ensure indicator is functioning as intended	Monthly

Source: Author.
Note: *FDA is Food and Drug Administration.

1.7 Water collection and storage technologies in Uganda

The 2004 National Service Delivery Survey, conducted by the Uganda Bureau of Statistics (UBOS) collaborating with the Ministry of Public Service, noted a sharp increase in the percentage of households using rainwater as their main source of drinking water in the wet season compared with the dry season, indicating the significance of RWH as a seasonal water source. Initiatives include the following:

- stick guiding roof water into a jerry can or pot;
- small iron gutters supported by sticks delivering water to variously sized containers;
- short gutters on roofs and even below ground;
- plastic-lined tanks; and
- stick/banana leaf/stem and jerry can.

According to UBOS statistics (2004), households store rainwater in relatively small volume containers, using private resources, as follows:

- most households use 20-liter jerry cans;
- others use
  - drums that hold approximately 100 liters
  - manufactured rainwater storage products (Aquatank or Polytank) with 250-liter to 15,000-liter capacity
  - underground tanks lined with plastic sheets
  - ferro-cement tanks
  - underground cement lined tanks; and
- in some areas, brick tanks are used.

2. Proposed rainwater harvesting technology

Given the importance and potential of rainwater as a main supply of clean, safe water for the Ugandan population, innovation technologies that can be sustainably applied must be adopted, adapted and developed. To this end, the Government of Uganda, through the Uganda Registration Services Bureau (URSB) and WIPO, have implemented the appropriate technology project for RWH. The NEG is responsible for reviewing, shortlisting and selecting the technologies that address the needs of the target communities.

2.1 Technology review process

Under the completed Bilateral Project on Appropriate Technology for Uganda, the NEG reviewed several technologies and shortlisted three patent technologies. The group conducted a further review and selected the final patent technology, an unpowered rainwater collection, discarding, overflow and purification integrated device (patent No. CN105672445A). This was recommended for inclusion in the business plan for future adoption and implementation in Uganda. The following is an abstract from Espacenet, the free online service for searching patents and patent applications:

> 'The invention particularly relates to a rainwater collection, discarding, overflow and purification unpowered integrated device, and aims at providing an integrated device which is suitable for various rainfalls and is energy saving. The device comprises grates; a water collection tank is arranged below the grates; the bottom end of the water collection tank is connected with an inlet of a water inlet pipe; a front cabin is arranged below the water inlet pipe; a discarding device is arranged in the front cabin; the discarding device comprises a hollow rotating shaft vertically arranged in the front cabin; the upper end of the inner side of the hollow rotating shaft is connected with an outlet of the air inlet pipe; the outer side of the hollow rotating shaft is connected with an upper guide wheel and a lower guide wheel through bearings. During light rainfall, after flowing past a gap between a lower guide plate and a lower bottom plate, rainwater flows into a discarding pipe; when the rainfall is relatively low, the lower guide plate is impacted by the rainwater to enable the lower guide wheel to rotate; a filter pipe is still closed within a certain time of rotation of the lower guide wheel; while the lower guide wheel rotates, an upper guide plate is impacted by the rainwater to drive the upper guide wheel to rotate by a certain angle to enable the filter pipe to be opened.'

2.2 Description of the technology

This RWH technology is composed of a two-chamber receiving tank. The first chamber (abandoned system chamber) reduces the speed of the flowing water, and the second chamber (rear storehouse) is installed with layers of filtering materials such as gravel, sand and chitosan fluid dressing. These two chambers are connected via a pipe (filter tube) installed with a valve at the bottom. An outlet pipe (municipal waste pipe) is installed with a valve to the abandoned system chamber to flush out dirty water. So, flowing water from the streets moves over grates installed into a manhole and is let into the abandoned system chamber through a pipe (abandoned system cut off). Rainwater passes through the filter tube and moves up through the

filtration layers (chitosan fluid dressing) and collects above. The two-chamber receiving tank is connected to a regulating reservoir via a pipe (collecting pipe), and stores water ready for further treatment. The regulating reservoir is installed with an overflow pipe. Then water is allowed to go through a purifying pond that is installed with permeable membranes made of activated carbon for further purification. Water then passes through a drainage pipe and valve ready for use.

2.3 Benefits of the technology

This technology has the following benefits:

- cost effective;
- simple to install;
- simple to operate and maintain;
- energy saving (power-free technology);
- improved water quality;
- robust; and
- environmentally friendly.

2.4 Comparison with other technology

- Includes filtration system, hence improved water quality.
- Power-free RWH technology.
- Appropriate for rural setting, with low maintenance costs and no power requirement.
- Affordable for small-scale business ventures.

2.5 Sustainability of the technology

- Long lasting, and manufacturers of tanks/other components can give 10 year-plus warranty.
- Skills required are mostly those possessed by local plumbers.
- Operation is simple and managed by owner.
- Water harvested can be sold on a business basis to generate income.

3. Target groups and current operating conditions

3.1 Potential target groups/communities

The target groups/communities for the proposed RWH technology are shown in table 2.

Table 2 **Target communities for rainwater harvesting technology**

S/N	*Target group*	*Uses for rainwater*	*Current situation*
1	Households	Cooking, bathing, cleaning and washing, drinking and other domestic uses such as substance animals	Boreholes, wells and streams, and minimal RWH. Normally, women and children walk 1 km to 5 km to fetch water
2	Schools	Drinking, cleaning and washing, bathing, toilets and landscaping	Some schools are connected to piped water, majority depend on fetched water from boreholes, dug wells and rivers. Some practice RWH
3	Health centers	Drinking, cleaning and washing, cooking and toilets	Health centers in large urban areas are served by piped water; in rural areas, most depend on fetched water, with some limited RWH
4	Water vendors	Collect water to be sold, especially in rural trading centers	Operate standpipes connected to pipelines, with some vendors carrying out RWH
5	Water bottling firms	Purify, package and supply bottled water	Use surface river water, piped water and boreholes as sources
6	Vehicle washing services	Washing vehicles, sometimes with jet spray machines	Use fetched water from streams or boreholes, piped water and sometimes river water
7	Industrial use	Some industries harvest rainwater for use in processes, especially steam generation and cooling machinery	Most connected to piped water. Some have production wells (boreholes), and a few practice RWH
8	Office blocks and urban institutions	Cooking, toilets, cleaning and washing, and drinking	Most have installed gutters and downpipes to channel storm water. Unfortunately, do not harvest/store the rainwater

Source: Author.

3.2 Specific selected target communities

For the project to succeed, practical demonstration of the technology is required at community level. For this, the Amazing Grace Primary School (Wakiso district) has been recommended. The NEG accepted this recommendation, which is subject to the target beneficiaries submitting expressions of interest in the project. As a precaution against members being unwilling to

participate, or slow to respond positively, approaches were also made to other communities, mostly schools.

3.2.1 The Amazing Grace community

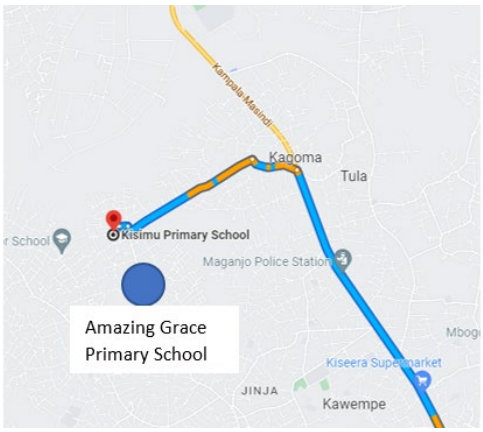
The Amazing Grace Primary School community is located approximately 11 km from Kampala, via Kampala-Gulu Road/Bombo Road. With regard to local government, the school community lies in Kisimu Local Council 1 parish, in Katooke subcounty, Nabweru county, Wakiso district, in the Central Region. It is surrounded by trading centers occupied by local people, but has several residential buildings for teachers and the school community. With a total of 400 pupils, 20 teachers and seven non-teaching staff, the school has three main buildings that serve as classrooms and offices. It consumes 800 liters of water daily, for cooking, bathing, washing, drinking and cleaning toilets and classrooms. According to the bursar, the school pays a monthly water bill of 1,200,000 Ugandan shillings to the National Water and Sewerage Corporation.

The surrounding community consists of some 3,000 people. Currently, the community has two sources of water; from the corporation and also locally pumped water from underground. It was selected for the following reasons:

- well organized due to Christian foundation;
- involved in education sector;
- easy to source finance for implementing the water project;
- proximity to Kampala for monitoring;
- sufficient rainfall given proximity to Lake Victoria (on average, Kisimu receives 1,400 mm per year);
- good population within a small area; and
- students and parents will act as 'disciples', spreading the technology to their home areas.

The location of Amazing Grace Primary School, with possible routes to it, is provided in figure 2.

Figure 2 **Map of Kisimu community**



Source: Google Maps.

3.2.2 Conditions in the Amazing Grace (Kisimu) community

Kisimu community has the following characteristics:

- Predominantly Christian and as such well organized.
- Biggest groups in the school population are students under 18 years and active teachers under 60 years.
- Parent teacher association (PTA) to involve parents in school life, particularly development projects.
- Employs private security guards.
- Average monthly salary for a teacher is 150 US dollars to 200 US dollars, plus a top-up from the PTA fund.
- Some of the schools have Savings and Credit Cooperative Societies (SACCOs) from which teachers borrow for development projects such as buildings.

3.3 Operating conditions

The following section covers the steps for implementing and modeling the technology in the Amazing Grace (Kisimu) community.

3.3.1 Technology development

To improve the chances of adaptation, research and development (R&D) in the technology is required. This will simplify the technology, making it easier to operate and maintain in the Amazing Grace community. It is proposed that a research project spearheaded by the School of Engineering at Makerere University be commissioned. The school will need to be provided with patent information and resources for prototyping. It is estimated that the R&D can be completed in a period of six months.

3.3.2 Mass manufacture of the technology

With designs from the R&D exercise, the NEG should appoint manufacturers to produce the technology ready for use in the Amazing Grace community.

3.3.3 Amazing Grace rainwater project management

The Amazing Grace rainwater project management should be directed by the NEG and include the following.

(a) Project coordinator

The coordinator should be recruited to oversee project implementation. They should be responsible for initiating project activities, mobilizing resources and coordinating with the beneficiary community through the project committee. They will provide technical assistance

and guidance to local contractors and officials during implementation, and report project progress to the NEG.

(b) Amazing Grace Community Project Committee

This will be comprised of one committee member nominated by the school, one resident member of the community, and the Nabweru subcounty water officer. Their duties will include project planning and implementation, representing the interests of their constituencies, and keeping the respective school management authorities informed.

(c) Procurement

Each school will procure the contractor with guidance from the project coordinator. Bill of quantities (BOQs) will be prepared by the project committee in conjunction with the project coordinator.

(d) Installation and commissioning of the rainwater harvesting system

The contractors will carry out the installation process and invite the project committee, project coordinator and NEG for commissioning.

(e) Monitoring and evaluation

The monitoring and evaluation will be conducted by NEG and the Wakiso district water officer.

4. Regulatory conditions

The key legal instruments governing water service provision in Uganda are as follows.

The Constitution of Uganda (1995)

- Defines clean and safe water as a fundamental right for all Ugandans.
- Compels the Government to take all practical measures to promote good water management at all levels of action.
- Article 176 defines the principle of decentralization as the system for local governance in Uganda (Government of Uganda, 1995a).

The National Environment Act (1995)

- Provides the legal framework for the sustainable management of environmental resources, including water.
- Establishes the National Environment Management Authority as the coordinating, monitoring and supervisory body (Government of Uganda, 1995b).

The National Water and Sewerage Corporation Act (1995)

- Establishes the National Water and Sewerage Corporation (NWSC) to operate and provide water and sewerage services in specific entrusted areas. Assigns NWSC to
  - manage water resources in the most beneficial way for the people of Uganda;
  - provide water supply services for domestic, stock, horticultural, industrial, commercial, recreational and environmental uses;
  - provide sewerage systems in the areas appointed under the Water Act of 1995;
  - develop water and sewerage systems in urban centers (15,000 inhabitants) and large national institutions (hospitals, etc.) throughout the country (NWSC, 1995).

The Water Act (1997), Cap. 152 and Land Act (1998), Cap. 227

- All water rights are vested in the Government. No water can be obstructed, dammed, diverted or polluted without a permit.
- Defines the powers and functions of water authorities as the responsible entities for provision of water supply services, and gives the Minister of Water and Environment authority to demarcate water supply areas and appoint water authorities to provide supply services in these areas through a notice in the Gazette.
- Give general rights to the occupiers of that land to use naturally existing water sources for domestic use. However, under Article 7, the occupier must receive approval from the Ministry to abstract water on their premises (Government of Uganda, 1997c; Government of Uganda, 1998).

The Local Government Act (1997) and Public Health Act (2000)

In districts and urban centers outside NWSC jurisdiction, water service provision and maintenance of facilities is the responsibility of local councils under the guidance of central government. Local councils must take lawful and necessary measures to prevent the pollution of any water supply, which the public have the right to use for drinking or domestic purposes. Districts are the legal owners of water infrastructure (Government of Uganda, 1997c; Government of Uganda, 1997a) and must purify any supply used for drinking or domestic purposes that is known to be polluted (Public Health Act, Cap. 281, 2000, Art. 103). The district water offices are responsible for planning, implementing and monitoring all water and sanitation activities in the district. They apply for district water supply and sanitation conditional grants and receive support from the Government to plan and implement water provision and public sanitation. Responsibilities of district water offices include:

- developing a district-wide water and sanitation plan;
- managing contracts with private operators;
- managing funds for the provision of water services; and
- reporting to the district council and ministries of Finance, Planning and Economic Development, and Water and Environment.

Though guided by the Ministry of Water and Environment, the finance ministry dictates the allocation formulas that outline how conditional grants can be spent and disburses funds to districts. The district council approves the district water officer's workplans and budgets for water service provision. The Ministry of Local Government is responsible for providing the administrative support, technical advice, guidance and mentoring required to effectively execute the district plan processes (Government of Uganda, 1997b; Government of Uganda, 2000).

4.1 Uganda's water and environmental policies

The key Ugandan water provision policies framing the national water sector are as follows.

The National Water Policy (1999)

The policy promotes an integrated approach to managing water resources in ways that are sustainable and most beneficial to the people of Uganda, based on Government recognition that water is a social and economic good. It is divided into water resources management and development of water uses. Water resources management covers the allocation and protection of resources. Water development covers domestic supply, water for agriculture and other water uses, such as industry, hydropower and recreation (Ministry of Water and Environment, 1999).

The Pro-Poor Strategy for the Water and Sanitation Sector (2006)

The strategy aims to improve the effectiveness of wash, sanitation and hygiene (WASH) pro-poor services. It establishes the need for operational water quality monitoring and appoints service providers to ensure that low-income households are consuming safe water (MWE, 2006).

The Water and Sanitation Gender Strategy (2018)

Acknowledges that water and sanitation policies affect men and women differently and seeks to develop a gender perspective in the sector. Specifically, the strategy provides guidelines to operationalize gender-sensitive program planning, implementation, and monitoring and evaluation. It also aims to increase the number of women in leadership positions on WASH committees (MWE, 2010).

The National Environment Management Policy (2014)

The policy addresses environmental issues in a holistic, integrated manner, specifically

- prioritizing watershed management to control, conserve and regulate the water balance in catchment regions;
- empowering lower levels of governance to systematically respond to local water challenges; and
- ensuring that water resources contribute to socioeconomic development (Government of Uganda, 2014).

The National Water Quality Management Strategy (2006)

The strategy seeks to safeguard the quality of water resources. It highlights the importance of water quality management and frames the approach for water quality standards. It established a National Water Quality Laboratory at Entebbe as the reference laboratory for water analysis. Additionally, it has created four water management zones to support stakeholders in monitoring water quality at catchment level. Quality standards are set by the Ugandan National Bureau of Standards (MWE, 2006).

The Water and Environment Sector Development Plan (2015–2020)

This outlines the specific objectives for the sector as part of the national development strategy to “attain the lower middle-income status by 2020 with an annual per capita income of 1,033 US dollars”, as articulated in the Uganda Vision 2040. This reinforces the Government’s commitment to achieving the Sustainable Development Goal for water (SDG 6) by increasing access to piped water and toilet facilities, and developing water treatment systems (MWE, 2015).

4.2 Approval of construction

RWH does not require special approval as with other water sources because the Government recognizes it as a self-supply system. Given the proposed Amazing Grace rainwater project is relatively large, construction approval will be sought from the Wakiso district engineer and health inspector.

4.3 Water quality

Those responsible will conduct routine maintenance on the systems, such as removing large debris from gutters and collection areas after every rain period. Water quality will be maintained by cleaning the system every six months and taking samples every three months for testing by the Ugandan National Bureau of Standards.

5. Implementing team

A team will be necessary for this next project on implementing the technology proposed in this business plan, as outlined below.

5.1 Institutions

- NEG-Uganda Registration Services Bureau (URSB): overall project management and coordination.
- Ministry of Water and Environment: regulator.
- Ministry of Finance, Planning and Economic Development: coordinate finance development.
- Schools: target community and implementers.
- Makerere University: R&D and prototyping.
- Local government: technical advice and water quality monitoring.

5.2 Enterprises

Certain enterprises will be necessary for the manufacture, supply, installation, and commissioning and maintenance of the systems. These exist in Wakiso district, and in Kampala and Lugazi, which are near the target community. They include:

- metal fabrication: manufacture of water purification devices, gutters;
- plastic: manufacture storage tanks, pipes and other connectors;
- plumbing: water connections; and
- building contracting: installation of systems

5.3 Communities

These are the target communities, as mentioned earlier:

- schools: procure, operate and maintain systems; and
- local residents: procure, operate and maintain systems.

5.4 Experts

The project will need various experts who will be hired as required. These include:

- consultants: business planning;
- project coordinator: harmonize project activities;
- water officers: offer technical advice and monitoring quality; and
- engineers: system design, BOQs preparation, supervision.

6. Stakeholders

The stakeholders listed below can be contacted for assistance, particularly financial and/or technical assistance:

- Water Aid: sponsors community water dispensing facilities (water taps).
- Water For Life: helps communities acquire safe and sustainable water sources.
- International Rescue Committee (IRC): responds to the world's worst humanitarian crises, helping those involved to survive and rebuild their lives.
- Water For People: helps people bring clean water and sanitation solutions to their communities.
- United Nations Children's Fund (UNICEF): provides humanitarian and developmental aid to children worldwide.
- German Agency for International Cooperation (GIZ): aid development organization.
- Water.org: gives water and sanitation loans to the poor in collaboration with banks and microfinance institutions.
- Aquaya: dedicated to advancing global health through universal access to safe water and sanitation.
- United States Agency for International Development (USAID): administers civilian foreign aid and development assistance.
- Japan International Cooperation Agency (JICA): manages small grant schemes for developing countries.
- Lifewater: constructs custom water access and sanitation solutions in the world's hardest to reach communities, including Mayuge and Kakumiro, in Uganda.
- Mercy Hands Uganda: core work is in agricultural development for Ugandans and refugees, supporting farmers to increase productivity through climate-smart agriculture techniques.
- Global Water Foundation: nonprofit organization dedicated to delivering clean water and sanitation to the neediest communities.

For the stakeholder analysis for the RWH project, see Appendix 1.

7. Governance and management structure

The following are the key players in project implementation (see figure 3 for the governance team).

NEG-URSB

Authority that will approve all project activities, including overall project management, payments and accounting. The URSB will appoint the project coordinator, and deal with the stakeholders and R&D institutions.

Project coordinator

The project coordinator will oversee overall project implementation. They should be responsible for initiating project activities, mobilizing resources and coordinating with the beneficiary community through the project committee. The coordinator will provide technical assistance and guidance to local contractors and officials during project implementation. They will report progress to the NEG.

School head teachers

They will be responsible for consulting a school's board of governors to seek project approval, and convening the PTA for its contribution to the project. Head teachers will nominate staff members to represent their school on the steering committee.

Steering committee

The committee will discuss the project and prepare BOQs for each school together with the project coordinator. It will present the BOQs to the respective procurement committees to recruit a contractor. The committee will recruit other experts as required.

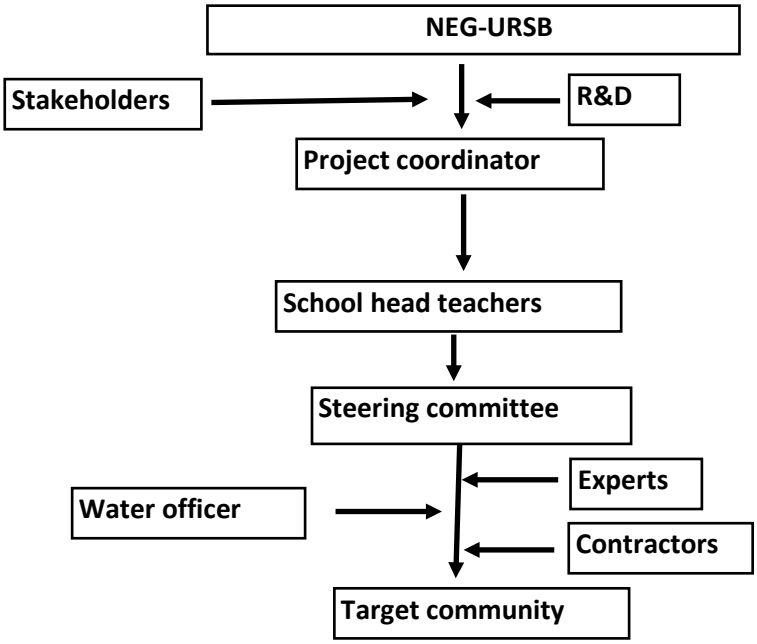
Amazing Grace community

This will be comprised of one committee member nominated by each of the five schools, one resident member of the community and the Nabweru subcounty water officer. Their duties will be (1) project planning and implementation, (2) representing the interests of their constituencies and (3) informing respective school management authorities.

The water officer

The officer will be responsible for conformity to national quality standards.

Figure 3 **Proposed organization for rainwater harvesting project**



Source: Author

8. Implementation steps and schedule

The proposed implementation plan is designed to facilitate a participatory and consultative approach that involves stakeholders at all stages. The steps are grouped in three phases. Phase I is the planning and selection of a manager, phase II, pre-operations and team mobilization, and phase III, operations and commissioning. Activities under each phase are described below. The project is estimated to last 12 months. See table 3 for steps and schedule.

Table 3 **Project implementation schedule**

S/N	*Activity*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*Responsibility*
	Phase I: Planning and selection of a manager													
1	R&D													College of Engineering, Design, Art and Technology at Makerere University
2	Recruit project coordinator													NEG
	Phase II: Pre-operations and team mobilization													
3	Community mobilization													Consultant and NEG
4	Resource mobilization													Project coordinator/NEG
5	Recruit contractors													Project coordinator/community
	Phase III: Operations and commissioning													
6	Installation of RWH system(s)													Contractors
7	Commissioning													NEG/URSB/Community
8	Operations and maintenance													Project coordinator/ community/contractors
9	Monitoring and evaluation													Project coordinator/water officer

Source: Author

8.1 Phase I: Planning and selection of a manager

In this phase, the NEG should prepare strategies to first, mobilize researchers from Makerere University's College of Engineering to optimize the RWH technology. This technology should be compatible with the communities in terms of affordability, materials and skills. And second, to recruit a project coordinator. A detailed description of each step is given below.

Step 1: Research and development

The R&D team should be able to (1) size an appropriate RWH system, (2) estimate the catchment surface area of the roof, (3) choose appropriate pipes and accessories (for example, high density polyethylene, or HDPE, pipes), (4) develop the water treatment device, which might be made of activated carbon, nanomaterials or filters, and ensure treated water conforms to national quality standards, and (5) choose tank materials (for example, plastic, concrete or steel). The research team should also provide engineering designs, manufacturing and installation procedures,

prototype, water treatment results and system costs, and any other information that might contribute to project success. Table 4 provides a detailed action plan for this.

Table 4 **Research and development action plan**

Phase I: Planning and selecting a manager					
Goal 1: Developing an appropriate RWH technology					
Strategies: Use university for R&D					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Appoint a consultant	Month 1	NEG	NEG time, email	Name and contacts for consultant	
Provide terms of reference	Month 1	NEG	RWH patent documents, NEG time	Emailed documents	
Conduct research on RWH (materials, procedures, optimized designs, standards, etc.)	Month 1 to Month 3	Consultant	Research funds, equipment, materials, time	Prototypes, research results and reports	
Presentation of results	Month 3	Consultant	Computer, stationery, Internet	Research report	
Approval of results	Month 3	NEG	Computer	Shared reports	

Source: Author

Step 2: Recruit project coordinator

The coordinator will be responsible for implementing the project on behalf of the NEG. The NEG/URSB will advertise the job. Interviews and recruitment activities will be undertaken to identify the right candidate. Table 5 provides the recruitment steps, and a job description is attached in Appendix 2.

Table 5 **Job advertisement action plan**

Phase I: Planning and selecting a manager					
Goal 1: Recruit project coordinator					
Strategies: Advertise job in newspapers					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Draft an advert	Month 1	NEG	NEG time, computer	Advert document	
Publish the advert	Month 1	NEG	Advert fee, NEG time	Advert in newspapers, receipt of curricula vitae	
Appoint project coordinator	Month 1	NEG	NEG time	Interviews, terms of reference, appointment letter	
Allocate office/space	Month 1	NEG	NEG time, computer and equipment	Work space	

Source: Author

8.2 Phase II: Pre-operations and team mobilization

Step 3: Community mobilization

The NEG team, with the project coordinator's assistance, will mobilize the community. The project coordinator should use approaches such as brochures, calls, emails, meetings and demonstrations as required to reach the target community. They should introduce the purpose of the project, and the role and expectations of users. The project coordinator should have covering letters from NEG/URSB to facilitate access to the communities. They should arrange a memorandum of understanding (MOU) with the community to ease communication. The target community is Amazing Grace Primary School (Kisimu), a private school located in Lugoba-Kawempe in the Wakiso district. It has a total of 400 pupils, 20 teachers and seven non-teaching stuff. The school has three main buildings that serve as classrooms and offices. It uses 800 liters of water a day, for cooking, and cleaning toilets and classrooms. According to the bursar, the school pays a monthly water bill of 1,200,000 Ugandan shillings to the National Water and Sewerage Corporation. The school director projected an estimated 80 per cent reduction in the water bill if the school acquires two 10,000-liter tanks. The school is willing to participate with project implementation, and to contribute resources. Table 6 provides steps to mobilize the community.

Table 6 **Community mobilization action plan**

Phase I: Pre-operations and team mobilization					
Goal 1: Community mobilization					
Strategies: Network with a community school					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Approach target school	Month 2	Project coordinator	Time/calls/ emails, travel funds, documents	Date for meeting	
Discuss terms of reference	Month 2	Project coordinator/ School officials	Time, travel funds, documents	Terms and conditions of collaboration	
Draft MOU	Month 2	Project coordinator/ School officials	Time, stationery, Internet	Signed MOU	
Draft common workplan	Month 2	Project coordinator/ School officials	Time, stationery, Internet	Workplan printed	

Source: Author

Step 4: Resource mobilization

Resource mobilization will be spearheaded by the URSB project office, assisted by the project coordinator. The project coordinator will consult stakeholders during a project funding meeting. They will consult the community for contributions to the project and committee formation. The project coordinator will contact financial institutions for credit finance for the residents' microfinance scheme; they will borrow from this to acquire the RWH system/s. Organizations that could be targeted for support include Water Aid, Water For Life, IRC, Water For People, UNICEF, GIZ, Aquaya, USAID, JICA and Lifewater. Table 7 provides the resource mobilization steps.

Table 7 **Resource mobilization action plan**

Phase I: Pre-operations and team mobilization					
Goal 1: Fundraise UGX 200,000,000					
Strategies: Water-related NGOs and community school contribution					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Identify possible funding (WaterAid, Water For Life, IRC, Water For People, UNICEF, GIZ, Aquaya, USAID, JICA and Lifewater)	Month 2	Project coordinator/ NEG	Time, calls, travel funds, documents, Internet	List of confirmed funds	
Present proposal	Month 2 to Month 4	Project coordinator/ NEG	Time, calls, travel funds, documents, Internet	Proposal document	
Sign agreement	Month 4 to Month 6	Project coordinator/ NEG/funding organization	Time, stationery	Copy of agreement	
Present progress reports	Month 7 to Month 10	Project coordinator/ NEG	Time, travel funds, documents, Internet	Progress report	
Present accountabilities and completion reports	Month 10	Project coordinator/ NEG	Time, travel funds, documents, Internet	Accountabilities and reports	

Source: Author

Step 5: Recruit experts (contractor – engineers and plumbers)

The project coordinator will develop terms of reference for the required experts. Working with the community procurement team, they will organize obtaining RWH system(s) according to the 2014 Public Procurement and Disposal of Assets regulations (PPDA Contracts-regs-2014). The coordinator advertises the consultancy, and, with the community, awards the job to the best candidate. They then advertise for contractors, who purchase and return the BOQs. The contractors should have the requisite skills, such as in pipelines, water treatment and construction, and in dealing with communities. The experts and the community evaluate the bids, and recommend the award of contracts. These are signed by the contractor and community. Table 8 provides the recruitment steps.

Table 8 **Publication of the tender action plan**

Phase II: Pre-operations and team mobilization					
Goal 1: Recruit contractor					
Strategies: Tender advert publication					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Tender advert preparation	Month 7	Project coordinator/ NEG/community user	Time, funds, documents	Tender in papers	
Select best bid	Month 7	Project coordinator/ NEG/community user	Time, documents	Company details	
Design and build contract	Month 7	Contractor/ project coordinator/ community user	Time, funds, stationery	Designs and drawings	
Contractor presents BOQs and workplan	Month 7	Contractor	Time, funds stationery	Workplan and BOQs	
Approve installation plan	Month 7	Project coordinator/ NEG/community user	Time, documents	Document	

Source: Author

8.3 Phase III: Operations and commissioning

Phase III involves activities such as installing RWH system/s, commissioning, operations and maintenance, and monitoring and evaluation, as explained below.

Step 6: Installing RWH systems

Contractors move to the site and set up as per the BOQs. Installation is carried out, with the expert supervising the work. The contractor should train users on the system, specifically operations and maintenance. Progress reports will be submitted to the management team. On completion, the site is handed over for commissioning. Table 9 provides the installation steps.

Table 9 **Installation of system action plan**

Phase III: Operations and commissioning					
Goal 1: Installation of RWH system/s					
Strategies: Contractor to install the system					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Procure materials	Month 8	Contractor/ project coordinator/ NEG/community user	Time, funds, labor, trucks	Materials, tools, equipment	
Site establishment	Month 8	Contractor/ project coordinator/ NEG/community user	Time, funds, labor, trucks	Storage facilities, local suppliers, labor	
Installation activities (piping, fitting, concrete work and filtering device)	Month 8	Contractor/ project coordinator/ NEG/community user	Time, funds, labor, trucks, tools	RWH systems installed	
Testing the system	Month 9	Contractor/ project coordinator/ NEG/community user	Time, funds, labor, equipment	Safe water, system works as required	
Completion report	Month 10	Contractor	Time, documents	Reports	

Source: Author

Step 7: Commissioning

On completion of the installation, and submission of implementation documents (progress reports, invoices, training reports), the implementation committee will organize commissioning of the project. This is performed by the NEG, URSB, Ministry of Water and Environment, district officials, and PTAs and other dignitaries. The project coordinator and community team will plan and organize the project commissioning and send invitations to participants. Table 10 provides the steps of commissioning.

Table 10 **Project commissioning action plan**

Phase III: Operations and commissioning					
Goal 1: Project commissioning					
Strategies: Celebrate the day with stakeholders, including a newspaper article					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Plan handover ceremony	Month 10	Contractor/ project coordinator/ NEG/community user	Time, stationery	Celebration plan	
Invite stakeholders	Month 10	Project coordinator/ NEG	Time, brochures, travel, calls	Invitation cards printed and delivered	
Procure ceremony materials	Month 10	Project Coordinator/ NEG	Refreshments, food, public communication system	Materials at the site	
Celebrate the day	Month 10	Contractor/ project coordinator/ NEG/community user	Time, funds, materials	People sharing ideas, speeches	
Handover	Month 10	Contractor/ project coordinator/ NEG/community user	Time, reports, people	Reports	
Newspaper coverage	Month 10	Project coordinator/ NEG/newsletter writers	Article, funds	Article in newspapers	

Source: Author

Step 8: Maintenance, monitoring and evaluation

Routine maintenance includes cleaning filters and emptying the first flush pipes, and is carried out by users. Tank cleaning is done by plumbers as recommended in quality standards. The user should be able to provide monthly reports on the system to the coordinator. The district water officer will monitor system performance every six months and take samples for testing. They report to NEG/URSB. Table 11 provides the monitoring and evaluation steps.

Table 11 **Monitoring and evaluation action plan**

Phase III: Operations and commissioning					
Goal 1: Maintenance, monitoring and evaluation					
Strategies: Reports from community user					
Action plan:					
Activity	*Timeline*	*Person(s) responsible*	*Resources needed*	*Anticipated results*	*Progress notes*
Record daily	Months 10, 11 and 12	Community user	Time, book	Records in the book	
Repair leakages	Months 10, 11 and 12	Contractor/ community user	Tools, labor	Repaired system	
Clean the system occasionally	Months 10, 11 and 12	Community user	Time, water	Clean system	
Monthly reports	Months 10, 11 and 12	Community user	Time, email, book	Reports	

Source: Author

8.4 Accounting and auditing

Although operating under the URSB, the project will have separate bank accounts and account books. Financial reports will be made to the NEG on a quarterly basis. The project will be audited according to domestic laws and guidelines (National Audit Act (NAA), 2008). The audited accounts will also be sent to the funding agencies.

9. Expected costs and required resources

The approximate budget for executing this project is 108,474,000 Ugandan shillings. This is contingent on the activities, which are grouped in phases. The main costs include technology development, mobilizing project resources and the community, paying the project coordinator and project piloting. The expected costs are divided into technology development, project management and project piloting costs.

9.1 Technology development (R&D) costs

Costs will cover recruiting and remunerating the project coordinator. Other costs include office expenses to purchase stationery for reports and printing. R&D expenses will be used to analyze and optimize the technology. Travel costs will help the project coordinator in establishing networks with funding institutions and other stakeholders. Table 12 shows the expected costs during R&D.

Table 12 **Planning costs**

S/N	*Particulars/activity*	*Quantity*	*Rate (UGX)*	*Amount (UGX)*	*Justification*
1	Consultancy fee	1	5,000,000	5,000,000	Financial facilitation to consultant
2	Material costs (prototypes during research)	1	10,000,000	10,000,000	Materials to test technology and draw conclusions
3	Lab expenses	1	5,000,000	5,000,000	Testing quality of treated water
	Total			**20,000,000**	

Source: Author

9.2 Pre-operation (project management) costs

Pre-operation costs are incurred in setting the grounds for project implementation. They include resource mobilization and conducting procurement procedures for recruiting the contractor. Table 13 itemizes these activities and costs.

Table 13 **Pre-operation (project management) costs**

S/N	*Particulars/activity*	*Quantity*	*Rate (UGX)*	*Amount (UGX)*	*Justification*
1	Project coordinator	12 months	2,500,000	30,000,000	Monthly remuneration for project coordinator
2	Office expenses (printing services and stationery)	12 months	400,000	4,800,000	Toner, printing paper, notebooks, pens, box files, etc.
3	Accounting, auditing and NEG activities	1	4,000,000	4,000,000	Facilitate supervision
4	Community mobilization	5	1,000,000	5,000,000	Stakeholder meetings, preparing reports, travel
5	Resource mobilization	1	5,000,000	5,000,000	Stakeholder meetings, preparing proposals, travel
6	Monitoring and evaluation	1	3,000,000	3,000,000	Transport, records, reports for regular check-ups
7	Commissioning	1	10,000,000	10,000,000	Launching/promoting technology (drinks, food, public communication systems, brochures, invitation cards, tent hire, chairs)
	Total			**18,000,000**	

Source: Author

9.3 Operations (project piloting)

Operation costs are set to implement and maintain the project. They consist of installing two RWH systems at Amazing Grace Primary School, plus supervision, maintenance and monitoring and evaluation. Table 14 details the costs and requirements.

Table 14 **Operation costs for RWH system installation and maintenance**

No.	*Particulars/activity*	*Quantity*	*Unit cost (UGX)*	*Total cost (UGX)*	*Justification*
1	Engineering designs for RWH system(s) and BOQs	1	3,000,000	3,000,000	Data collection, designs for installations, preparation of BOQs, engineering drawing
2	Installation of pilot systems at Amazing Grace Primary School	2 systems	9,337,000	18,674,000	Expenditure for two systems (purchase storage tanks, pipes and fittings, treatment device, tank supports, transport and installation fee)
3	Supervision	1	3,000,000	3,000,000	Facilitation during installation of systems (field) to NEG and project coordinator
4	Operations and maintenance	1	2,000,000	2,000,000	Extra materials to repair system, transport
	Total			**26,674,000**	

Source: Author

Note: RWH system comprises gutters and supports, water filtration and purification device, pipes and storage tank. Cost includes installation of each system. For a 10,000 liter tank, estimated cost is 9,337,000 Ugandan shillings.

9.4 Comparative analysis of project

The RWH project is comparable with similar systems on the market. The comparison is based on a random school with three classrooms, each measuring 10 m x 20 m and totaling an estimated length of 30 m. A list of materials required to set up a market rainwater system is provided in table 15, while table 16 shows the proposed system. The proposed system has an additional treatment device and a flushing system that, for the first rains, allows dirty water to be flushed out before reaching the tank. Such devices together cost an additional 1,200,000 Ugandan shillings.

Table 15 **Market value of rainwater system**

S/N	*Item/description*	*Quantity*	*Unit*	*Rate (UGX)*	*Amount (UGX)*
1	Gutter, plastic	15	pcs	40,000	600,000
2	Gutter clips	120	pcs	4,000	480,000
3	Screws/nails	8	pcs	12,000	96,000
4	Corners/fittings	4	pcs	10,000	40,000
5	Connectors/fittings	8	pcs	12,000	96,000
6	Solvent cement	2	tins	20,000	40,000
7	Gutter outlet	1	pcs	15,000	15,000
8	PVC pipe, 3 inch	2	pcs	40,000	80,000
9	PVC corners	4	pcs	10,000	40,000
10	10,000-liter tank, plastic	1	pcs	2,500,000	2,500,000
11	Tank fittings	1	LS	150,000	150,000
12	Tank platform/support	1	LS	2,000,000	2,000,000
13	Labor/transport	1	LS	2,000,000	2,000,000
	Total				**8,137,000**

Source: Author

Notes: pcs is piece/pieces; LS is lump sum.

Table 16 **Proposed material requirements for rainwater harvesting system**

S/N	*Item/description*	*Quantity*	*Unit*	*Rate (UGX)*	*Amount (UGX)*
1	Gutter, plastic	15	pcs	40,000	600,000
2	Gutter clips	120	pcs	4,000	480,000
3	Screws/nails	8	pcs	12,000	96,000
4	Corners/fittings	4	pcs	10,000	40,000
5	Connectors/fittings	8	pcs	12,000	96,000
6	Solvent cement	2	tins	20,000	40,000
7	Gutter outlet	1	pcs	15,000	15,000
8	PVC pipe, 3 inch	2	pcs	40,000	80,000
9	PVC corners	4	pcs	10,000	40,000
10	10,000-liter tank, plastic	1	pcs	2,500,000	2,500,000
11	Tank fittings	1	LS	150,000	150,000
12	Tank platform/support	1	LS	2,000,000	2,000,000
13	Labor/transport	1	LS	2,000,000	2,000,000
14	Water treatment device	1	LS	1,000,000	1,000,000
15	Flushing system	1	LS	200,000	200,000
	Total				**9,337,000**

Source: Author

Notes: pcs is piece/pieces; LS is lump sum.

9.5 RWH financial projections

The projected cash flow for 12 months is provided in Appendix 3.

The cash flow shows the recommended periods and amount of inflow and outflow for good project implementation. The following assumptions are made:

1. Funds will be received when needed. If from the Government, funds will be received on a quarterly basis.
2. The systems will be staggered according to the funding.
3. All other expenses are on a monthly basis where possible.

9.6 Proposed financing structure

Table 17 shows a fundraising structure for project implementation. The community is expected to contribute some resources, and the project coordinator will raise finance from funders.

Table 17 **Proposed fundraising structure**

No.	*Source*	*Amount (UGX)*	*Percentage*
1	Grant	75,931,800	70
2	Microfinance	16,271,100	15
3	Contribution community	16,271,100	15
	Total	**108,474,000**	**100**

Source: Author

Note: Grants will be from Government and stakeholders in water sector; microfinance funding will be through SACCOs to support cost sharing by residents; and contributions from communities will be via cash from residents and a development levy per student from schools. Roofs are assumed to be in place to act as collection surfaces.

10. Expected impacts and outcomes

Installing a RWH system will generate significant direct benefits for approximately 1,000 people at school community level and in the local neighborhoods. The project has a number of outcomes and expected impacts that will improve well-being at Amazing Grace Primary School. These are elaborated in the sections below.

10.1 Expected project outcomes

The immediate project outcomes will be fewer resources spent on getting water, improved availability, and better sanitation and foodstuffs.

(a) Fewer resources (time and cash) spent by the school community to obtain water
Lugoba-Kawempe is hilly with less naturally occurring water sources and communities rely mostly on the national water supply. Due to occasional pipeline breakdowns, Amazing Grace Primary School has to invest a lot of money in sourcing water. The school spends 1,200,000 Ugandan shillings a month, which will be reduced by 80 per cent once the RWH system is in place.

(b) Increased availability of water and improved sanitation
Activities such as cleaning toilets, cooking, mopping classrooms and offices, and watering flowers and the small school garden rely on water. The national supply is not totally reliable. Installing storage tanks will mean water is available most of the time, enhancing school activities. Further, school attendance will improve due to better health and reduced water carrying burdens, especially for girls, along with school management and support for decentralization efforts.

(c) Improved food stuffs especially vegetables
The RWH system will enable the school to start – and maintain – modern agriculture practices. Vegetable gardens will be managed and pupils will eat a balanced diet. This will improve their health and happiness at school.

10.2 Expected impacts

Implementing a RWH system at Amazing Grace Primary School will benefit some 1,000 people at community level, and include environmental and health improvements, increased food security, and school development from the economies made.

(a) Environmental and health improvements
Diarrhea and typhoid are common waterborne diseases in Lugoba and surrounding areas, generally the result of an inconsistent water supply. The benefits of improving the supply will be significant for the school and the local community. Better sanitation will significantly add to better health by helping isolate disease pathogens from the household and community environment. Studies have shown that regular use of improved sanitation facilities, coupled with hygiene and behavioral change, has a considerably greater health impact than simply providing

clean water. The project focus on safe hygiene practices – such as regular use of improved latrines and washing face and hands with soap (or suitable substitutes) at appropriate times – will ensure these benefits are realized.

(b) Improved food security

Awareness of a balanced diet and the food value of vegetables, combined with higher accessibility and increased ability in managing them, are necessary to improve nutrition, and thus student health. The school will be able to produce vegetables throughout the year for pupil meals. The RWH process will provide water for growing these vegetables, helping achieve a balanced diet for pupils, hence improving health outcomes.

(c) School development from money saved

Amazing Grace Primary School's vision is to expand to more than 1,000 pupils. Extra infrastructure (classrooms and offices), playground space, libraries, storage facilities, among others, are therefore required. These facilities demand resources in terms of funds. Thus, if the school reduces its water bill, such savings can be used to improve its prospects.

11. Risks and measures to address

The RWH project may experience risks that could threaten its success. An effective risk and control measures assessment is essential. Risk and mitigation planning is the process of identifying and determining specific risks and developing actions to support opportunities and reduce threats to the mission. Some risks have been identified at the proposal stage, others will emerge during subsequent project phases. This document is produced as a baseline deliverable though envisioned as a dynamic, changing one intended to support management decision-making.

A risk is a potential event or condition that could have a negative effect on a project's objectives. Risk management is the process of identifying, assessing, responding to, and monitoring and reporting risks. This plan defines how risks associated with the RWH project will be identified, analyzed and managed. It outlines how risk management activities will be performed, recorded and monitored throughout the project. Risk management and the associated mitigation efforts are differentiated across two areas:

1. **Internal risks**: technical risks that can be directly related to project progress; for example, service delivery, and changes to the team and staff, the schedule and.
2. **External risks**: risks that cannot be directly influenced by the project team. Generally, these can hinder progress. They include inflation (cost/revenue changes), funders and sponsor changes, and changes to law and regulations.

Risk management includes up-front planning on how identified risks will be mitigated and managed. Thus, risk mitigation strategies and specific action plans are taken care of in the RWH project.

11.1 Measures to address risks (tools and practices)

Generally, risk mitigation plans should:

- outline the root causes of risks identified and quantified in earlier phases of the risk management process;
- evaluate risk interactions and common causes;
- identify alternative mitigation strategies, methods and tools for each major risk;
- assess and prioritize mitigation alternatives;
- select and commit resources required for specific mitigation alternatives; and
- communicate planning results to all project participants for implementation.

How can such common project risks be tackled for optimal success? When employed together, the following tactics will help protect an organization and significantly lower exposure to risk.

(a) Risk register

Identifying risks prior to the project start is a good way to tackle/avoid common pitfalls. A risk register acts as a tool that helps project managers track issues and deal with them as they arise. Details of all identified risks are recorded, along with analysis and plans on how they will be handled. In short, a risk register/log identifies different risks and their severity, and provides actions to mitigate them (table 18 provides a risk register for the RWH project).

(b) Project management software (Microsoft Project)

Allows project tasks and activities to be streamlined, and work planned to the last detail. Software is one of the top options in avoiding risk as it allows project managers to anticipate problems, and plan accordingly. When used with a risk register, all bases are effectively covered.

(c) Occasional project stakeholder meetings

Can help identify risks and change the course of the project accordingly. Occasional meetings at different stages can thus be helpful.

Table 18 **Risk register for rainwater harvesting project**

S/N	*Risk category*	*Risks*	*Measures to address*	*Risk impact if unmitigated*
1	Project schedule	Delayed schedule leads to higher costs	Be strict and keep to project schedule	Medium
2	Budget (cost and revenue variances)	Inflation that leads to increased project cost Revenue variance as a result of funder withdrawal	Allow for inflation in the budget Look for microfinancing and beneficiary contributions to take up the slack Stick to agreed terms with funders	High
3	Output performance changes	Worker strikes can cause lost production	Pay attractive compensation to encourage staff motivation/retention.	High
4	Team and staff changes	Staff leaving for greener pastures	Make package competitive	High

5	Law and regulation changes	Regulation requirements by the district	Build quality control in the project Conduct regular testing and quality control to meet standards	Medium
6	Funding and sponsor changes	Lack of sufficient funds for the project	Diversification of funding sources	High
7	Scope	Possibility of scope creep	Stick to project scope	High
8	Technical	Software issues	Procure reputable software	Medium
9	Quality	Poor product quality	Apply standards and qualified labor	High

Source: Author

12. Conclusions and recommendation

12.1 Conclusions

This project for adopting and developing the identified rainwater-harvesting technology can be implemented in the selected communities (Amazing Grace Primary School and surrounding areas) with tangible benefits, such as available water, reduced water bills and improved livelihoods. The average cost of a RWH system (tank support, gutters, device, pipes, tank) will be 9,337,000 Ugandan shillings per 10,000-liter capacity. The water will be used for irrigating small vegetable gardens, thereby improving food security and nutrition.

12.2 Recommendation

It is recommended that the RWH project be implemented in the selected target communities. If successful, it can be rolled out to other communities.

13. References

Appendix 1: Stakeholder analysis for rainwater harvesting project

S/N	*Stakeholder*	*Role of stakeholder*	*Stakeholder influence on Appropriate Technology Project* (*high, medium, low*)	*Interest in the Appropriate Technology Project* (*high, medium, low*)
1	Ministry of Finance, Planning and Economic Development	Government agency that coordinates development finance	High	High
2	Ministry of Water and Environment	Line ministry for water	High	High
3	Ministry of Local Government	Ministry responsible for service delivery at district and lower government levels	Medium	Medium
4	Science, Technology and Innovation Secretariat	Responsible for administering the Innovation Fund	High	High
5	Makerere University, School of Engineering	R&D and innovation in water and environmental engineering	High	High
6	Water Aid	Sponsors community water dispensing facilities (water taps)	High	High
7	Water For Life	Help communities acquire safe and sustainable water sources	High	High
8	IRC	Responds to the world's worst humanitarian crisis, helping people survive and rebuild their lives	Medium	Medium
9	Water For People	Helps people bring clean water and sanitation solutions to their communities	High	High
10	UNICEF	Responsible for providing humanitarian	High	High

		and developmental aid to children worldwide		
11	GIZ	German aid development organization	High	Medium
12	Water.org	Provides water and sanitation loans to the poor in collaboration with banks and microfinance institutions	High	High
13	Aquaya	Dedicated to advancing global health through universal access to safe water and sanitation	High	High
14	USAID	Administers civilian foreign aid and development assistance	High	Medium
15	JICA	Manages small grants scheme for developing countries	High	Medium
16	Lifewater	Builds custom water access and sanitation solutions in hardest to reach communities, including Mayuge and Kakumiro in Uganda.	High	High
17	Mercy Hands Uganda	Core work is in agricultural development, supporting farmers to increase productivity through climate-smart techniques	High	High
18	Global Water Foundation	Nonprofit organization dedicated to delivering clean water and sanitation to the world's neediest communities	High	High
19	Appropriate Technology Centre	Premised on the desire to unlock WASH R&D potential and catalyze uptake of appropriate technology in Uganda	High	High

Appendix 2: Job description for project coordinator

To successfully accomplish the above tasks, the project coordinator for the rainwater harvesting project should have:

- A Bachelor's degree in Business Administration/Economics/Engineering/Social Science/Natural Resources, preferably with a focus on water systems, from a recognised/reputed university.
- At least five years' relevant working experience on projects, preferably in Uganda, with either a bilateral or multilateral donor organization, construction firm or other private sector player, with responsibility for infrastructure projects, preferably in the water sector.
- Strong problem solving and analytical capacity, and ability to prioritize activities and identify relevant issues and trade offs. Appropriate recommendations must be provided.
- Excellent oral and written communication skills in English, as well as strong presentation skills for a wide range of audiences.
- Demonstrated ability to interface effectively, and collaborate and communicate with different clients and partners, from the public to the private sector, as well show intercultural competence.
- Demonstrated ability to work flexibly on a range of assignments, adjust to changes in schedule and priorities, and handle concurrent tasks effectively and efficiently.

Appendix 3: Financial projections

The Cash Flow Statement follows.

Cash Flow Statement

Fiscal year begins: 1/2/2023	(Pre-) Startup EST	JAN 02	FEB 02	MAR 02	APR 02	MAY 02	JUN 02	JUL 02	AUG 02	SEP 02	OCT 02	NOV 02	DEC 02	Total Item EST
Cash on hand (beginning of month)	-		8,700,000	17,400,000	17,450,000	128,100,000	119,800,000	83,900,000	63,000,000	48,600,000	24,200,000	14,800,000	5,400,000	5,400,000
Cash receipts														
Balance brought forward	-													-
Grant					117,950,000									117,950,000
Community contribution		20,000,000	20,000,000	10,550,000										50,550,000
Total	-	20,000,000	20,000,000	10,550,000	117,950,000	-	-	-	-	-	-	-	-	168,500,000
Total cash available (before cash out)	-	20,000,000	28,700,000	27,950,000	135,400,000	128,100,000	119,800,000	83,900,000	63,000,000	48,600,000	24,200,000	14,800,000	5,400,000	173,900,000
Cash paid out														
Project coordinator		4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	48,000,000
Office expenses (printing & stationery)		400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	4,800,000
Planning facilitations		900,000	900,000	900,000	900,000	900,000								4,500,000
R&D		2,000,000	2,000,000	2,200,000										6,200,000
Acounting, auditing & NEG activities		1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000			10,000,000
Community mobilization		1,000,000	1,000,000	1,000,000	1,000,000	1,000,000								5,000,000
Resource mobilization		2,000,000	2,000,000	1,000,000										5,000,000
Engineering designs for structures							2,500,000	2,500,000						5,000,000
Procurement						1,000,000	1,000,000	1,000,000						3,000,000
Amazing Grace Primary School							20,000,000	5,000,000	5,000,000					30,000,000
Supervision of installation							5,000,000	5,000,000	3,000,000					13,000,000
Testing of water samples							2,000,000	2,000,000	1,000,000					5,000,000
Operations & maintenance										2,000,000	2,000,000	3,000,000		7,000,000
Monitoring & evaluation										2,000,000	2,000,000	2,000,000	1,000,000	7,000,000
Commissioning										15,000,000				15,000,000
														-
Other (specify)														-
Other (specify)														-
Miscellaneous														-
Total	-	11,300,000	11,300,000	10,500,000	7,300,000	8,300,000	35,900,000	20,900,000	14,400,000	24,400,000	9,400,000	9,400,000	5,400,000	168,500,000
Cash paid out (non P&L)														
Loan principal payment														-
Capital purchase (specify)														-
Other startup costs														-
Reserve and/or escrow														-
Owner withdrawal														-
Total	-	0	0	0	0	0	0	0	0	0	0	0	0	-
Total cash paid out	-	11,300,000	11,300,000	10,500,000	7,300,000	8,300,000	35,900,000	20,900,000	14,400,000	24,400,000	9,400,000	9,400,000	5,400,000	168,500,000
Cash position (end of month)	-	8,700,000	17,400,000	17,450,000	128,100,000	119,800,000	83,900,000	63,000,000	48,600,000	24,200,000	14,800,000	5,400,000	-	5,400,000

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