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Healthy Hospital Design and Water Supply
– the case of Kolandoto Hospital in Tanzania

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CHALMERS
UNIVERSITY OF TECHNOLOGY

Engineering Aid in Practice and its Challenges

A case study on improvements of water and power systems at a hospital in Tanzania

Master's Thesis in the Master's Programme Infrastructure and Environmental Engineering

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ABSTRACT

Aid projects involves issues and challenges, such as donor influence, aid dependency and lack of ownership for the recipient. In order to prevent this, a change in aid policy has been implemented. The Sida frame organisation Forum Syd has switched their policy from a need-based aid approach to focus more towards aid for human rights. Instead of working with improving fundamental needs, attention is given to demanding governmental support and responsibility.

Within this master thesis, the engineering aid project *Healthy Hospitals* was conducted at a hospital in a village in Tanzania. The project is carried out as a collaboration between three NGOs; I Aid Africa, Engineers Without Borders and Architects Without Borders. The *Healthy Hospitals* project is divided into two phases. During the first phase, a full survey of the hospitals' infrastructure was carried out together with short term engineering solutions. In the second phase, the suggestions made in the survey report are intended to be implemented in order to promote future development of the hospital.

The *Healthy Hospitals* project have been used as a case study for the master thesis in order to discuss and evaluate issues connected to engineering aid work, in the context of Kolandoto Hospital.

Results from this master thesis indicates increasing aid dependency for Kolandoto Hospital during the first phase of the *Healthy Hospitals* project. A more thorough planning of phase two could allow for the hospital management to be more included, increase ownership and therefore decrease aid dependency. In addition, the thesis' suggests that need-based aid can be used to improve human rights, despite the change in Swedish aid policy.

Key words: Sida, Engineering aid, water systems, aid dependency, donor influence, Tanzania, Engineers Without Borders

Ingenjörsbistånd i Praktiken och dess Utmaningar
En fallstudie om förbättringar av vatten- och elsystem på ett sjukhus i Tanzania

Examensarbete inom masterprogrammet Infrastructure and Environmental Engineering

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SAMMANFATTNING

Biståndsprojekt kommer med stora utmaningar. Biståndsberoende, givarinflytande och ägandebrist är vanliga termer som berör problematiken. För att minska och förhindra utmaningar kopplade till bistånd har Forum Syd, ramorganisation till Sida, ändrat sitt tillvägagångsätt. Istället för att fokusera på behovsbaserat bistånd främjas nu mänskliga rättigheter, där statligt stöd och ansvar krävs.

Inom denna masteruppsats har ett ingenjörsbiståndsprojekt, *Healthy Hospitals,* utförts på ett sjukhus i Tanzania. Projektet är ett samarbete mellan tre organisationer; I Aid Africa, Ingenjörer Utan Gränser och Arkitekter Utan Gränser. Projektet *Healthy Hospitals* är indelat i två faser. Under den första fasen gjordes en komplett undersökning av sjukhusets infrastruktur, tillsammans med kortsiktiga ingenjörsmässiga lösningar. Under den andra fasen skall de föreslagna förbättringarna under fas ett implementeras för att möjliggöra fortsatt utveckling av sjukhuset.

Healthy Hospitals-projektet användes som en fallstudie i masteruppsatsen för att diskutera och utvärdera frågor kopplade till ingenjörsbistånd, i kontext av Kolandoto Sjukhus.

Resultat från masteruppsatsen visar att Kolandoto Sjukhus biståndsberoende ökade till viss del under fas ett av projektet. Rekommendationer för fas två inkluderar därför en mer grundlig planering, där sjukhusledningen är mer involverad, vilket kan öka sjukhusets ägandeskap och därmed minska biståndsberoendet. Resultatet visar även att behovsbaserat bistånd kan användas för att främja mänskliga rättigheter, trots förändringen i svensk biståndspolitik.

Nyckelord: Sida, Ingenjörsbistånd, vattensystem, biståndsberoende, givarinflytande, Tanzania, Ingenjörer Utan Gränser

Contents

Preface

In this master thesis issues regarding engineering aid work are studied using the *Healthy Hospitals* project as a case study. The thesis have been conducted during the period January – June 2015 at Chalmers University of Technology, combined with a nine week field study in Kolandoto, Tanzania. The project is a collaboration between three organisations; I Aid Africa, Engineers Without Borders and Architects Without Borders.

We would like to express our gratitude towards Mikael Mangold, both for supervision throughout the master project, as well as technical support during the field study in Tanzania. Also, Jon Gunnarsson Ruthman's dedication and involvement in the project needs to be acknowledged and highlighted.

Finally, a special thanks to the staff at Kolandoto Hospital, including Dr. Katani, Robert Isack, Kassim Said Mohamed and the entire water staff. Your guidance and enthusiasm during the field study were crucial for the project.

Göteborg June 2015

Andreas Berg

Daniel Kallus

Notations

AICT	Africa Inland Church Tanzania
ASF	Architecture Sans Frontières (Architects Without Borders)
CDH	Council Designated Hospital
IAA	I Aid Africa
IMF	International Monetary Fund
ISF	Ingénieurs Sans Frontières (Engineers Without Borders)
NGO	Non-governmental Organisation
SHUWASA	Shinyanga Urban Water & Sewerage Authority
Sida	Swedish International Development Cooperation Agency
TANESCO	Tanzania Electric Supply Company
WHO	World Health Organisation

1 Introduction

All aid work entails issues and challenges. An unequal relation between the donor and the receiver is established when aid is given, and a situation of long term dependency may arise. Throughout the history donors has failed to acknowledge this, which has led to aid in some cases doing more harm than good. This has also led to a shift in policy by the Sida organisation Forum Syd, from focusing on need-based aid to prioritising human rights based aid.

Engineering Aid in Practice and its Challenges: A case study on improvements of water and power systems at a hospital in Tanzania is a master thesis at the department of Civil and Environmental Engineering at Chalmers University of Technology. Within the master thesis, the aid project *Healthy Hospitals* was performed together with the Engineers Without Boarders (ISF), Architects Without Boarders (ASF) and the Swedish aid organisations I Aid Africa (IAA). The overall objective of the *Healthy Hospitals* project was to suggest and implement improvements for the infrastructure at the hospital in the village of Kolandoto, Tanzania.

The *Healthy Hospitals* project has been utilised as a case study for this master thesis, to contextualise and discuss issues connected with conducting engineering aid work.

1.1 Background

The issues of extreme inequality in living standards between countries carelessly labelled as "developed" and "developing" has long been a hot topic for public debate. This discussion often centralises around the extreme poverty faced in large parts of Africa and despite large sums of aid transferred to the continent throughout the history, sub-Saharan Africa still remains the poorest region in the world (Moyo, 2009). The fact that 48.5 % of the region's population still are living on less than $1.25 a day (United Nations Development Programme, 2013) while hundreds of millions of people in East Asia has escaped poverty the recent decades (Tallroth, 2010), has had the current aid regime questioned by many.

The Swedish aid organisation Forum Syd is a Sida (Swedish International Development Cooperation Agency) frame organisation responsible of forwarding Sweden's governmental aid funds to other Swedish aid organisations. In their policy platform for 2013 – 2022, Forum Syd states that their main objectives are to "strengthen marginalised people around the world who organise to claim their rights [and] advocate for changes that contributes to a just and sustainable world" (Forum Syd, 2012). This follows the human rights-based approach to developmental aid which Tallroth (2010) means has gained momentum in recent decades and become the major form in which Swedish aid is given. Accordingly, the need-based approach which focuses on direct aid to counter poverty and encourage growth, has been given lower priority. In contrast to this, the *Healthy Hospitals* project fit arguably into the need-based approach rather than the more in-fashion approach for human rights.

1.1.1 Project: Healthy Hospitals

The main purpose of the *Healthy Hospitals* project was to improve the infrastructure at the Kolandoto Hospital, mainly focusing on water, electricity and buildings. From the findings during the field study which was the project's first phase, proposals on future improvements were put forward to the hospital management and the involved NGOs. The aim is to implement as many of these suggestions as possible in the second phase of the project, depending on the feasibility and the amount of funds accumulated.

Furthermore, the purpose of the field study also was to investigate if so called "quick engineering solutions", to improve urgent and necessary infrastructure issues at the Kolandoto Hospital, also could be implemented during the first phase of the project. A budget of in total 90 000 SEK was available for this purpose, which is presented more thoroughly in Chapter 4.2.

In summary, the main aims for the project was to:

- Implement quick engineering solutions in phase one
- Suggest improvements suitable for the hospital for phase two

The proposed suggestions and implemented quick solutions were presented to IAA in a report which can be found in its entirety attached to this thesis, labelled *Survey Report*.

1.2 Purpose

The purpose of this thesis is to make conclusion regarding engineering aid work, by evaluating the work conducted within the *Healthy Hospitals* project. Furthermore, the purpose is also to exemplify how engineering aid work contributes to *aid dependency* and to present how phase two can be conducted in order to increase recipient *ownership*.

Finally, the decision by Forum Syd, to focus on human rights based aid and to limit funding for physical aid work, will be analysed in the light of the *Healthy Hospitals* project.

1.2.1 Research questions

RQ1: Did the *Healthy Hospitals* project increase aid dependency at Kolandoto Hospital? If so, how could aid dependency have been minimised, and who has the responsibility to end an aid project?

RQ2: Did the *Healthy Hospitals* phase one involve Kolandoto Hospital, i.e. promote ownership, sufficiently?

RQ3: Can the suggested physical improvements, i.e. need-based aid work, for phase two of the *Healthy Hospitals* project contribute to achieve the objectives of human rights based aid work?

2 Method

A scientific methodology was adapted to fulfil the purpose of this thesis, answer the research questions and draw conclusions. The project *Healthy Hospitals* have been used as a case study in the research and will together with complementary literature on history and theory provide a basis for this report's discussion and conclusions.

A historical background to aid in general is given at first and is followed by an assessment of some of the available literature on the subject. The intention is however not to give a complete presentation of the available literature on the topic, but to contextualise the subject and support the thesis' argumentation.

2.1 Case study

The fundamental design of this case study research is based on the methodology put forward by Robert K. Yin in his *Case Study Research: Design and Methods* (2003). However, Yin's research programme has not been followed entirely but the fundamental points have been used.

Yin proposes "*six sources of evidence*", which are the main sources of information available for a case study, even though additional sources in some cases can be necessary. The proposed major sources are: documentation, archival records, interviews, direct-observations, participant-observation, and physical artefacts. It is pointed out that all of these do not have to be utilised even though a case study benefits from using several sources of information (Yin, 2003). For this case study, the main sources were interviews, direct-observations, and participant-observations.

2.1.1 Interviews

The interview is considered as one of the most important sources of information to the case study. Yin argues that the interview should be more of a fluid "guided conversation" than a firm formal enquiry. Furthermore, he stresses that the interviewer has to ask non leading questions, and appear friendly and non-threatening. This is done by asking "how"-questions, preferred to "why"-questions, which can cause defensiveness with the interview object (Yin, 2003).

Interviews for this case study were conducted with Dr. Katani, the medical officer in charge, medical and technical staff at the hospital, and IAA's *Healthy Hospitals* project leader Jon Gunnarsson Ruthman (see full list in *Table 2.1*).

Table 2.1 Interview objects including their occupation.

Name	Occupation
Dr. Elimeleki Katani	Medical Officer in Charge
Robert Isack	Dental nurse
Metsela 'Nkaka' Charles	Responsible for Power Supply
Julius Omango	Responsible for Water Distribution
Jon Gunnarsson Ruthman	IAA project leader

Questions used for the interviews were adjusted depending on people's occupation and role in the project, but Yin's abovementioned interview guidelines were followed at all times. All questions are presented in Appendix I – Interview questions.

2.1.2 Observations

By the nature of the thesis, where the execution of the *Healthy Hospitals* project was an essential part, the direct-observations and participant-observations became the obvious major sources of evidence. In participant-observation, the researchers play an active part of the work, compared to the direct-observation where the researchers merely are passive beholders (Yin, 2003). As a large part of the aid work analysed by this thesis was conducted by the authors themselves, the recommendations for the special mode of observation that is participant-observation has to be carefully regarded.

Yin (2003) describes some potential problems faced for the participating observer, all related to risk for biases. One example is the loss of external overview for the researcher, which might conflict with "good scientific practice". For the research done within this thesis, the risk of biased experiences has to be accounted for. However, the opportunities which comes with participant-observation is still regarded predominant to the potential drawbacks. Yin writes that a "*distinctive opportunity is the ability to perceive reality from the viewpoint of someone 'inside' the case study rather than external to it*" and acknowledge this as great chance to produce a precise representation of a case study's course of events (Yin, 2003). The advantages of participant-observation provides the *Healthy Hospitals* case study with a scope and a unique opportunity of insight into practical engineering aid work.

2.1.3 Principles of data collection

When obtaining information through one of the six sources of evidence, Yin (2003) urges the researcher to follow his three "*principles of data collection*": "*use multiple sources of evidence*", "*create a case study database*", and "*maintain a chain of evidence*". When used properly, the principles facilitate validity and reliability of the conclusions made from the case study.

The use of several different evidence sources is recommended to ensure the accuracy of a fact and make the conclusions more convincing. Interviews is therefore used in this case study as verification to the data obtained through observations and experiences. A proper database has however not been assembled in the manner suggested by Yin's (2003) second principle of data collection. Nevertheless, a thorough *Survey Report* from the case study, with extensive additional documentation as appendices, is supplemented to this thesis. The purpose of the database is, according to Yin (2003), to be available for independent inspection by the reader. This requirement is to a large degree fulfilled by the documentation in the *Survey Report*.

Finally, Yin (2003) stresses the importance to maintain the evidential chain. The chain should be able to be traced either way; from collected data to conclusion, and from conclusion back to the data from which it was derived. To fulfil this principle Yin (2003) proposes the use of comprehensive citations so the reader can follow the authors' line of thought. This thesis therefore includes detailed referencing to the *Survey Report* throughout.

2.2 Limitations

The majority of the conclusions and results in this master thesis is only based on one small-scale case study. Experiences from other projects is merely regarded to some degree in the literature review.

Interviews were made during the field study with hospital management and staff. The will of the aid recipients to keep the donors satisfied could however result in biased answers from the interviews. Also, a personal relationship was established with the participants, possibly influencing the respondent. A particular close connection was established with the interview object Robert Isack, since he also functioned as the survey team's English-Swahili interpreter for communication with non-English speakers.

His role could be described as an "informant" more than a respondent, according to Yin's terminology, where an informant is regarded as a person who not only responds to questions but also can recommend and initiate further sources of evidence (Yin, 2003). Even though Yin states that the use of an informant can be vital for the execution of a successful case study, he also warns for potential over-dependency and personal influence from the informants. This risk could however be managed by the use of several different sources, yet the survey team still had to be aware of the issue.

3 Aid: Background and Theory

In order to evaluate the field study in Kolandoto, knowledge from existing theory needs to be presented. In this chapter, different views and opinions are described, as well as a background history. In addition, the distinctions between need- and human rights-based aid are defined, together with concerns regarding its application.

3.1 Aid after the Bretton Woods-agreement

In *Dead Aid* (Moyo, 2009), the author's critique of the current aid system is supported by a brief recapitulation over the history of aid. From the birth of aid in 1944 in Bretton Woods, USA up to present time, the exposé highlights the 1960's as "the decade of industrialization", when the focus of aid was directed towards funding large-scale industrial projects. After the Marshall Plan, which in general was viewed as a great success, where aid was transferred from USA to rebuild post-war Europe, IMF and World Bank funds were freed up and available for other purposes. Africa then became the new primary target for aid; to support the industrialisation and economic growth in Africa, and for the former colonial powers to maintain their influence in their recently lost territories (Moyo, 2009).

In Sweden, aid arose as a political idea in the late 1940's, and Sweden's first aid agency was funded in 1952 under the name *The Central Committee for Swedish Technical Aid in Less Developed Countries*, known as CK (Hydén, 2010). CK initially chose to work with Ethiopia and Pakistan, providing professional training in for example health and building technology, as Sweden internationally was regarded prominent in these areas (Odén, 2006). In 1965, CK was replaced as SIDA was founded. This started an era in Sweden when foreign aid gained in popularity as SIDA further developed Swedish aid under the 1970's (Hydén, 2010).

Internationally, the focus of aid (commonly in the form of grants and discounted loans) then shifted in the 1970's as the oil crisis was followed by an increase in food and commodity prices. This resulted in a period of recessions for several African countries, and funds were redirected from large infrastructure projects to poverty relief and aid to the social and health sectors. The following decades, physical infrastructure did not return as a prioritised target for aid (Moyo, 2009).

The oil crisis and high degree of loaning in the 1970's were followed by rising interest rates in the 1980's. This lead to widespread defaulting on debt payments all over the world, including eleven countries in Africa. A large part of the aid to African nations during the 1980's went to repaying old debts and, Moyo (2009) writes, "necessary though this was, the end result only served to increase poor countries' aid-dependence and put them deeper into debt". In *Bistånd på villovägar* Tallroth (2010) claims that several African governments had to cut their infrastructure investments in order to reduce their unsustainable budget deficits, and Moyo (2009) even labels the 1980's as "the lost age of development".

Pressure from aid organisations on African governments to channel funds to social sectors, as well as bi- and multilateral donors redirecting their aid in the same way, led to further cuts in the infrastructure budgets in the 1990's. From 1993 to 2003 the foreign aid directed towards infrastructure investments dropped by 70 percent, while only eight percent of Sida's total aid to African countries in 2007 went to such projects (Tallroth, 2010).

The Swedish aid policy was transformed during the 2000's. Experiences from the structural adjustments of the 1980's and 1990's lead to emphasis on the importance of recipient ownership in order for the aid projects to be successful. Also, the proposition *Policy for Global Development*, known as PGU, was adopted by the Swedish government in 2003. This declared that the developmental foreign aid should be focused on a human rights-based approach and centre around poor people's interests (Odén, 2006).

3.2 Approach of aid organisations

Economic development consultant Dr. Ernesto Sirolli have expressed his concerns regarding aid organisations approach in recipient countries. According to Sirolli (2012), aid organisations often aims to fix problems they find urgent themselves, before consulting with the local people. Arriving to a new community with an attitude of listening to the people and providing them with knowledge should instead be prioritised. He claims local people with own ideas are more passionate and have a willingness to grow, and the aid organisations should function as servants and promote these ideas. He also highlights the most important aspect of economic development as "If people don't want your help, leave them alone".

Uganda born journalist Andrew Mwenda is a well-known critic of aid to Western Africa. Mwenda (2007) considers aid to be concentrating on fixing the symptoms instead of the actual cause. As a consequence money are spent on fundamental necessities, such as medicine and food, making countries in Africa a subject for charity. He suggests supporting research and private investments instead, which are more important to encourage future development in the recipient countries.

3.3 Aid dependency and donor influence

Bertil Odén writes in *Biståndets Idéhistoria* that even though aid donors often argues aid only to be a pure transaction of resources, it will always cause political consequences in the receiving country (Odén, 2006). Giving aid, regardless of initial intention, introduces an imbalanced relation of power between the donor and the receiver. The receiver becomes dependent of the donor, while the donor gain influence over the receiving organisation.

Furthermore, the position of power provides the donor with the opportunity to conditionalise the aid. To give aid under reasonable conditionalities are generally accepted from both parts. However, the question instead comes to agree on what to be regarded as reasonable (Odén, 2006). It is within the aid community generally considered necessary to involve and engage the aid recipient in each project in order to gain long term success. This is achieved by making the recipient *owner* of the project. Conditionality, used as a tool to reach the project's targets, clashes with the idea of recipient ownership. This is pointed out by Odén (2006) as a built in contradiction in aid theory.

3.3.1 A relationship of dependency

The former Sida chairman Jan Bjerninger addresses in *Det framgångsrika biståndet* (2013) some of the potential negative impacts which comes with foreign aid. As one of the most relevant issues, Bjerninger (2013) raises the problem with aid putting the receiver in a situation of dependency towards the donor. He writes that up to, and beyond, a third of a country's total state budget can in some cases come from foreign aid. Likewise, several NGOs might obtain the majority of their finances from different kinds of aid projects. According to Bjerninger (2013), there is a risk that aid in such cases act pacifying as it removes responsibility from the local actor when they become dependent on the donor.

Odén (2006) also identifies the risk that aid could pacify the receiver. He argues that long term aid projects can establish a mind set in the receiving organisation where the solution to a problem becomes "which aid organisation can solve this for us?" rather than "how can we solve this?". As remedial measures to prevent this, Odén (2006) suggests improved leadership and increased ownership.

In *Det Omöjliga Biståndet* by Bo Karlsson, research regarding aid dependency in four different countries, among them Tanzania, was studied. The author claims an increase of aid dependency during recent years, where the level is described as "unsustainable". The author labels the time period of which the recipient receives aid as a decisive aspect, where a long term collaboration can cause dependency (Karlsson, 1996).

3.3.2 Donor influence

Mwenda (2007) argues by receiving large sums of foreign aid, governments in the recipient country include the donor in the decision-process rather than their own citizens. Hence, the citizens of the recipient countries have no real influence since the aid dependent government too heavily rely on the donor (Mwenda, 2007). This makes an aid benefitting organisation or country to answer towards the donor, rather than to their members or citizens (Odén, 2006).

Bjerninger (2013) identifies this as a democratic issue, as strategies or policies can be implemented without passing the democratic decision process in the receiving country. He argues that the democracy in a country thus can be undermined by aid given under conditions. If the condition is to implement a certain policy important to the donor, the receiving government or organisation might not afford to reject the aid, even if the condition under which it is given goes against the public opinion in the receiving country (Bjerninger, 2013). Odén (2006) exemplifies this with the structural adjustments of the 1980s, when countries indebted to the IMF/ World Bank had no option but to accept the demands of their creditors and adjust to their policies in order to receive further aid. The principle of ownership was in this case overlooked in favour of the donor's conditionality.

3.4 Need- or human rights-based aid?

The methodology of foreign developmental aid can be categorised into either need-based aid or human rights-based aid. Need-based aid, throughout the history the most common method when providing foreign aid, is by Forum Syd (2015) exemplified as:

- Help and alleviation for the poor
- Meet fundamental needs where the government fails
- Improve current structures

The issues with aid described earlier in this chapter are by Forum Syd regarded partially as a consequence of the need-based aid approach. To counteract these problems, such as aid dependency and lack of ownership, Swedish developmental aid policy has shifted from a need-based policy to a human rights focus. Forum Syd (2015) exemplifies human rights-based aid as:

- Empowering people living in poverty to organise themselves
- Demanding responsibility by the government where needs are linked with human rights
- Organisational changes in structures

Focusing more on human rights-based aid involves education where citizens are informed about their rights (Blüchner, 2014). People living in poverty are viewed as entities participating in the projects and the organisations are tools, used for change (Forum Syd, 2015). Further, human rights-based aid promotes democracy and therefore the ability for citizens to change and develop (Utrikesdepartementet, 2008).

According to Forum Syd (2012), the shift in aid policy contributes to more sustainable changes, where the government is made responsible to comply with human rights. Promoting need-based aid neglects the government's responsibility to encourage their own citizens' needs, since the government rely on the aid organisation (Blüchner, 2014). In addition, local organisations are used to reach the poor who are viewed as objects and items for the project (Forum Syd, 2015).

In *Bistånd på villovägar*, Tallroth (2010) discusses the shift to human rights-based aid in Swedish aid policy. According to the author, promotion of democracy and human rights often deprives focus on fundamental needs, such as food, water and shelter. Furthermore, he argues that the promotion of human rights-based aid often results in a decrease of improvements regarding fundamental needs in situations where they are a necessity. The author criticizes the Swedish government's definition of poverty, stated as "lack of freedom, influence, power and safety". He claims this definition to be more applicable in regions where basic needs already are present.

4 Case: The Healthy Hospitals project

Healthy Hospitals is a project of multiple phases, as described further in Chapter 4.2. The project functions as a case study for the master thesis, where different situations encountered during the field study in phase one have been selected as examples. These situations will be evaluated and discussed in Chapter 5, based on presented theory and interviews. The purpose of using these situations when evaluating the proposed research questions in Chapter 1.2.1, is to use a real case study, where actual engineering aid work has been conducted. Also, experiences from the field team as well as the hospital staff will be applied when answering the suggested research questions. Additional information to the case study is presented in the *Survey Report*.

4.1 Kolandoto Hospital

Kolandoto is a village located in the Shinyanga province in the north of Tanzania, about 750 km north-west of Dar es-Salaam, see map in *Figure 4.1*.

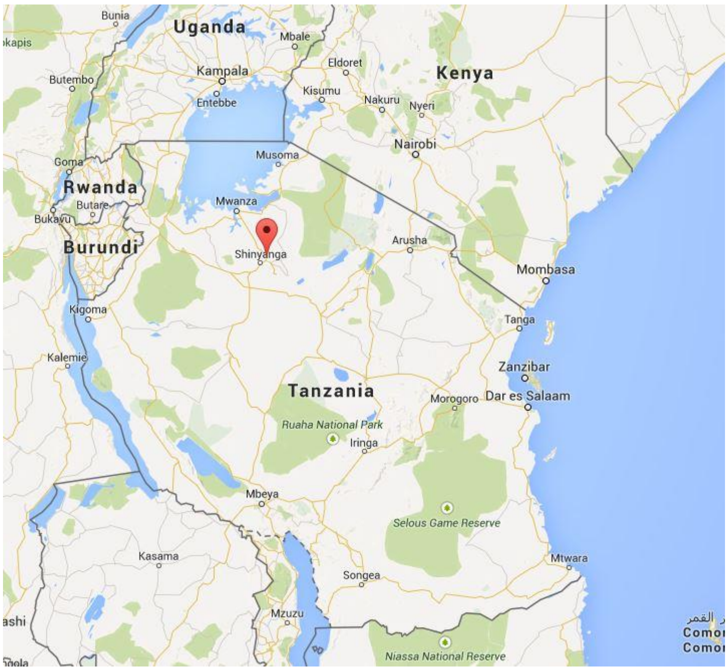

Figure 4.1 Location of Kolandoto (Google Maps, 2015).

The village has a population of approximately 10 000 inhabitants and centres around the Kolandoto Hospital, a teaching hospital with 500 students and approximately 180 beds, entrance seen in Figure 4.2. The hospital has been collaborating with IAA and the Swedish Red Cross for educational purposes during several years.

Figure 4.2 Entrance of the Kolandoto Hospital.

Kolandoto Hospital was founded by missionaries in 1913 (Röda Korsets Högskola, 2015). Donations from aid organisations have allowed the hospital to grow from a small medical reception to a large regional hospital. The hospital specialises in eye care, and a fully equipped eye theatre is located in the premises. Also, an eye ward including 24 beds are available in the hospital area. Specializing in eye care have been influenced by aid donors, since most of the available equipment have been obtained from aid organisations.

4.1.1 Situation today: failing infrastructure systems

The hospital receives their potable water from an own drilled well. The hospital and the surrounding village have however long been suffering from a failing water system, with malfunctioning groundwater pumps and an ageing pipe network. Kolandoto Hospital officials have expressed a desire to be assisted with a full survey of the water system, including pumps, pipes and water towers, as well as recommendations for improvements. In order to secure a sustainable future usage of the ground water, a full examination of the water system, distribution as well as quality, is therefore necessary and urgent.

There is also issues regarding the water quality of the groundwater which is used for domestic consumption. Faecal contamination has been detected at the source, with coliform level above recommended guidelines. Additionally, high fluoride concentrations of about 10 ppm has been measured in the drinking water, raising above the World Health Organisation guidelines, of 1.5 ppm. Values above the guidelines will primarily discolour teeth, but wearing of equipment is also of concern. However, when levels exceed 10 ppm the consumers are exposed to the risk of skeletal diseases (WHO, 2006). No signs of negative impact from fluoride consumption have been observed according to doctors at Kolandoto Hospital.

In addition, the hospital suffers from regular power cuts. The hospital receives power from the national grid, provided by TANESCO, Tanzania Electric Supply Company. Power cuts are considered a health risk since the regular occurrence have caused abrupt cancellation of on-going surgeries as well as other negative impacts on health care. Additional information is available in Chapter 4.2 in the *Survey Report*.

4.2 Project structure

Phase one of the *Healthy Hospital* project is the first phase within a larger project consisting of two phases, where the suggestions from phase one are intended to be implemented during phase two. Phase one was executed during the spring in 2015, while the project is planned to continue with phase two during 2015/2016. In *Figure 4.3*, a schematic overview of the collaboration in the project is presented.

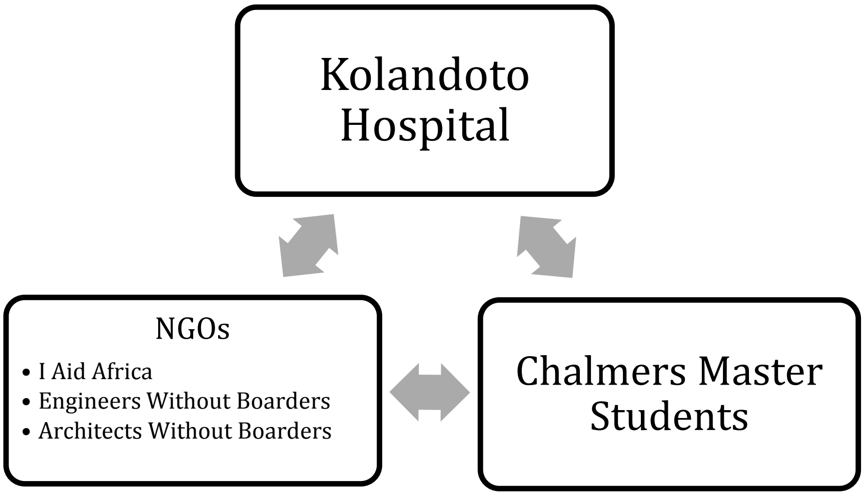

Figure 4.3 Schematic map over collaborations in the project.

In the *Healthy Hospital* phase one project there were three deliverables:

- An engineering master thesis written by Andreas Berg and Daniel Kallus
- An architectural master thesis regarding a master plan of the hospital by Annika Danielsson
- A report to IAA with recommendations for future improvements. The report to IAA will be written in cooperation between Andreas, Daniel and Annika.

In addition to these theoretical deliverables the intention was also to implement quick engineering solutions during the field study at Kolandoto Hospital. Examples of such solutions were to specify demands for a new ground water pump, purchase it with funds from IAA, ISF and Kolandoto hospital and install it. Another example was water quality tests, necessary to design a disinfection process. However, the feasibility for quick solutions had to be evaluated at site in terms of their applicability and available funding.

A total of 40 000 SEK was promised by these organisations, and a form for requesting these funds were developed. Additional funding has also been granted from scholarships. 50 000 SEK was obtained from the ARQ foundation, explicitly for quick solutions in phase one. A table and a schematic overview of the funding in the project are presented in *Table 4.1* and *Figure 4.4* respectively.

Table 4.1 Budget for phase one of the project

Budget for phase one	
Organisation	Amount
I Aid Africa	20 000 SEK
Engineers Without Borders	20 000 SEK
Scholarship	Amount
ARQ Foundation	50 000 SEK
Total	**90 000 SEK**

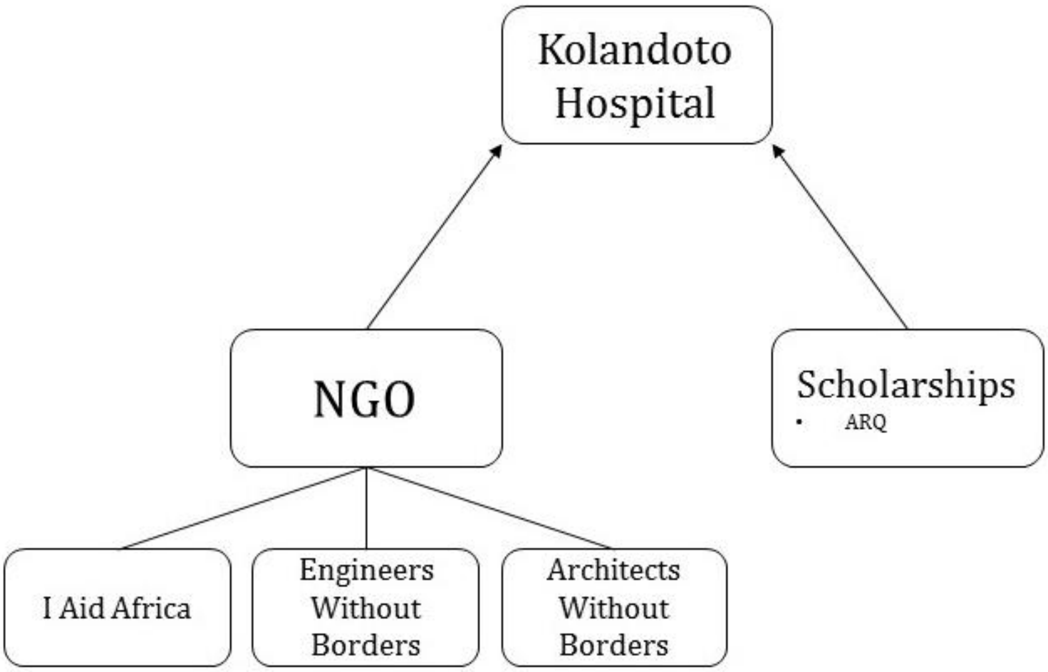

Figure 4.4 Schematic overview of project funding

4.3 I Aid Africa's approach

IAA have developed a document, concerning their approach in aid projects. Key points mainly includes focus on the aid recipient, where aid will promote future development for the receiver. IAA's vision is to improve the future for individuals, where a long term development is encouraged. Their overall project aim is to be an active organisation and to complete all initiated projects. The full document is presented in Swedish in Appendix II – IAA's statutes.

Ruthman (2015) mentions IAA's aim of the collaboration with Kolandoto Hospital as "not to be needed". He also claims IAA's work are contributing to aid dependency, however, the risk can be mitigated. Supporting interventions which has an end, as IAA's overall project aim declares, should be promoted. (Ruthman, 2015)

4.4 Project's approach

During the start-up of the project the project team thoroughly discussed potential challenges and issues, and which approach to have towards the recipients. During the collaboration, Kolandoto Hospital has to be regarded as bigger than IAA. This means that the development of Kolandoto Hospital is more important than the success of the involved organisations. Furthermore, it means that the hospital has the final say in all decisions and has the right to end the project at all times.

An important strategy used in the project was also to employ local contractors and purchase domestic material whenever possible. The thought is that local spending strengthens the regional economy and gives positive spin-off effects in the area. To hire local personnel also facilitates the hospital's ownership over the project and enables the hospital to create lasting collaborations with local entrepreneurs after the end of the project. Finally, it is also important for the field survey team to have an understanding and respectful approach to local traditions and customs.

4.5 Roles of hospital management and staff

Dr Elimeleki Katani is medical officer in charge of Kolandoto Hospital. He has a great influence on the hospital and decisions made in the *Healthy Hospitals* project. In addition, Dr. Katani also have influence on decisions which will affect the surrounding village, since his status as head doctor is highly respected.

His function in the project has both been as a project formal leader and as a vital part of the decision process. Together with the hospital management team, consisting of doctors from different wards, most decisions and priorities for phase one and two were made. All meetings during the field study was prepared by Dr. Katani, who invited staff relevant to the process.

Robert Isack is a dental nurse, practicing at Kolandoto Hospital. Due to his knowledge in English, he was suggested to be a translator by Dr. Katani, at the beginning of the field study. Also, Kassim Said Mohamed was assigned to the project with the aim to help with interpretation. Kassim currently works as an environmental health practitioner at the Shinyanga Municipality. Robert's and Kassim's role during the project change as it progressed. First, their function were mainly planned to be as translators and support the communication with water staff and contractors. As the project prolonged Kassim assisted the survey team with direct communication to contractors and representatives from the municipality of Shinyanga and investigated vital parts of the project. Since Robert was located in Kolandoto, he functioned as a valuable link between the survey team and the water staff. Both a professional and friendly connection were established with Robert and Kassim during the project where Robert also was a participant of the interviews conducted in Kolandoto.

The water staff were present during all test and installations in the project, contributing with their expertise and experience. However, the water staff had no real influence concerning decisions made during phase one, or suggested improvements for phase two. These decisions and priorities were mainly made during meetings with the hospital management, managed by Dr. Katani.

5 Results

Various situations of certain interest from an aid-theory perspective were encountered by the survey team during the field study. A selection of these situations are described and evaluated in the following section. These situations, together with aid theory and field interviews, are utilised to answer the thesis' proposed research questions. The answers are presented as results in the following chapter. Additional information and technical details regarding these events are available in the *Survey Report*. Each situation have also been connected to relevant research questions which have been presented in Chapter 1.2.1.

5.1 Hospital to become CDH

Kolandoto Hospital is currently a Regional Hospital where medicines and salaries mainly are funded by Africa Inland Church Tanzania, AICT. AICT is a faith based organisation and has been collaborating with Kolandoto Hospital for an extensive time.

The hospital management desire to make the hospital a Council Designated Hospital, CDH. Becoming a CDH entails governmental support, where drugs and salaries are funded by the government. Furthermore, if the hospital reaches CDH-status, the patient fees would be reduced, allowing more people to seek medical treatment. The governmental financial support would allow the hospital to employ more doctors and nurses, which could improve the current health care and access. However, governmental salaries are only paid to staff with diplomas, employees without a degree still need to rely on AICT to receive salaries. The potential negative effects from this are further discussed in Chapter 6.2.3.

In order to obtain the title CDH, requirements have been established by the government which has to be fulfilled. These requirements include the presence of certain wards and a steady and stable water and power supply. Improvements conducted during phase one (Chapter 5 in the *Survey Report*) promotes the hospitals attempt to become a CDH. Also, suggested improvements for phase two, see Chapter 6 in the *Survey Report*, will support the hospital to obtain CDH-status.

5.1.1 Need-based aid to promote human rights?

In contrast to Forum Syd's change in aid policy, described in Chapter 3.4, the *Healthy Hospitals* project involves aid to physical improvements. A new ground water pump was purchased during phase one, and large improvements concerning the hospitals power supply are suggested for phase two (both described further in *Survey Report*). These need-based improvements are promoting the hospital to receive CDH-status, which in turn will provide the hospital with governmental support.

Forum Syd exemplifies human rights-based aid as "*Demand responsibility by the government where needs are linked with human rights*". Obtaining CDH-status implies governmental responsibility, but need-based projects will be needed to achieve this change. In **RQ3**, the need of physical improvements in order to promote human rights-based aid are questioned. By addressing fundamental needs in the *Healthy Hospital* project, human rights can be promoted as a result.

Furthermore, the (need-based) aid provided to Kolandoto Hospital in the *Healthy Hospitals* project forms yet another source of income to the hospital. Multiple sources of income; from the government, AICT and different aid organisations, enhances the hospital's possibilities to demand rights and influence since it strengthens their negotiation position in relation to each of the income sources. The result is that the hospital can afford to abandon a donor if they are not satisfied with the terms of collaboration. Thus is not only the hospital's dependency towards aid donors decreased, but the hospital's position to make demands to the government which can empower human rights for their patients is also supported. Furthermore, if the hospital overall has an overall well-functioning infrastructure it facilitates increased governmental responsibility for the hospital.

5.1.2 Can CDH-status decrease aid dependency?

To reach CDH-status is believed to decrease Kolandoto Hospital's aid dependency, since increased governmental funding would make the hospital less dependent on funds from foreign aid. Ruthman (2015) discussed the possibility of decreasing aid dependency, and eventually ending the collaboration between IAA and Kolandoto Hospital. According to him, helping the hospital to receive governmental funds and demanding governmental responsibility, can result in a decrease of aid dependency. This can be achieved by supporting the hospital to obtain CDH-status.

These statements are both connected to **RQ1** and **RQ3**, since it addresses the possibility of a decrease of aid dependency and how physical improvements contribute to promote human rights. Therefore, the decision by Forum Syd to entirely switch focus from need-based to human rights-based aid should be questioned.

The eventual end of the collaboration between IAA and Kolandoto Hospital are questioned in **RQ1**. According to Ruthman (2015), both parties has the possibility to end the collaboration. However, he also mentions the unequal balance of power in the relationship, and regards the probability of Kolandoto Hospital ending the collaboration as low. Dr. Katani (2015) considers the cooperation between the organisations "to have reached approximately 40 %", meaning that he sees the collaboration soon to have reached the midpoint of its total duration.

5.2 Pump test

Information provided from the hospital before the field study clearly stated the limited water supply as a major concern. During the first week of the field work, the hospital management confirmed the lack of available water as the main issue. As stated in Chapter 4.2 funds were available in phase one for small engineering improvements. A new groundwater pump could possibly solve the supply problem in a short term perspective. However, a thorough investigation of the existing borehole was necessary before any final decisions could be made.

Three meetings with companies specializing on pump tests were arranged in Shinyanga; *Wedeco Ltd*, *Shinyanga Drilling* and *Drilling and Dam Construction Agency*. Due to insufficient pump capacity, *Shinyanga Drilling* was not suitable for the assignment. In order to involve the hospital management, new meetings with

Wedeco Ltd and *Drilling and Dam Construction Agency* together with the hospital patron, Zacharia Dalawah, were arranged. Due to the accessibility of a large pump, affordable pricing and a professional impression with engineers and years of experience, *Wedeco Ltd* was hired. A formal contract, stating both parties' responsibilities was signed by Dr Katani and the CEO of *Wedeco Ltd*. Additional information is available in Chapter 4.1.9 in the *Survey Report*.

The pump test was conducted at the 21st of February, 2015. Performing the test during a weekend was decided together with Dr Katani, since the hospitals usage of water decreases. Three persons arrived from *Wedeco Ltd*, with two different pumps. During the first test, personnel from *Wedeco Ltd* recorded a small amount of measurements, and during the final test, the survey team supervised and recorded all the measurements.

A final report from *Wedeco Ltd* was agreed to be submitted within one week of the pump test, but three days late, a first draft was presented. The draft was inadequate and contained estimated values, instead of the actual measurements. Also, no calculations or recommendations were presented, as promised by *Wedeco Ltd*. After a meeting, a new revised draft would be presented. However, the second draft was without any improvements but *Wedeco Ltd* assured a final report within the coming days, without any inaccuracies.

The final report was received nine days late, containing insufficient information. Estimated values had been removed and replaced with actual measurements. However, as observed during the pump test, the amount of measurements were not enough. During a final meeting, complaints were raised regarding the report, and the price was decreased. *Wedeco Ltd* wished to conduct an additional pump test, but due to time limits this was not an option. The final pump report is presented as Appendix 12 in the *Survey Report*.

Due to the inadequate quality of the work conducted by *Wedeco Ltd* the survey team had to put forward complaints towards the company, since the provided services not reached the initial promises. As pointed out earlier, the role as aid donors includes respecting local culture and customs, and this causes a dilemma. Yet if no concerns would have been raised, the services provided to the hospital would have been unusable.

5.2.1 Involvement of hospital management

In order to obtain information regarding the current borehole and to have enough time to purchase a new groundwater pump, the final decision regarding a suitable pump company was relatively rushed. The process of finding a suitable company was protracted resulting in involvement of the hospital management being neglected. An attempt to involve the management was made when the hospital patron accompanied the field team to different pump companies. However, the final decision was mainly made by the field team, instead of interacting with the hospital management.

As concerned in **RQ2**, ownership is a vital part of aid work. During the process of deciding a suitable pump company, involvement of the hospital management was not promoted sufficiently. As Odén (2006) describes, long term success is best achieved by engaging the aid recipient and hence, promoting ownership. Therefore, the approach of determining a suitable pump company for Kolandoto Hospital should have been managed differently, where the final decision was made by the hospital management, based on recommendations from the field team. Furthermore, in order to increase recipient ownership in the future project phases, it is important to establish lasting contacts between the hired contractors and Kolandoto Hospital. This allows the hospital management to remain in charge of the project and develop it further if desired.

5.3 New pump

As mentioned above, a new pump for the existing borehole was early regarded as a possible short term solution for the lack of potable water. With the results from the pump test and additional investigations of the existing water distribution network, enough information had been obtained to decide on suitable pump design. The purchase and installation of the new pump is thoroughly described from a technical point of view in Chapter 5.1 in the *Survey Report*.

5.3.1 Pump purchase

Several different pump retailers both locally and nationwide were enquired in order to find the most appropriate pump to the best available price. However, due to time constraints as the survey period approached its end, it was prioritised to act quickly to get the pump before the end of the field study rather than making a complete market search.

Among the queried sellers, the East-African company Davis & Shirtliff offered the best price and service, and purchase was therefore agreed with them. However, the pump was not in stock in Tanzania, but instead available at their Nairobi branch. Davis & Shirtliff could not organise the additional transportation required from Nairobi to Kolandoto, but due to the tight time schedule for the field study arrangement to bring the pump from Nairobi was made. This was organised by Dr. Katani as he had contacts in Nairobi which have been assisting him with imports earlier.

5.3.2 Installation

The pump technician from Davis & Shirtliff arrived on the evening of Friday 27th March to make a brief inspection on site before the installation. No issues were identified and the task of fitting the pump was estimated to be done during the following day. The technician came back with the pump and installation material and begun installation on Saturday. He worked together with the water staff at the hospital during that day to complete the installation.

The installation was finished on the evening of 28th March, but the pump was not able to start. After thorough troubleshooting by the technician during Saturday evening and Sunday, it was clear that the pump itself had been correctly installed and that the issues originated from malfunctioning power supply. The poor power lines from the hospital to the pump house resulted in a voltage drop which triggered the electric protection to stop the pump. Yet, if the protection was bypassed the pump could run with close to full capacity, but without any protection against voltage drops/peaks and dry running. Further details on the electrical issues with the installation can be found in Chapter 5.1.1. in the *Survey Report*.

Under the given circumstances, careful choices had to be made on how to proceed for both the short and long term. Dr. Katani took great interest in the installation of the pump and was present at a large part of the time during the installation process. He was also present as the aforementioned problems arise, and could therefore play a part in the upcoming decisions.

5.3.3 Pump issues and how to proceed

The borehole was at the moment the only source of water to Kolandoto Hospital. The borehole could therefore not be without a pump for more than approximately one day, as the hospital's limited water reserves would run out. The old pump could neither be refitted as it broke when it was removed before the installation, and could at the earliest be fixed in a week. In the short term, the only alternative was to continue and run the new pump unprotected. However, the technician only allowed this if a hospital representative signed a warranty release form stating that Davis & Shirtliff would not be responsible for any damage made to the pump when it was run without protection. Dr. Katani agreed with the engineering team that this was the only option, and signed the release form on the 29th of March.

In the long term perspective, additional options on remedial actions were available. These included: to replace the old power lines from hospital to the pump house, to buy a new diesel generator designated for the pump, or to continue to run the pump unprotected. A cost-benefit analysis, summarised in *Table 5.1*, was made to support the decision, (see Chapter 5.1.2 in the *Survey Report* for full details).

Table 5.1 Summary of cost-benefit analysis for long term pump measures

	Investment costs	Running costs	Outcome
New power lines	Very high	Low	If worked, pump would run flawless. Additional transformer could be needed.
Buy generator	High	High	Would need scheme for continuous diesel supply.
Run unprotected	Non	Medium	Pump would run at lower capacity and at risk of damage.

The investment costs associated with new power lines were very high due to the copper prices. Furthermore, even if all lines were to be replaced it was a risk that a new transformer would be needed as well, which would increase the costs even more. This option was therefore dismissed due to the extremely high investment costs and some uncertainty regarding if a new transformer would be needed or not. The second option, to buy a diesel generator designated for the pump, was dismissed since it not only would entail a fairly large investment cost but also large running costs. Further drawbacks of the generator option was that introducing a new scheme for diesel supply could be insecure and would be vulnerable to regional fluctuations of the diesel market.

The hospital management, on advice from the survey team, agreed to continue to run the pump unprotected. To run the pump without protection is according to the pump technician likely to shorten its expected life length to 1-5 years instead of approximately 20 years. Given this, replacement costs is still not likely to exceed the running costs associated with the two other available options.

5.3.4 The decision process

In the process of obtaining the new pump, decisions had to be taken quickly due to the time constraints during both the purchase and the handling of the installation issues. In this case, where the survey team represents the donors and the hospital management represents the receiver, it is desired from the donor's perspective to involve the receiver as much as possible to achieve recipient ownership, as described in Chapter 3.3. The necessity in some cases to make quick decisions however complicates the task of involving additional people in the decision process, and isolates the influence to a small group with technical knowledge directly involved in the process, i.e. the survey team. So, even if the formal decisions always were made by representatives of the hospital management, they were heavily influenced by the surveys team's recommendations.

RQ2 questions whether the *Healthy Hospitals* project involved Kolandoto Hospital sufficiently to enhance receiver's ownership. It can be claimed that total recipient ownership was not fully achieved in this case, since the survey team had too much influence. However, a conflict arises in such situations. The technical competence lies with the external engineer (aid donors representatives), yet it is desired from a theoretical point of view to leave the decision-making to the local leader (the aid receiver representatives) in order to increase ownership.

5.4 Pumping schedule

The present pumping schedule for the groundwater pump was created by the water staff and has been used for several years. After the installation of the new pump, a new schedule needed to be formed. Since the new water pump extracted more water from the borehole, inlets to the hospital, college and village could be open more often.

A new schedule was created by the survey team and presented to the water staff during a staff meeting, together with a translator. The new schedule was intended to be used as a base, where the responsible staff could implement adjustments and tweaks. During the meeting some concerns were raised regarding the design and a finalised schedule was presented to the staff a few days before the survey teams' departure from Kolandoto.

During the final two days of the field study the new pump schedule was established. The process, which is more thoroughly described in Chapter 5.4.1, mainly included ideas and calculations from the field team. However, the pump was not running according to the schedule, probably due to lack of communication. The final pump schedule is presented in Appendix 3 in the *Survey Report*.

5.4.1 Introducing a new schedule

Andrew Mwenda describes the influence of the donor in his TED Talks. By receiving large sums of aid from organisations, governments include the aid organisation in the decision process instead of their own citizens (Mwenda, 2007). His concerns can also be applied in a smaller scale. Kolandoto Hospital receives aid from IAA, resulting in the field team having a large influence in the decision process. Dr. Katani confirms the field team's role in the project, which he describes as a "big role, where you can give advice and educate people" (Katani, 2015). Jon Gunnarsson Ruthman, the project leader and former Vice President of IAA, describes our role as "unbalanced relationship, since you represent donors. Hopefully they feel ownership, but the engineer stamp give some power" (Ruthman, 2015). In order to improve ownership in the project, which is concerned in **RQ2**, involvement of the water staff should have been more significant.

The proposal of the new pump schedule was presented to the water staff, during a meeting in the hospitals canteen, two days before departure. The aim of the meeting was to obtain ideas and input from the water staff, in order to improve the proposal. However, no concerns were raised by the water staff during the meeting. As Ruthman (2015) states, the engineering stamp provides power and influence, which could result in staff withholding their opinions. By using Ernesto Sirolli's approach, this could have been prevented, resulting in a larger involvement of the water staff, and hence, promotion of ownership.

Proposing a significant modification of an existing system, two days prior departure is not ideal relating to **RQ1** and the aim to decrease aid dependency. As mentioned by Katani (2015), our role in the project involved education, which was neglected in this situation. Further, Ruthman (2015) describes how to avoid engineering aid dependency by educating and promoting the competence of the local staff. By presenting a new pumping schedule close to departure the possibility of education is decreased, which could result in an increase of engineering aid dependency.

5.5 Connection to the Municipal Water Network

As described in Chapter 4.1 in *Survey Report*, the hospital has for a long time been suffering from a shortage of potable water, and it is essential to find a long term solution which can meet its full demand. The survey team therefore had to search for additional available water sources in the area. One investigated possibility was to connect a pipeline to the municipal water network in the regional capital Shinyanga, located 15 km south west from Kolandoto village.

The survey team contacted SHUWASA (Shinyanga Urban Water & Sewerage Authority), which is the municipal authority responsible to supply potable water to the local community. The managing director of SHUWASA declared that they were tasked to provide water to all communities within the Shinyanga Municipality, including Kolandoto village, and expected to achieve this before June 2015.

If feasible, a connection to the municipal water network would by the survey team be regarded as a favourable opportunity for the hospital and village of Kolandoto. An additional water source, provided by the local authorities, would increase supply stability as well as the amount of accessible water. However, Dr. Katani had previous poor experiences from breached SHUWASA promises regarding supplying water to the village, even though he stated that he also would prefer this solution if possible.

5.5.1 Lack of communication and delegation

The contact with SHUWASA was reinitiated by the survey team as a part of the search for additional water sources. However, even when it was clear that SHUWASA intended – and was obliged – to supply water to Kolandoto, the survey team still did not put the hospital management in contact with SHUWASA. If the survey team would had opened contact between SHUWASA and hospital management at this stage, it could have aided members of the Kolandoto community to enforce their rights to access potable water, in the same manner as described in Chapter 5.1.1. Instead there is a risk that SHUWASA, when they see Kolandoto Hospital being provided with water by an external aid organisation, might give lower priority to Kolandoto water supply and focus their efforts elsewhere. This connects to **RQ3**, asking if need-based aid work can satisfy objectives for human rights based aid work. In this case, there is risk for the effect being the opposite.

Furthermore, **RQ1** examines whether the *Healthy Hospitals* project increases aid dependency at Kolandoto Hospital. By taking contact with SHUWASA but not forward it properly to the hospital, there is a risk aid dependency actually was increased, since the contact with an important municipal authority unnecessarily is handled through the donor organisation. **RQ2** here merges with **RQ1** regarding involvement and ownership. Since the survey team failed to sufficiently involve the hospital in the communication with SHUWASA, ownership regarding this part of the project was not completely achieved.

5.6 Power back-up system

Kolandoto Hospital including the surrounding village and college receives power from the national grid. The hospital suffers from power cuts, where the extent differs. Normally, the power cuts 1-5 times per week, and the mean duration is approximately two hours. These irregular breaks is a health risk for patients at the hospital since cuts have occurred during surgeries several times. In order to secure a steady power supply and to improve the health care at Kolandoto Hospital, the possibility of installing a back-up system was investigated.

There were two available solutions suitable for Kolandoto Hospital; a back-up system consisting of only a battery-bank which was charged from the national grid and a solar powered back-up system, charged from solar panels. Using solar power as a source is sustainable and have a low running cost but the economic advantages of using only a battery-bank is much higher, since both the investment- and running cost are low in comparison. However, framework stated by IAA before the project suggested promotion of sustainable solutions, therefore a solar powered back-up system was considered as most suitable for Kolandoto Hospital.

5.6.1 Workshop with hospital management

Designing the back-up system included interactions with the hospital management as well as staff working in each ward. A full inventory of all electrical devices at the hospital was made, together with Metsela 'Nkaka' Charles, responsible for the power at the hospital. In order to determine the extent of the solar powered back-up system, the critical level for each ward had to be decided.

A workshop together with the hospital management and staff was arranged in the adjacent church where the purpose of the workshop was to include staff members from each ward, and to determine critical levels. The levels and their definition was determined by the survey team, and are presented in Table 5.2. Approximately 20 staff members participated, including Dr Katani. Results and evaluations from the workshop functioned as a background for the final design proposal of the back-up system and all results are presented in Chapter 6.5 in the *Survey Report*.

Table 5.2 Critical levels and their definition.

Critical Level	Definition
1	Risk of immediate life threat to patients if power cuts
2	Negative health impact for patients, not life threatening if power cuts
3	Inconvenient if power cuts

The purpose of the workshop was to include staff members in the decision process and to obtain their input on the subject. Mainly doctors from each ward, together with Dr. Katani, were present at the workshop.

5.6.2 Including hospital opinions

In Ernesto Sirolli's TED Talks he suggest a different approach for interaction with the recipient. Instead of using workshops and meetings for collection of data, personal and private discussions should be promoted (Sirolli, 2012). Hence, using another method for data collection could result in different data. A further risk by using a workshop, together with the head doctor in charge could be staff withholding their actual opinions.

As Bertil Odén writes in *Biståndets Idéhistoria;* in order to gain a long term success the recipient needs to be the owner of the project. This can be achieved by involving the aid recipient (Odén, 2006). Involvement of the hospital management is addressed in **RQ2.** By using a workshop, the hospital are involved in the project and ownership are promoted. However, the workshop conducted in Kolandoto could have been executed differently. For example, dividing the medical staff into smaller groups encouraging Ernesto Sirolli's approach could result in more involvement of the staff. An additional approach could include Sirolli's suggestion entirely by having private discussions with both nurses and doctors instead of gathering groups of the medical staff for a workshop.

To increase the quality and relevance of the workshop, and thus further enhance ownership, the project could have been more economically transparent. Since the budget for phase two was not completely established and presented to the participants, the hospital management's prioritising was complicated.

6 Discussion

In this chapter, a wider perspective of the aid work conducted in Kolandoto will presented and discussed. Deficiencies during the field work will be evaluated, resulting in recommendations for the later phase of the project.

6.1 Methodical concerns

A scientific methodology has been adapted for the research work of this thesis. Yet, the used methodology has some limitations which need to be regarded.

The case study provides the thesis with an opportunity to study engineering aid work closely as it is carried out. However, only a single case study has been used, and the experiences obtained during this case study may not be representative under other circumstances and for other types of engineering aid work. Furthermore, large emphasis has been given to the author's personal experiences from carrying out the field work, and there is a risk for these experiences being subjective or biased. Also, since the authors were active participants in the aid work criticised in this thesis, there is a risk that the authors not completely succeeds in their effort to be impartial.

Personal relationships were developed during the case study between the authors and people whose opinions were important to the research. This allowed greater insight into the studied issues, but also entails a risk of a biased understanding of the situations.

Information gained from interviews forms a vital part of the thesis. Some of the interviews, as well as a large part of the daily work, had to be executed by using interpreters. These persons were not professional interpreters, and were only appointed as interpreters as they were available to the hospital and spoke good English. In some cases this might have affected the communication, with a risk of losing parts of the information or the message being influenced by the interpreters own values. In order to minimise such risks, attempts were made to be extra clear in the communication and check facts from different sources.

6.2 Recommendations for phase two

Based on the field study conducted in Kolandoto, combined with results from this master thesis, recommendations for phase two are presented in the following chapter.

6.2.1 Promote ownership more sufficiently

During the field study the aim was to include the hospital management in the decision process, both regarding direct implementations in phase one and suggested improvements for phase two. Meetings with the hospital management as well as workshops were used in order to involve both the head doctor, Dr. Katani, and other staff members. As mentioned in both Chapter 3.2 and 5.6.2 different approaches to promote ownership can be used. Instead of mainly using large meetings and workshops with the hospital staff, a combination together with private conversations should be encouraged.

During phase two, the recommendation is to engage the hospital management even more. Include the hospital during the planning process of phase two is a vital part. Representatives from the hospital should be present during skype-meetings as well as email-conversations, where planning of phase two occur. Involving the hospital early in the process has benefits, since the hospital will be more engaged in the project, resulting in an increase of ownership.

Rushed decisions deprived the possibility of including the hospital management in the final decision regarding a new groundwater pump and a suitable pump company. Ahead of phase two, a more thorough plan should be established in order to mitigate the risk of making rush decisions, and hence, neglecting the involvement of the hospital. However, situations needing quick actions will always occur. If a close collaboration, which includes the hospital in the project thoroughly from the beginning, quick decisions can involve the hospital sufficiently.

6.2.2 Continue with physical improvements

A recommendation for phase two is to continue with physical improvements. If need-based aid are promoting human rights, concerns raised in Chapter 3.4 can be mitigated. During phase two, suggested implementations will promote the hospital to become a CDH, which will result in governmental support and responsibility.

6.2.3 Concerns regarding a possible CDH-status

As mentioned in Chapter 5.1, the governmental support is explicitly for staff with a degree. Current staff without a diploma will rely on AICT to receive a salary. During the interview with Robert Isack, he raised his concerns regarding the future development of the hospital. He stated “people are afraid that uncertified workers will get fired. Will the hospital still pay staff without diplomas if the hospital becomes a CDH?” (Isack, 2015). Metsela ‘Nkaka’ Charles and Julius Omango shares his concerns where Charles describes the situation as “I don’t know what will happen to me if the hospital becomes a CDH, since I don’t have a diploma.” (Charles, 2015). Omango continues with “I hope that the government can employ all staff if they become a CDH, but not sure it will happen.” (Omango, 2015).

Relating to the insecurity among the current staff, strategies should be established in phase two regarding possible negative consequences. Ruthman (2015) mentions the possibility for the hospital to provide education to staff without diplomas, in order to meet the formal requirements. However, since no discussions with the hospital management regarding the future employment of the staff have occurred, further attention to this issue during phase two is needed (Ruthman, 2015).

Although the promotion of supporting the hospital to achieve CDH-status could have negative impact for individuals, the overall advantage for the hospital and patients are significant. Focus in phase two should involve different approaches to mitigate the risk of current staff losing their work and the possibility of educating staff without a diploma should be further investigated.

6.3 Exit strategy

It is vital for all aid projects to have an exit strategy in order to reduce aid dependency. The donor, in this case IAA, should be responsible to establish the exit strategy together with the recipient, to end the collaboration in due time. The recipient's economic situation complicates their ability to decline financial aid and end the cooperation. Furthermore, an exit strategy should be applied to each subproject in the collaboration, as well as the overall aid project. For this case, this applies to establish an exit strategy for both the *Healthy Hospitals* project and the collaboration between IAA and Kolandoto Hospital in general.

6.4 Using donor influence?

Donor influence have been described negatively throughout the thesis. According to Mwenda (2007), governments include the aid organisation in the decision process instead of their own citizens. Odén (2006) further describes donor influence as a limitation for ownership.

Is there such a thing as using the donor influence in a positive manner? As mentioned previously in Chapter 6.2.3, staff without a degree are uncertain regarding their future employment if the hospital becomes a CDH. Therefore, could IAA use their influence to demand further education of current staff? This will have a positive impact on the concerned individuals but possible endanger the long term success of the project.

Another aspect of using donor influence is the decision regarding a power back-up system. IAA strongly promotes the use of sustainable solutions, and the possibility of implementing a solar powered back-up system was the only investigated option. Other solutions, possibly more economic beneficial were not considered during the project. The final decision to suggest a solar powered back-up system was thus undoubtedly influenced by the donor.

7 Conclusion

Kolandoto Hospital have been collaborating with IAA since 2007. The future development of the hospital depends on the amount of aid the hospital receives from different organisations. The fact that the hospital has several different sources of income; from aid organisations, AICT and the government, strengthens the hospital's independency and enables the hospital to put forward demands towards organisations and the government.

An overall aim for the *Healthy Hospital* project have been to include the hospital in the decision process, both concerning implementations in phase one and suggestions for phase two. Yet, phase one of the project undoubtedly increased Kolandoto Hospital's aid dependency as involvement of the hospital was neglected when rushed decisions had to be taken. For phase two, the recommendation is to focus more on the planning of the project, in order to involve the hospital in the process. Furthermore, education of implemented solutions needs to be promoted to decrease aid dependency.

As Ruthman (2015) describes, both IAA and Kolandoto Hospital have the theoretical possibility to end the collaboration. However, the hospital is not very likely to do this since they economically depend on the cooperation. IAA should therefore be responsible to establish an exit strategy for the aid donations resulting in an economical sustainable future development for Kolandoto Hospital.

A plan to increase the aid receiver's project ownership is needed. It is vital to increase the transparency in the decision processes in order to involve the aid recipient in the project. Additionally, the background information and technical knowledge has to be more extensively shared to all the decision-makers in the project. Due to time constraints it can however be challenging to achieve this, but improved planning and in advance created structures for decision-making and knowledge sharing can support increased ownership.

Examples described in this thesis verifies the possibility of using need-based aid to promote human rights. Implementations conducted during phase one, including a new groundwater pump, combined with suggested improvements for phase two will promote the hospital to obtain CDH-status. The governmental funding and responsibility the CDH-status entails are important aspects to decrease Kolandoto Hospital's aid dependency.

In summary, a more thorough planning process is recommended for later phases as well as future aid projects. The plans should aim towards involving the hospital more in each project, decrease aid dependency, and promote ownership.

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Appendix I – Interview questions

Hospital and water staff

Robert Isack – nurse in dental department
Metsela Charles – Responsible for power supply
Julius Omango – Water staff, working mainly with wastewater and water distribution

- How was the purpose of our project presented to you? By us? By the managerial staff?
- Which role do you think we had during this project? Did it change as the work went on?
- How did the planning work? Too little/too much?
- Did you receive enough information during the project?
- Do you feel you had the possibility to influence the decisions? Would you like to have had more influence?
- Have your daily work on the hospital become affected since we came? (Good/bad?)
- Did you have any expectations before the project started?
- What are your expectations for the outcome of this project?
- Have this project been meaningful to you? Have we been doing relevant things in your opinion?
- Have you obtained new knowledge because of this project?
- Have you been part of earlier aid projects? How was this compared with that?

Hospital management

Dr. Katani – Head doctor

- What do you think about aid work in Tanzania in general?
- What do you think about aid work here at the hospital?
- Is the hospital dependent on aid work? How does dependency affect the hospital?
- How do you see aid in the short/long term? Possibilities and problems? Risks?
- Since we come from another context (life, land etc.) and stay here for a limited time, what do you think about the fact that we have a relatively big influence over decisions about the hospital future?
- What do you think our role in the project should be?
- What do you think about the hospital's relation to IAA? Now and in the future?
- What are your main concerns about this project for the future?
- Could Phase 1 have been made in another, better, way? How?
- What do you expect for Phase 2? After phase 2?
- How long do you think this collaboration should continue?

Jon Gunnarsson, Project leader, I Aid Africa

- Where does the name I Aid Africa come from?
- What were your expectations regarding phase one?
- What information did I Aid Africa get from the hospital management regarding the project?
- Do you feel that your long collaboration with the hospital have made them aid dependent?
- Is I Aid Africa responsible?
- Can aid dependency be avoided in these kind of projects?
- How long do you think the collaboration should continue?
- Who is responsible to end it? I Aid Africa? The hospital?
- How should the collaboration end?
- What will happen after all improvements have been implemented?
- Do you think “good” aid exists?
- What do you consider as “good” aid?
- Do you think I Aid Africa will continue with engineering aid work?
- Do you think there are negative consequences from phase one or two?
- If the hospital becomes a CDH, the future employment of many workers are endangered, what is your thoughts?
- Do you think the collaboration should continue if this becomes a reality?
- Do you think we had a big influence on decisions made during phase one and two?
- What do you think about it?
- What will happen if I Aid Africa think priorities made by the hospital is wrong? Since I Aid Africa provide funds for phase two.
- Why did I Aid Africa use Swedish engineers instead of local people?

Appendix II – IAA’s statutes

Grundtanke

Biståndstagaren i centrum: Biståndstagaren ska ligga i fokus för vårt arbete. Biståndet skall syfta till att vara ett led i utveckling för individen samt bidra till bättre framtidsutsikter för denne.

Biståndsförmedlare: Vår organisation ska förmedla biståndet mellan biståndsgivare och biståndstagare med målet att ha så låga administrativa kostnader som möjligt. Målet här är att ha fokus på biståndstagaren och inte på organisationen.

Småskaligt bistånd: Med hjälp av små insatser vill vi bidra till att individer kan skapa sig en bättre vardag tillsammans med bättre framtidsutsikter.

Personligt bistånd: Du som givare ska kunna känna personlig kontakt med biståndstagaren. Du ska ha möjligheten att se vilka du hjälper och vad ditt stöd går till.

De projekt vi bedriver ska grunda sig på en förfrågan och ett behov från problemområdet och inte tvärtom.

Vision

Att kunna förändra människors framtidsutsikter genom att hjälpa dem att hjälpa sig själva, vilket syftar till att främja en långsiktig och hållbar utveckling. Detta kan uppnås genom att vi strävar efter att vara en liten och effektiv biståndsorganisation med enbart ideellt arbetande personer och låga administrativa kostnader.

Övergripande mål:

- Vara en drivande organisation med stort engagemang.
- Slutföra de projekt vi påbörjat då vi strävar efter långsiktiga lösningar.

Om 10 år:

- Vara en självklar kandidat vid valet av biståndsförmedlare.
- Vara en betydelsefull aktör inom humanitärt bistånd vad gäller kunskap och utveckling.
- Ha lagt grunden för ett nytt, personligt och mer effektivt sätt att förmedla bistånd.
- Vara den biståndsorganisation med lägst administrativa kostnader i Sverige.

Utarbetad av styrelsen under 2009

Survey report

Healthy Hospital Kolandoto Hospital

Andreas Berg

Annika Danielsson

Daniel Kallus

Table of contents

1 Summary

This project concerns the infrastructure at Kolandoto Hospital in Tanzania. The project is a collaboration between Kolandoto Hospital and the three NGOs I Aid Africa, Engineers Without Borders and Architects Without Borders. Phase one of the project has been conducted as a field study, resulting in a survey report which will function as a basis for implementations during phase two. Infrastructural issues regarding water, electricity and buildings are a main concern for the hospital in Kolandoto. In order to secure sufficient and safe health care for patients, improvements in those areas are vital.

Future development of the hospital includes becoming a Council Designated Hospital, CDH, where the amount of patients and staff are expected to increase. Also, a college, with a close collaboration to the hospital, is located in the area. The college receives water and electricity from the same source as the hospital. A future desire is to become a university which would increase the number of students.

Water supplied from the existing borehole is insufficient to meet the current requirements. During phase one, a new pump was purchased and installed, allowing more water to be extracted. However, an increase of patients, staff, students and villagers will require a higher water demand and a new additional source is therefore recommended.

The municipality of Shinyanga is planning the construction of a new water pipeline, from Shinyanga to Kolandoto. However, the start of the construction has been postponed for many years and the progress needs to be monitored during phase two. If the construction of the pipeline is further postponed, drilling a new borehole is recommended. Full tender sheets are presented in the survey report.

Analyses made on the groundwater during phase one indicates both a high fluoride and coliform content. Using groundwater contaminated with fluoride for drinking purposes results in dental fluorosis, a common problem in the region. Removal of fluoride is a costly process and only considered as a cosmetic issue and therefore not a priority in phase two. Coliforms in the water can cause different diseases and the recommendation is to install a chlorine-based disinfection process.

The hospital receives power from the city grid, provided by TANESCO. The power supply is unreliable and considered a health risk since malfunctions during surgeries has occurred. A solar powered back-up system is recommended to secure the supply, using a sustainable source. However, the recommended back-up system is only covering the most vital parts of the hospital, such as theatres and the maternity ward, due to high investment costs.

With the goal of creating an architectural masterplan for the development of building infrastructure at Kolandoto Hospital during the next ten years, three site and building assessments were made: an assessment of the logistics and flows through the hospital site, an assessment of the medical zoning, and an assessment of the needs for renovation, extensions and new constructions. The full

masterplan with design proposals will be available in June 2015, but this survey report contains results of the assessments and some suggestions for planning for future building projects.

Site circulation and flows of patients, staff, materials and visitors across the hospital area plays an important part in making sure the hospital is an environment which does not cause illnesses or poor health. Appropriately designed flows will decrease the risk of medical errors and nosocomial infections or diseases. Among other things the analysis shows an unnecessary flow of students, an inefficient emergency flow, a spread out outpatient flow and a visitor flow that is unnecessarily long and causing congestion.

In a hospital site layout, one should strive to not overlap different medical zones in order create a comfortable healing environment for patients, to decrease the risk of transmission of communicable diseases and nosocomial infections, and to create an environment that minimizes room for errors among other things. The analysis shows that there currently are unnecessary public function inside the hospital, that the goods and material functions are spread out, that the outpatient areas are spread out and overlapping with inpatient areas, and that the diagnostics and treatment areas (excluding the lab) are a bit too public.

The assessment of the needs concerning building structures was done through a participatory process involving the hospital staff and management. A comprehensive list of needs for renovations, extensions and new construction was created. Priorities were made in terms of what Kolandoto Hospital consider to be an appropriate order of the identified building projects in order to develop the hospital step by step to provide appropriate health care services to the surrounding communities.

During phase two it is recommended to start planning more in detail for some of the larger building projects with highest priority: a casualty unit including a short stay ward, a new private ward and an extended maternity ward. In addition, some smaller building interventions could be implemented, such as building a new public path that decreases the congestion and movement of visitors through the diagnostics and treatment areas, reorganization of the imaging department to facilitate for easier access for bedridden patients, to create social areas for patients and relatives to meet outside the general ward, to extend the waiting areas at the outpatient department, and to finish the construction of the maternity theatre extension.

Keywords: Kolandoto Hospital, water, borehole, Shinyanga, electricity, solar power, masterplan, flows, zoning, building needs

2 Timeline

Week	Focus
6 *(2 – 8 feb)*	• First week on site in Kolandoto. Create contacts, good relations and common ground for the project • Investigation of water system and infrastructure (3 weeks) • Visit by supervisor Mikael Mangold • Model water system in EPANET • Mapping hospital site • Produce justification report for a new eye clinic
7 *(9 – 15 feb)*	• Investigation of boreholes • Visit companies in Shinyanga regarding pump test • Writing report (on-going throughout the field study) • Mapping flows and zoning at the hospital
8 *(16 – 22 feb)*	• Investigation and evaluation of storm water harvesting system • Model water system in EPANET • Mapping building and spatial needs for the next 10 years • Investigating local building techniques and available materials
9 *(23 feb – 1 mar)*	• Pump test • Evaluate pump test (2 weeks) • Mapping distribution system in hospital area • Study visits to Shinyanga Regional Hospital and Mwadui Mining Hospital • Sketching masterplan alternatives
10 *(2 – 8 mar)*	• Establish contact with pump retailer in the region • Investigation of waste zone (2 weeks) • Evaluating master plan alternatives • Initiating architectural low-hanging-fruit interventions • Prioritizing among identified building needs • Sketching eye clinic building design alternatives • Study visit on a busy day for the eye clinic • Maternity theatre extension investigation and sketching

Week	Focus
11 *(9 – 15 mar)*	• Investigation of current power supply (2 weeks) • Workshop with hospital management regarding power supply • Design solar powered back-up system (3 weeks) • Water quality test • Receiving material and budget estimations for the maternity extension • Evaluating eye clinic building alternatives • Renovation of the general theatre doors (2 weeks)
12 *(16 – 22 mar)*	• Installation of new pump • Establish contact with solar power retailer in the region • Priority meetings with hospital management • Construction of the maternity theatre extension started • Mid-term seminar for Annika • Sketching on the eye clinic building
13 *(23 – 29 mar)*	• Visit by Jon Gunnarsson Ruthman from I Aid Africa. • Wrap up the field study in Kolandoto. • Final meetings with hospital management • Investigation of sewage system • Finalizing report for phase 1 • Departure for Andreas and Daniel • Continued construction of the maternity theatre extension
14 *(30 mar – 5 apr)*	• Catch up work • Continued construction of the maternity theatre extension • Continued sketching for the eye clinic building
15 *(6 apr – 12 apr)*	• Continued construction of the maternity theatre extension • In-depth masterplan programming and prioritization • Departure for Annika

3 Introduction

Kolandoto Hospital, overview presented in Figure 1, have raised concerns regarding their infrastructure at the hospital. The hospital and the surrounding village have long been suffering from a failing water distribution system, with malfunctioning groundwater pumps and an ageing pipe network. Kolandoto Hospital officials have expressed a desire to be assisted with a full survey of the water system, including pumps, pipes and water towers, as well as recommendations for improvements. Also, concerns regarding a failing power supply and an insufficient building infrastructure have been raised. In order to promote the future development of the hospital a full survey of the infrastructure is necessary.

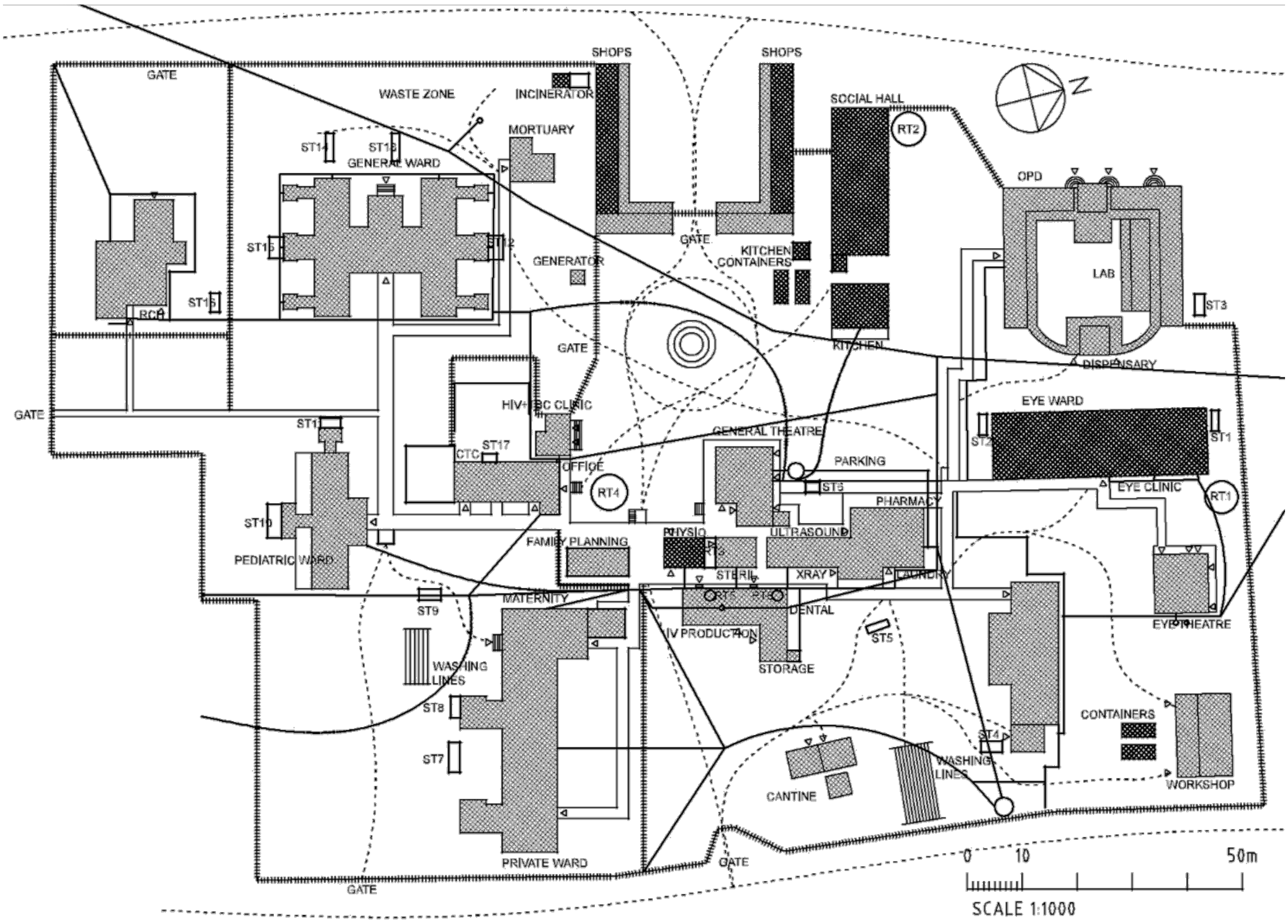

Figure 1: An overview of the hospital area.

This project is divided into two parts, where the first phase has been conducted as a field study at the hospital. The result of phase one is a survey report, where the current situation is described. Also, suggested improvements are presented, including cost estimations. The following survey report will function as a base for phase two, where the suggested improvements is planned to be implemented.

4 Current situation

The following chapter will describe the current situation at Kolandoto Hospital. All data have been obtained during a field study from meetings, observations and tests.

4.1 Water

Issues regarding the water supply, including the distribution network and quality have been expressed as a big concern of the hospital. There is no available surface water located close to the hospital suitable for drinking water purposes. The only available water sources for the hospital is groundwater and rainwater.

4.1.1 Groundwater

There are different sources of water located in the Kolandoto village. The main source is a drilled borehole (BH1) located approximately 1000 m west of the hospital. According to investigations made earlier, see Appendix 1. The soil profile consists of a massive sand layer on top of hard rock. Staff responsible for the borehole has stated that the amount of accessible water is significant. The borehole is drilled to 20.7 m depth with a diameter of 6 inch. The water level is located at 6.9 m below surface and the borehole was drilled in the 1970s.

Another borehole (BH2) is located approximately 500 m east of BH1 and 800 m south of the hospital area. The borehole was drilled in 1995 and was preceded by a geophysical survey to decide the location for the borehole, see Appendix 1.The work was carried out within the Domestic Water Supply Programme, DWSP, a Shinyanga based programme active from 1994 to 1997 with the aim to improve Kolandoto Hospital's water supply.

BH2 is 37 m deep, a diameter of 6 inch, installed with permanent casings, has an estimated yield at that time of 1.5 m^3/h and static water level at 6.5 m. BH2 was only used to fill up the hospital tank. It was constructed by the DWSP with funds from two Dutch NGOs but additional funds for purchase and installation of a submersible pump and construction of pump house, power supply, a new storage tank and pipeline to the hospital was at the time not available. These were instead recommended by the DWSP to be built when funds were available.

BH2 has not been in use since 1997 due to issues regarding the malfunction of the pump. Staff mentioned that the pump was heated causing it to malfunction. However, a full pipe network is installed but not in use. The water staff tried to repair the pump and use the borehole three years ago, but the pump malfunctioned due to heating once again. An option is to install a hand pump in BH2, allowing villagers living close to extract water directly from the well. BH2 is illustrated in Figure 2.

Figure 2: Image of BH2, not currently in use.

Further information on BH2 has been found in (some) reports conducted for the hospital (Shinyanga Municipal Council, 2010). The specifications regarding the borehole differs slightly between the reports, with information on depth ranging from 35 – 37 m and yield at 1.5 – 3.2 m^3/h. Fluoride content is estimated to be 12 ppm, which is almost the same as in BH1. The reports also states particles in the groundwater as the main reason for the malfunction of the pump. A submersible pump is therefore considered unsuitable.

In order to determine the actual water available for extraction different tests on the BH1 has been conducted. Measurements of the flow directly from the pump were done twice at different times. First, the pump test was made at 06.00 when the pump and borehole had been resting for 8 hours. Four measurements were made and the flow was calculated to 3.16 l/s. Another pump test was made at 22.00 when the pump has been running for 16 hours. Four measurements were made and the flow was calculated to 3.16 l/s. Since there is no difference between the flow in the morning and the evening the conclusion is that more water can be extracted from the borehole. In order to determine the capacity of the borehole, the possibility of hiring an accredited company to perform a pump test was investigated. Three different companies, located in Shinyanga were visited and a performance sheet was obtained from Wedeco Ltd, see Appendix 2. Consultation with the hospital management and staff responsible for the water system were done in order to determine the most suitable company for the task.

4.1.1.1 Pump condition

An old pump, which is made from spare parts from two old pumps are used to extract water from BH1, see Figure 3. The type is a mono-pump where pipes formed as screws are inserted to the borehole and an engine located at the surface forces the water up from the borehole. Due to abrasion and age, the pump breaks a lot. Consumables are of poor quality since spare parts of good quality is rare. The pump screw is located at 18 m below surface.

Figure 3: Old screw-pump currently in use at BH1.

A pump schedule has been implemented by the responsible staff. Pumping starts at 06.00 and stops at 22.00. A rest time of 8 hours is necessary in order to prevent malfunction of the pump. There is also a more detailed tank filling schedule where the exact time of filling each tank is presented, see Figure 7.

A new pump has been purchased and installed during phase one, which is described in detail in chapter 5. In addition, a new pump schedule has been implemented together with the water staff, which is presented in Appendix 3.

4.1.1.2 Water quality

Water quality tests have been carried out by the Water Development and Irrigation Division in 1971, shown in Appendix 4. The test indicates high fluoride (approximately 15 ppm) content as well as a high hardness (levels above 100) in the groundwater. The water examination states that the water is unsuitable for drinking purposes due to high fluoride content. The water sample was extracted from wells sunk in the tributary of Nhumbu river. The possibility of conducting a new water analysis test was investigated and tender sheets were obtained from the *Ministry of Water*, see Appendix 5.

According to Dr. Katani *E.coli* is also present in the water tanks. Due to the poor quality, most people only use it for cooking, cleaning and washing. Those who can afford, buy bottled water.

A new water quality test was made by the Ministry of water in Shinyanga. Bacteriological analyses (Appendix 6) and a physical and chemical analysis (Appendix 7Appendix) were performed. Two tests were made in order to increase the accuracy of the test and the water was collected at a tap located in the pump house.

As illustrated in the appendices, the fluoride content is high in the groundwater, 7 mg/l. The water is also considered slightly hard and alkaline. The bacteriological test showed a concentration of total coliforms from 10 coliforms/100 ml to 20 coliforms/100 ml. The concentration of fecal coliforms in the groundwater was decided to 6 coliforms/100 ml and 14 coliforms/100 ml. This was considered *unsatisfactory* by the laboratory.

With regard to the fluoride level, the ministry of water considers the groundwater acceptable for domestic use. However, the high content of total and fecal coliforms is of a big concern and the recommendation is disinfection.

The accepted fluoride content in drinking water is set to 1.5 mg/l. In some countries, this value is revised and a new guideline is set. In Tanzania, a fluoride level of 4 mg/l is considered as acceptable (The United Republic of Tanzania: Ministry of Water, 2013). A level of 7 mg/l, which is the case of Kolandoto, can cause skeletal and dental fluorosis (WHO, 2004).

During meetings and discussions with the hospital management, the issues regarding a high fluoride content was not considered a priority for phase two. If the hospital and village receives water from Shinyanga municipality in the future, the usage of groundwater will decrease since the borehole only will be used as a backup. Also, implementing a treatment process for fluoride is an expensive option, and not considered as vital as other parts of the project. However, the hospital management expressed a desire for further investigations regarding the fluoride level and its consequences. The extent of the skeletal and dental fluorosis is unknown in Kolandoto whereby a treatment process is a low priority. If a new study results in a high magnitude of skeletal and dental fluorosis in the area, a change of priorities for a later phase of the project is possible.

The detected levels of total and faecal coliforms are not acceptable for domestic use. According to WHO, coliforms "Must not be found in a 100 ml sample" for drinking water (WHO, 2011). Disinfection is therefore needed in order to improve the quality and make the groundwater more suitable for domestic use.

4.1.1.3 Distribution network

The distribution network has been mapped, using a GPS, and modelled in the software EPANET. In Figure 4 an overview of the system is shown, with the location of the borehole and the three tanks. Descriptions are presented in Appendix 8.

Figure 4: Supply network from borehole to tanks, from EPANET-model (backdrop from maps.google.com)

Also, the distribution network in the hospital area were mapped, see Figure 5 with Appendix 8 for descriptions. Only junctions, outlets and tanks were mapped, not the actual pipes. Therefore, the lines in the figure only roughly represents the true location for each pipe.

Figure 5: Distribution network at hospital with junction labels from EPANET-model (backdrop from maps.google.com)

The distribution network consists of different pipes, where material and size alter. See Figure 6 together with Appendix 9 for diameter of each pipe. EPANET has been used in order to determine if the network can handle higher pressure and a higher flow before breaking. Simulations indicates that a higher pressure and therefore a higher flow can be implemented without damaging the pipes.

Figure 6: Distribution network at hospital with pipe labels from EPANET-model (backdrop from maps.google.com)

The aim with the present system in Kolandoto is to extract water from the borehole and transport it to the tanks where it is distributed. However, different *ad hoc* solutions have been conducted in order to secure the availability of water in the hospital. Many buildings of the hospital are therefore directly connected to the main line which enables water supply even when the tanks are empty.

After installing the new pump, the possibility of closing incisions connected directly to the main line was discussed. However, the laundry is dependent on a high water pressure and is not able to function using only water from the tanks. Therefore, the connections are still present in the network. Also, closing the connections is not believed to increase the flow to the water tanks significantly.

4.1.1.3.1 Water towers and pressure levels

There are four different tanks in the Kolandoto village, presented in Table 1.

Table 1: Tanks located in Kolandoto and their corresponding size.

Tank	Building year	Size	Time to fill
Leprosy tank	1953	20 000 litre	2 hours
Hospital tank	1998	20 000 litre	3 hours
Upper main tank	1950	25 000 litre	7 hours[1]
Lower main tank	1948 (ren. 2005)	50 000 litre	4 hours

The leprosy tank is mainly used by the leprosy ward which is located approximately 100 m from the tank. Also, the college and a home for poor people (max 60 persons) receive water from the tank. The hospital tank, which is located inside the hospital area, is used by all wards and staff houses. The biggest tank, the lower main tank is used by the hospital and the college. Finally, the upper main tank is only distributed to the village. However, only half of the lower main tank capacity is used each day, since water needs to be available if an emergency at the hospital occur.

The outflow in different wards at the hospital has also been measured in order to determine if the flow is higher from 06-09, when the hospital is receiving water from both the tanks and the main line. A comparison with wards which are only receiving water from the tanks has been conducted. Flow measurements are presented in Table 2.

Table 2: Outflow in different parts of the hospital.

Ward	Connected to main line?	Time and flow Measurement 1	Time and flow Measurement 2
IV-production	Yes	08:45 – 12 seconds	09:10 – 12 seconds
Laboratory	Yes	08:45 – 44 seconds	09:30 – 49 seconds
Eye ward	Yes	08:40 – 6 seconds	09:20 – 13 seconds
General ward	No	08:55 – 36 seconds	09:40 - No water
College	No	08:55 – 22 seconds	09:45 – No water
CTC	Yes	-	09:50 – 4 seconds
Laundry	Yes	-	10:00 – 4 seconds

Wards connected to the main line continuously receive water throughout the day, even though the flow decreases. The magnitude of the decrease depends on where the ward is located and how long the pipe between the ward and main line is. For example, the connected pipe between the main line and the laundry is very short and therefore the flow is high even after 09:00. For the eye ward and

[1] The pump starts to fill the upper main tank at 06:00. At the same time the outlet to the village is opened. Therefore water is extracted from the tank, simultaneously as it is filled up, explaining 7 hours to fill the tank completely.

laboratory, the pipe is longer which has a negative effect on the water flow in the taps. Wards only connected to the water tanks stops receiving water after 09:00.

4.1.2 Rain water harvesting

There are several tanks located at the hospital for rain water. The rain water is mainly used for sterilization of hospital equipment, but can also be used as an extra water source when the pump has malfunctioned. Combined there are six rain water tanks and their location is presented in the overview blueprint, see Figure 1. Information regarding the rain water tanks, including their size, catchment roof and users, are presented in Table 3.

Table 3: The rain tanks in the hospital area, including their size, catchment roof and users.

Name	Size [m^3]	Catchment roof	Used by
RT 1	44	Eye ward	Eye ward, Eye theatre, IV-Production, General theatre
RT 2	44	Social hall	Kitchen, Social hall
RT 3	25	General theatre, Physiotherapy, Sterilization	IV-production, Dental, Pumps to RT 5 and RT 6
RT 4	55	CTC	Pumps to RT 3
RT 5	2	Same as RT3	IV-production
RT 6	2	Same as RT3	Dental

The tanks used for rainwater harvesting was originally built explicit for the IV-production. However, now only three tanks are used for this purpose, RT 3, RT 4 and RT 5, since the other tanks are used for surgeries and by the eye ward. Problems regarding the connection between the gutter and the rain tanks have been expressed.

Using rain water as an extra water source is common in the college where insufficient water supply is of big concern. The amount of rain water available depends on the season, where the rain season produces more. Staff has mentioned that the usage of groundwater decreases during the rain period.

4.1.3 Water demands

The present water usage has been calculated for different services in the hospital area. Each service requires a specific amount of water, which has been obtained from guidelines from Doctors Without Borders. A full table is presented in Table 4.

Table 4: Water demand calculations including current water demand and future usage.

Service	Current Quantities	Future Quantities (10 years)	Unit	Current water use	Future water use	Unit2
In-patients	186	558	[Patients/day]	60	60	[l/patient]
Out-patients	19911	59733	[Patients/year]	5	5	[l/patient]
Major surgeries	578	1734	[Surgeries/year]	100	100	[l/intervention]
Minor surgeries	497	1491	[Surgeries/year]	100	100	[l/intervention]
Eye surgeries	711	2133	[Surgeries/year]	100	100	[l/intervention]
Normal deliveries	1034	3102	[Deliveries/year]	100	100	[l/intervention]
Abnormal deliveries	115	345	[Deliveries/year]	100	100	[l/intervention]
Caesarian deliveries	230	690	[Deliveries/year]	100	100	[l/intervention]
Laundry	16	48	[Machines]	50	50	[l/machine]
Staff needs	134	402	[Staff members]	25	25	[l/person]
Student needs	500	1000	[Students]	40	100	[l/person]
Villagers without own well	400	600	[Villagers]	40	100	[l/person]

Service	Current water demand	Future water demand	Unit
In-patients	11160	33480	[l/day]
Out-patients	273	818	[l/day]
Major surgeries	158	475	[l/day]
Minor surgeries	136	408	[l/day]
Eye surgeries	195	584	[l/day]
Normal deliveries	283	850	[l/day]
Abnormal deliveries	32	95	[l/day]
Caesarian deliveries	63	189	[l/day]
Laundry	800	2400	[l/day]
Staff needs	3350	10050	[l/day]
Student needs	20000	100000	[l/day]
Villagers without own well	16000	60000	[l/day]
TOTAL	**52450**	**209350**	[l/day]
Losses	**43%**	**43%**	[%]
Total incl. Losses	**92160**	**367850**	[l/day]

Load increase at hospital	**300**	**[%]**
Population increase	**50**	**[%]**
Flow from old pump	**1,6**	**[l/s]**
Flow from old pump	**92160**	**[l/day]**
Total losses	**43%**	

From the calculations, the total loss in the distribution network can be obtained. A loss of 43 % in the system has been detected. The total loss was calculated by knowing the current water demand (52450 L) and the actual water flow from the old pump (92160 L/day). Therefore approximately 39000 litres are loss, which is 43 % of the total flow. According to the calculations, the hospital including the college and the surrounding village uses approximately 53000 litres, but almost 93000 litres are extracted from the borehole.

A meeting was held with the hospital management where the main discussions were considering the future water demand for the hospital, during a ten year period. An increase of 300 %, both for in- and out-patients is expected due to reduced patient fees. During this period, the college is expected to be classified as a university, resulting in an increase of students by 100 %. Using these predictions the future water demand for the forthcoming ten years can be calculated. 209350 litres is the future water demand, and including 43 % losses, the total water demand will be 367850 litres. All calculations is illustrated in Table 4.

4.1.4 Water supply from Shinyanga to Kolandoto

According to the Strategic Plan of SHUWASA (Shinyanga Urban Water Supply and Sanitation Authority), the authority has “a mandate to supply water and sewerage disposal services within the Shinyanga Municipality” (SHUWASA, 2013). On a meeting with Engineer Silvester S. Mahole, the Managing Director of SHUWASA on 10th March, it was confirmed that this includes providing potable water to Kolandoto since it is situated in the Shinyanga Municipality District. It was also declared that the pipes for this already have been purchased and that the work of constructing the pipeline is to start within the near future. (Mahole, 2015)

According to Mahole, an 8’’ pipeline from Shinyanga town to the TANESCO power station in Ibadakuli already exists, and from this point to Kolandoto only approximately 5 km remains to complete the connection from Shinyanga town to Kolandoto. This will be made with a 6’’ pipeline; the construction is expected to start in April 2015 and reach Kolandoto in June the same year. SHUWASA will also in this April start the task of evaluating water demand and current status of the existing water distribution network in Kolandoto. (Mahole, 2015)

SHUWASA is the authority responsible to supply water connections to institutions (such as the hospital and the college) and also to provide water connection for private houses, but for a connection fee. Necessary investments for the local distribution network are to be covered by governmental funding, and SHUWASA has been assured to receive such funding in time. Still, if the funds for any reason not would be granted, SHUWASA is determined to fulfil their task with own means, even though this would slow down the process. However, as soon as the main pipe reaches Kolandoto it will be connected to the existing distribution network and any changes will be made later on if deemed necessary. Additionally, SHUWASA will also attempt to establish water kiosks in the village to supply water to villagers who not could afford a private connection. The water kiosks are aimed to be managed by local entrepreneurs in collaboration with SHUWASA. (Mahole, 2015)

4.1.4.1 Quality and supply

SHUWASA is one of several regional authorities in Tanzania with the task to supply water and sewerage disposal to community institutions, industries, commercial facilities and domestic users. (SHUWASA, 2013) The work of these authorities is regulated by another governmental authority; EWURA (Energy and Water Utilities Regulatory Authority). EWURA annually produces a report on the regional water supply authorities' performances, were issues such as water quality and supply are appraised and ranked among the regional water authorities.

In the *Water Utilities Performance Review Report 2013/2014*, SHUWASA was in the overall ranking placed as 6th out of the 23 regional authorities. In this ranking, 10 different indicators have been used and measured indicators of particular importance this report (i.e. affects the consumers) are: "Water Quality Compliance" and "Average Hours of Supply". (EWURA, 2014)

4.1.4.2 Water Quality Compliance

"Water Quality Compliance" is measured as the percentage of water tests which pass the limit for potable water of the total number of water tests made (*number of passed tests/ total number of tests*). The exact number of water tests carried out is however not stated, but the report states that "[the] water utilities are obliged to carry out regular water quality tests". (EWURA, 2014) The water samples taken are tested against *E.Coli*, turbidity, residual chlorine and pH, see Table 5. The Tanzania Bureau of Standards (TBS) guidelines are used as limits for the tests, see Appendix 10. In the year 2013/2014, 100 % of the tests made in water supplied by SHUWASA complied with the TBS demands. (EWURA, 2014)

Table 5: Water quality of municipal water.

	E.Coli	Turbidity	Residual Chlorine	pH
2011/2012	99 %	97 %	96 %	99 %
2012/2013	100 %	96 %	96 %	100 %
2013/2014	100 %	100 %	100 %	100 %

4.1.4.3 Total Supply and Average Hours of Supply

The main part of the water supplied by SHUWASA – over 80 % – comes from KASHWASA (Kahama Shinyanga Water Supply Authority), the authority responsible for production and distribution of treated surface water from Lake Victoria to the regions of Kahama and Shinyanga. The remaining parts come from surface water from a dam construction as well as ground water from a well field and shallow wells. (SHUWASA, 2013) This large bulk supply from Lake Victoria combined with additional local back up supply provides enough volumes to supply the consumers connected to the SHUWASA network. Still, SHUWASA does not manage to provide a 24 h/day service. This is mainly due a vulnerable distribution network which suffers from occasional pipe brakeage, even though the 0.4 pipe breaks/km and year is low compared to other Tanzanian suppliers.

The indicator "Average Hours of Supply" describes the average amount of hours per day that the consumer can withdraw water from their own tap or public tap stand (water kiosk). For SHUWASA the average hours of supply is 22 h/day. (EWURA, 2014)

4.1.4.4 Pricing

As stated above, SHUWASA is bound to provide the main trunk line to Kolandoto as well as the distribution system within the main village of Kolandoto (however, not to the surrounding settlements). If institutions and inhabitants are connected to the municipal water from Shinyanga they become customers of SHUWASA and thus have to pay for the water they consume. According to Mahole (2015) the tariff structure of SHUWASA is about to be revised and increased, but the prices for 2013/2014 gives an indication on the prices ranges that could be expected (see Table 6). Using todays costs, and the hospitals current consumption at 1500 m^3/month, the monthly total would be about 1 900 000 TZH.

Table 6: Pricing for SHUWASA supplied water 2013/2014 (EWURA, 2014)

Category	Domestic	Institutions	Kiosks
TZS/m^3	790 – 1 000	1 000 – 1 270	1 000
Service charge, TZS/month	2 000	3 500	-

4.1.5 Water management

Today, four people are responsible for the pump. There is always staff present in the pump house, even though the pump is only running from 06 – 22. Groundwater is pumped from the drilled borehole and transported through the distribution network to the tanks. Each tank is filled up at a certain time, see Figure 7. During phase one, a new pump was bought and installed. A new pump schedule was created together with the water staff, presented in Appendix 3.

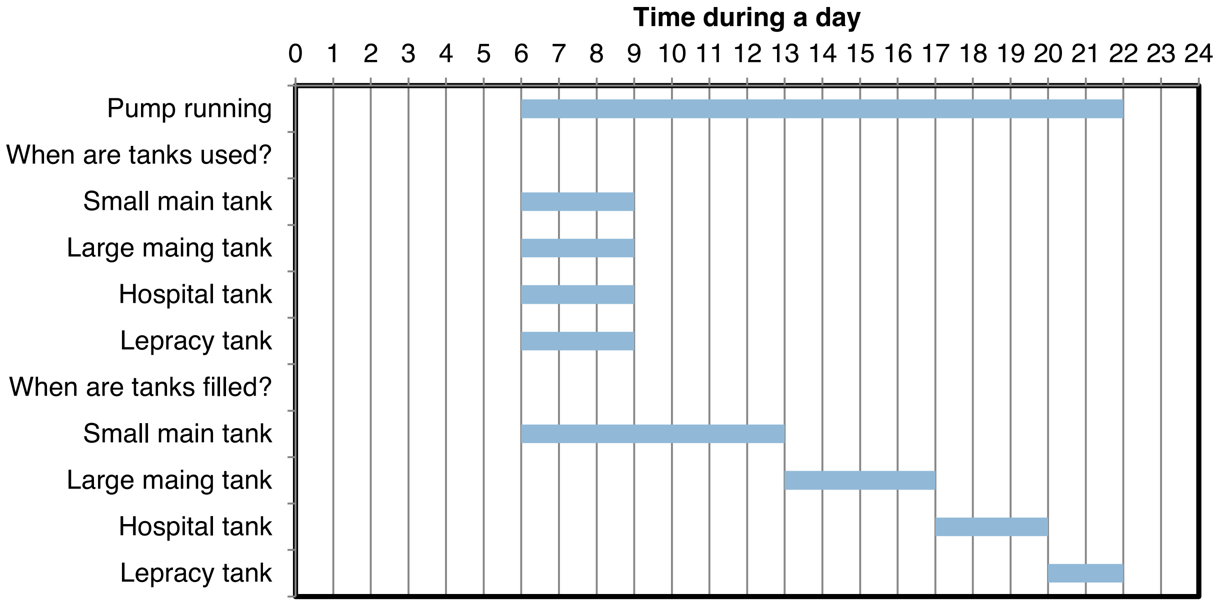

Figure 7: A complete pump and tank schedule, stating when tanks are filled and used.

The tanks are opened at 06 and are emptied by 09. Most hospital wards continuously receive water directly from the main line during the day, however, the flow in the taps is higher from 06 – 09 when the wards receive water from both the main line and the tanks.

Villagers, students and staff at the hospital fill up big buckets (60 – 120 litres) in their home/working place from 06 – 09 in order to ensure that they will have water throughout the day.

Villagers connected directly to the tank pays a monthly fee of 5000 TZS to the hospital. Other villagers can collect water directly at the tank and pay a fee of 100 TZS/20 litres. The water staff collects the money, makes a summary of the amount of water sold and deliver it to the accountant. Villagers connected to the main tank can also sell water from their own taps, where they decide the price and amount.

Due to power cuts and malfunctioning of the existing pump, water is not always available for the hospital. In case of emergencies, the hospital has bought water from the army. The water is delivered in army trucks, where two trucks fills up the rain tank located underground. The hospital bought water once in 2014, where water from four full trucks was delivered. The water bought from the army is however of poor quality and a large amount of energy and raw material is needed in order to purify it. The water is only used for IV-production.

4.1.6 Environmental consequences

There is no big concern regarding the extraction of water from an environmental aspect. However, the lack of water often results in less cleaning which impacts the indoor environment. In the hospital wards, cleaning is a vital part in order to prevent disease spreading.

The cleaning schedule is almost the same all over the hospital, except in the theatres. In the wards, there is a daily routine where dusting, sweeping and mopping is included. There is also a weekly schedule where a more thorough cleaning is done. Dusting of roofs and walls is for example done on a weekly basis.

All wards have one person who is responsible for cleaning the wards daily, but during the weekly cleaning the hospital staff contributes. However, nurses in the general ward and maternity have mentioned that they sometimes clean on a daily basis since the person responsible is not available. In the theatres the cleaning schedule is a bit different. A thorough cleaning is done after every surgery.

Water from the taps is used when cleaning the wards, but when the availability of water is limited rainwater is used instead. The nursing staff has expressed big problems regarding the usage of rainwater. This procedure often includes heavy lifting which is not suitable. The nursing staff in the maternity also mentioned that mopping is sometimes cancelled due to lack of water.

4.1.7 Running costs and investment costs

Due to malfunction of the old pump, approximately 200 000 TZS per month is used for repair costs. During 2014, 1 million TZS was used to buy water from the army.

4.1.8 Desires expressed by Kolandoto Hospital

During meetings with the hospital management the water supply has been described as the main concern for the hospital. The amount of water available can differ on a daily basis causing issues for the hospital in order to provide sufficient healthcare. The desire among the hospital staff is to have consisting water flow 24 hours per day, in all wards.

Management has also stated that the hospital and college work together with issues such as water and electricity. Students at the college collect between 10 – 20 litres water every day, which can be compared to the amount of water available in refugee camps. Management has stated that water supply for the college is a vital part as well.

Water quality is also of concern since it affects people’s health. A system where pathogen and fluoride levels are decreased to an approved level is desired.

4.1.9 Solutions with attached blueprints and technical info

During phase one the possibility of extracting more water from BH1 was examined. Firstly, the current capacity of the pump was determined by measuring the water flow in connection to the pump. The water distribution system was mapped using a GPS and the software EPANET, where the maximum pressure in the network was determined.

In order to determine the actual capacity of the borehole a drilling company was hired to perform a pump test. Conducting this test using an accredited company is an advantage since it will provide the hospital with useful documentation for future changes. Three different companies in the

Shinyanga region was contacted and visited, Wedeco Ltd, Drilling and Dam Construction Agency and Shinyanga Drilling. A performa was received from Wedeco Ltd, see Appendix 2. However, Shinyanga Drillings pump was insufficient and therefore suitable for this test.

Another visit together with the Hospital Patron was also conducted. Meetings with Wedeco Ltd and the Drilling and Dam Construction Agency resulted in hiring Wedeco Ltd. A contract which stated the both parties' responsibilities was created and signed by Dr. Katani and Wedeco Ltd's CEO, see Appendix 11.

Wedeco Ltd performed a pump test on the existing borehole on the 21st of February. The pump test started at 13.00 and finished at 23.00. The hospital was informed about the interruption in the water supply, but since the test was conducted at a Saturday, this was of no concern.

First, a pump with the capacity of 13 m^3/h was used for two hours before a stronger pump, with a capacity of 23 m^3/h was used for seven hours. During the final hour a recovery test was made in the borehole.

During the pump test Wedeco Ltd acted unprofessional and did not record enough measurements. The final recovery test was conducted by Andreas and Daniel in order to obtain enough values. A meeting where the final report would be presented was set to the 5th of March, see Appendix 12.

Wedeco also arranged a meeting with a hydrogeologist to discuss our borehole and difference between seasons. According to the hydrogeologist some areas exhibit no difference in terms of water discharge during the wet and dry season. Based on the data provided from our pump test and recovery test, the hydrogeologist classified the well as "a high capacity well" which is drilled in a very good aquifer. He also recommended purchasing a pump with a capacity below 20 m^3/h, since other factors were unknown. Finally, he made some calculations for the transmissivity and conductivity, see Appendix 13.

Further, the possibility of flushing the existing borehole was studied. A well performed flush of a borehole can increase the amount of available water. However, there is a large risk when performing a flushing since it involves cleaning the pipe with high pressure. BH1 was drilled in the 1970s and information regarding the borehole is lacking. According to responsible staff, a flushing was made 2000, by a company from South-Africa. However, no documentation regarding the flushing was found at the hospital or at the regional office in Shinyanga.

Mr. Biku, an employee from Shinyanga Drilling, visited the borehole (18/2) and talked about the risks and possibilities for flushing. In order to ensure that the borehole will not collapse, re-casing is the best option. However this procedure is expensive and therefore not suitable in phase 1. A complete performa is presented in Appendix 14.

4.2 Electricity

The power supply to the hospital is unreliable and of big concern. An uninterrupted supply is a major desire and needed in order for the hospital to provide good healthcare.

4.2.1 City power

City power is provided from TANESCO (Tanzania electric supply company) who has its headquarter in Dar es-Salaam, but a regional office in Shinyanga. The power provided by Tanesco breaks down a lot during a week. Normally, the power cuts between 1-5 times a week and last for approximately one hour. However, longer power cuts have been observed, but the occurrence is not on a regular basis.

4.2.2 Generators and backup system

There are two generators present in the village, where one is not used due to malfunction. Both generators are located in a small building next to the church. A schedule is filled every time the generator is used. In January, the generator was used four times with an average running time of two hours. The present generator was purchased 2000 and produces 36 kW, see Figure 8. The generator only produces enough electricity to cover some parts of the hospital and it is mainly used for emergencies, such as ongoing surgeries, or when the pump needs to produce water.

The main reason for not using the generator every time the city power breaks down is economy. It is very expensive to use a generator for this amount of time.

Figure 8: The generator which is currently in use.

4.2.3 Management

There is one technician in the maintenance staff responsible for electricity, named Metsela Charles but known as Nkaka. He is in charge of all work regarding electrical issues at the hospital and its surrounding facilities. Nkaka is also responsible for the hospital's generator, and when it is needed, ha has to be called to start the generator.

4.2.4 Environmental consequences

The generator uses diesel as fuel which has negative influence on the surrounding environment. However, since the generator only runs for emergencies, the emissions are relative small. As stated earlier, the generator was used four times in January with an average running time of two hours.

4.2.5 Running costs and investment costs

The running cost for the electricity varies from month to month. For December, 2014 the total cost for all electricity provided from TANESCO was 3.62 million TZS, or approximately 200 TZS/kWh.

If the generator requires four litres of diesel every hour, and the cost for diesel is 1800 TZS/litre, the total cost for running the generator in January is 57 600 TZS.

4.2.6 Load needs – critical and non-critical needs

In order to prioritize patient care when the power supply is limited, critical and non-critical loads must be determined.

According to a report written by the *Ministry of Health and Social Welfare* in the Republic of Liberia, a critical load is defined as "Loads associated with building occupant safety and patient life systems". Non-critical loads are defined as "Loads associated with normal facility operations where power loss does not affect patient care" (Ministry of Health and Social Welfare: Republic of Liberia, 2013).

A full inventory of the hospitals electrical appliances was done in order to determine the total load need. The inventory is presented in Appendix 15. During a workshop with hospital management, each device presented in the inventory was categorized with a critical level, ranging from 1-3, see output in Table 15 in Chapter 6.5. Also, the amount of time without power before patient care in the hospital is affected was determined at the workshop.

4.2.7 Critical time for central devices

Some parts and devices at the hospital are depending on a steady and stable power supply and a power cut could cause severe health risks to patients. When designing the solar powered back-up system, the time a device could function without power was determined. A list with appliances, from wards prioritized as *critical* in chapter 4.2.6 was filled in by the hospital management and is presented in Appendix 16.

4.2.8 Desires expressed by Kolandoto Hospital

During the first management meeting (10/2 - 2015) Dr. Bwiri expressed his desire to obtain the same electricity even when the city power has broken down. He mentioned that he had to cancel two different child births due to interrupted power supply, which could have had severe consequences.

The hospital management also stated the importance of continuously power supply to the students. Lasting power cuts interfere with the students' possibility to study and are also of big concern. There are several NGOs supplying students with solar powered lamps, which should be investigated further in a later phase. Also, the possibility of implementing a solar system explicit for lights at the college should also be considered.

A new system, with a new generator is desired, where enough electricity could be produced in order to supply the whole hospital with electricity for a long time. A switch which automatically turns on the generator when the city power is down is also desired. However, a new, more powerful generator is more expensive to use, which also needs to be taken into account.

4.3 Solid waste

There does not exist any central waste treatment in Kolandoto, and all solid waste generated at the hospital is therefore treated locally at the hospital's own waste treatment zone.

4.3.1 Waste treatment zone lay out

The solid waste from the hospital is treated at the solid waste zone located in the western part of hospital premises, between the entrance and the college area (see overview in Figure 1). At this area there is one concrete and steel incinerator (outside dimensions 1.9 m x 1.25 m, height 1 m). The incinerator is equipped with a 5 m long stack to divert hazardous gases. In direct connection with the incinerator, there is a small concrete floored area for temporary accumulation of waste, 4.6 m x 4.5 m with 1.5 m high concrete walls. There are three pits in the waste zone; one pit enclosed with concrete lid, and two open dug pits, one approximately 4 m diameter and 2 m deep, and the other approximately 2 m diameter and 2 m deep.

In the eastern part of the hospital premises there is a small independent canteen. This canteen treats its own waste according to local praxis: with a small dug pit where the waste is burned as the pit becomes full.

4.3.2 Setup and routines

All wards and units on the hospital use the *three bucket system* for collection of solid waste. This means that the solid waste is collected and divided in three different categories, each collected in different colour-coded buckets: non-dangerous (blue or black bucket), dangerous (yellow bucket) and very dangerous (red bucket), for examples of type of waste from each category, see Table 7. (Food waste is at some wards collected in a separate bucket, but it is treated in the same manner as the non-dangerous waste.)

Table 7: Examples of waste types within each solid waste category

Waste category	Examples
Non-dangerous	food, plastic bottles, other domestic trash etc.
Dangerous	non-stained gloves, IV-bags etc.
Very dangerous	infectious material, blood stained items, catheters etc.

Normally the buckets are in the size of 20 l, even though 50 l buckets are used for the non-dangerous waste in the general ward. In addition to this, used syringes and sharp equipment are disposed in yellow well-pap “Kojak safety boxes”, specially designed for the purpose, see Figure 9.

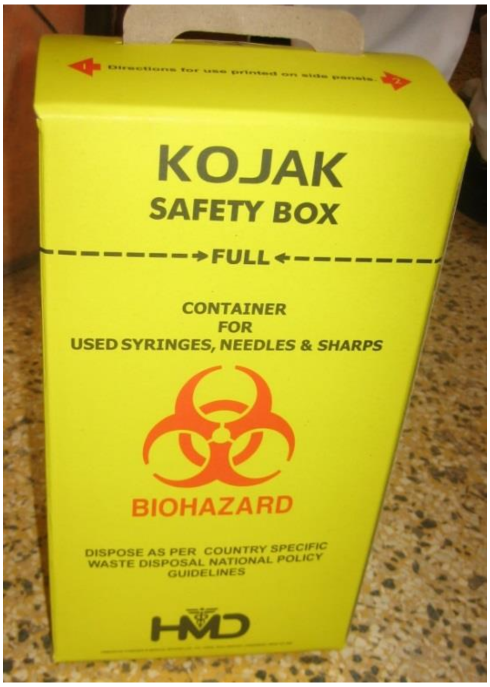

Figure 9: "Kojak safety box" for disposal of used syringes, needles and sharp objects.

When buckets and yellow safety boxes become full cleaning staff at the respective ward carries these to the hospital’s central solid waste zone. At the waste treatment zone, the waste is immediately placed in pit or incinerator by one of the staff working at the waste zone as it is received. The non-dangerous waste is burned in the large open dug pit and the dangerous and very dangerous waste is burned in the incinerator, which can hold up to approximately two 50 L buckets at a time according to the waste zone staff. The ashes remaining after incineration are deposited in the small open dug pit, situated adjacent to the incinerator.

The enclosed pit, with area of 2.5 m x 2.1 m but unknown depth, is used for biological waste from the hospital, such as placenta and waste from surgeries. Since the waste to this pit is disposed in plastic bags, no natural biodegradation can occur.

The area next to the incinerator could allow stocking up waste and burn in bulks during night time when less persons is present in the area and the hospital’s activity is low. However, this is not used since it is lacking a roof and rain would wet the waste and inhibit the burning, see Figure 10. The waste is instead continuously burned throughout the day as it is received.

Figure 10: Waste area, including the incinerator and the area without roof.

4.3.3 Production rates

The hospital does not keep track on the amount of solid waste that is created each day, and the waste buckets are emptied on demand. However, staff from different wards has stated that the buckets has emptied on average one time per day.

4.3.4 Environmental consequences

The burning of solid waste has obvious negative environmental consequences. When plastic is burnt, hazardous gases are released which can be carcinogenic and cause several different types of respiratory diseases. The waste management staff working at the waste zone is particularly exposed to these risks, but people at the nearby road, shops and outside the hospital entrance also run the risk of inhaling harmful fumes.

Since this is the only waste treatment facility for the hospital, and has been for a long period, it can be expected that other types of toxic materials has been deposited or burnt here throughout the years. It is also possible that sharps such as not completely destroyed knifes and syringes can be found at the site, and careful caution should therefore be kept when entering or planning any construction work at the site.

4.3.5 Desires expressed by Kolandoto Hospital

Issues with the waste zone are yet to be raised by anyone in the hospital's management team. However, personnel working in the waste zone have put forward several concerns over the waste treatment and the work environment for the staff.

Since the waste management staffs are lacking proper protective clothes and equipment, the issues raised are mainly concerning safety and health. No protective equipment other than thin silicone surgical gloves, regular hospital staff clothes, and a thin fabric face protection have been provided to the workers by the hospital. Furthermore, no proper tools are accessible for the waste zone staff.

Issues from the waste management perspective concern the size of the incinerator and the in adequate roofing. Even though the incinerator was built in 2014 it has a severely damaged roof and, according to the waste staff, is of insufficient capacity. As stated above, the waste accumulation area is also completely lacking roof, which unable storage of waste for bulk incineration.

4.4 Wastewater

The following chapter will describe the wastewater system at Kolandoto hospital. The system is based on an old infiltration bed and septic tanks, located throughout the hospital area.

4.4.1 Setup

The wastewater is treated in an infiltration bed, located west of Kolandoto Hospital. The infiltration bed has been in use since 1996, according to responsible staff and there are five different inlets to the infiltration bed from the hospital.

Before entering the infiltration bed, the wastewater passes through septic tanks located at the hospital. There are 17 septic tanks in the hospital area and their location is presented in the overview blueprint, see Figure 1. The corresponding size, and ward connected to the septic tank is presented in Table 8.

Table 8: Size and location of septic tanks.

Tank	Surface area [m²]	Ward
ST 1	4,9	Eye ward, Eye theatre
ST 2	5,3	Eye ward (female)
ST 3	7,0	Laboratory, OPD
ST 4	7,8	Administration
ST 5	5,5	Storage
ST 6	4,6	General theatre, X-Ray, Pharmacy
ST 7	10,9	Private ward
ST 8	7,0	Maternity
ST 9	7,9	Staff part in Maternity
ST 10	15,6	Paediatrics
ST 11	6,7	Paediatrics
ST 12	11,5	General ward (female)
ST 13	7,1	General ward (female)
ST 14	7,1	General ward (male)
ST 15	9,9	General ward (male)
ST 16	6,0	RCH, Private ward
ST 17	4,0	CTC

The solids in the wastewater are separated in the septic tanks, allowing only the water to infiltrate in the bed. When the septic tanks get full, a contractor is hired for emptying the tanks which was done three years ago.

4.4.2 Production rates

The amount of produced wastewater is connected to the amount of available water. The wastewater flow is equal to approximately 80-90 % of the drinking water flow (Pettersson, 2014).

In a regional hospital the generated wastewater can be assumed to 57-114 litres/day and person. OPD-patience generates approximately 4-11 litres/day and person. Using mentioned values, the total wastewater flow is 37 000 litres/day in Kolandoto Hospital.

4.4.3 Management / maintenance

Julius Omango is responsible for the wastewater system at Kolandoto Hospital. Inspection hatches for the wastewater system is of poor quality and is in need of maintenance, also the quality of the inspection bed should be investigated further.

Some hatches on the septic tanks are inadequate due to wear over the years, causing smell to spread in the surroundings. Also, mosquito eggs are present in the septic tanks, which make a well-constructed hatch more vital.

4.4.4 Environmental consequences

Wastewater treatment by soil infiltration provides adequate treatment for the type of wastewater that is generated by the hospital. The most important risk with wastewater treatment is if it were to cross-contaminate the drinking water, but the distance between the infiltration bed and the borehole makes this impossible. Most pathogens can travel 1-2 m in the ground and no pathogen can travel more than 20-30 m. The distance from the infiltration bed to the borehole is over 700 m.

4.4.5 Desires expressed by Kolandoto Hospital

According to the responsible staff, there are no issues regarding the wastewater at the hospital.

4.5 Logistics and flows

Site circulation and flows of patients, staff, materials and visitors across the hospital area plays an important part in making sure the hospital is an environment that does not cause illnesses or poor health. Appropriately designed flows will decrease the risk of medical errors and nosocomial infections or diseases. Appropriate access and entrance points to the site for different types of flows need to be considered.

4.5.1 Inpatient flow

The inpatient flow, illustrated in Figure 11, starts by registration at the outpatient department (OPD) before the patients are brought to their respective appropriate wards. From the wards, the patients sometimes go to the centre of the hospital to the x-ray department or the general theatre.

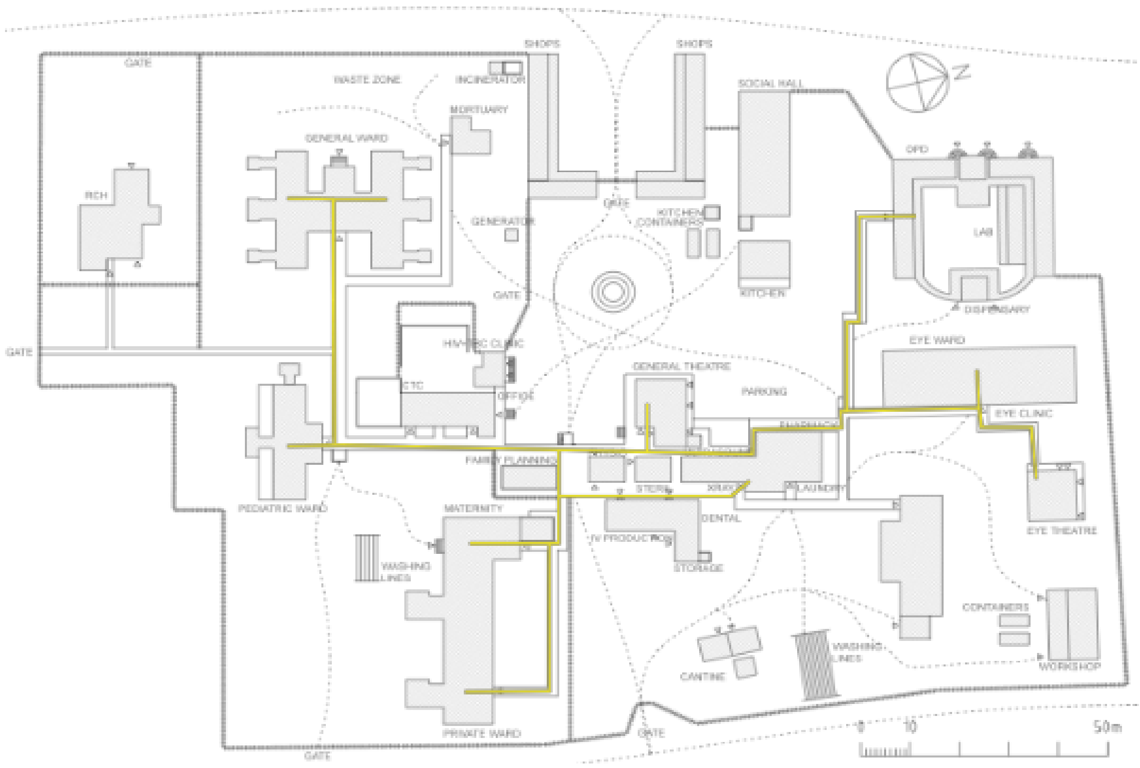

Figure 11: Inpatient flow

4.5.2 Outpatient flow

The outpatient flow, illustrated in Figure 12, often starts at the outpatient department (OPD) with registration and payment. The consultations and examinations of patients happen at the OPD during daytime. A lot of outpatients are only in that area since the laboratory department is also in the same building.

Some clinics are however not situated close to the main OPD, but instead the patients have to cross other areas to reach their destination. That is the situation for the patients going to the Care Treatment Clinic (CTC), the Reproductive Child Health Clinic (RCH), the physiotherapy, the dental clinic and the x-ray department. This movement is probably most problematic for pregnant mother coming to the RCH, who sometimes have to walk all the way there, then go back to the laboratory and then back again to the RCH.

At night-time the OPD is closed. This has the effect that outpatients will enter through the main gate, and are then expected to find their way to the appropriate ward where the examination and consultation can take place.

An overall issue with the outpatient flow is that it is quite spread out throughout the whole hospital area. This causes confusion and also means that the outpatient flow is crossing for example the inpatient and emergency flow.

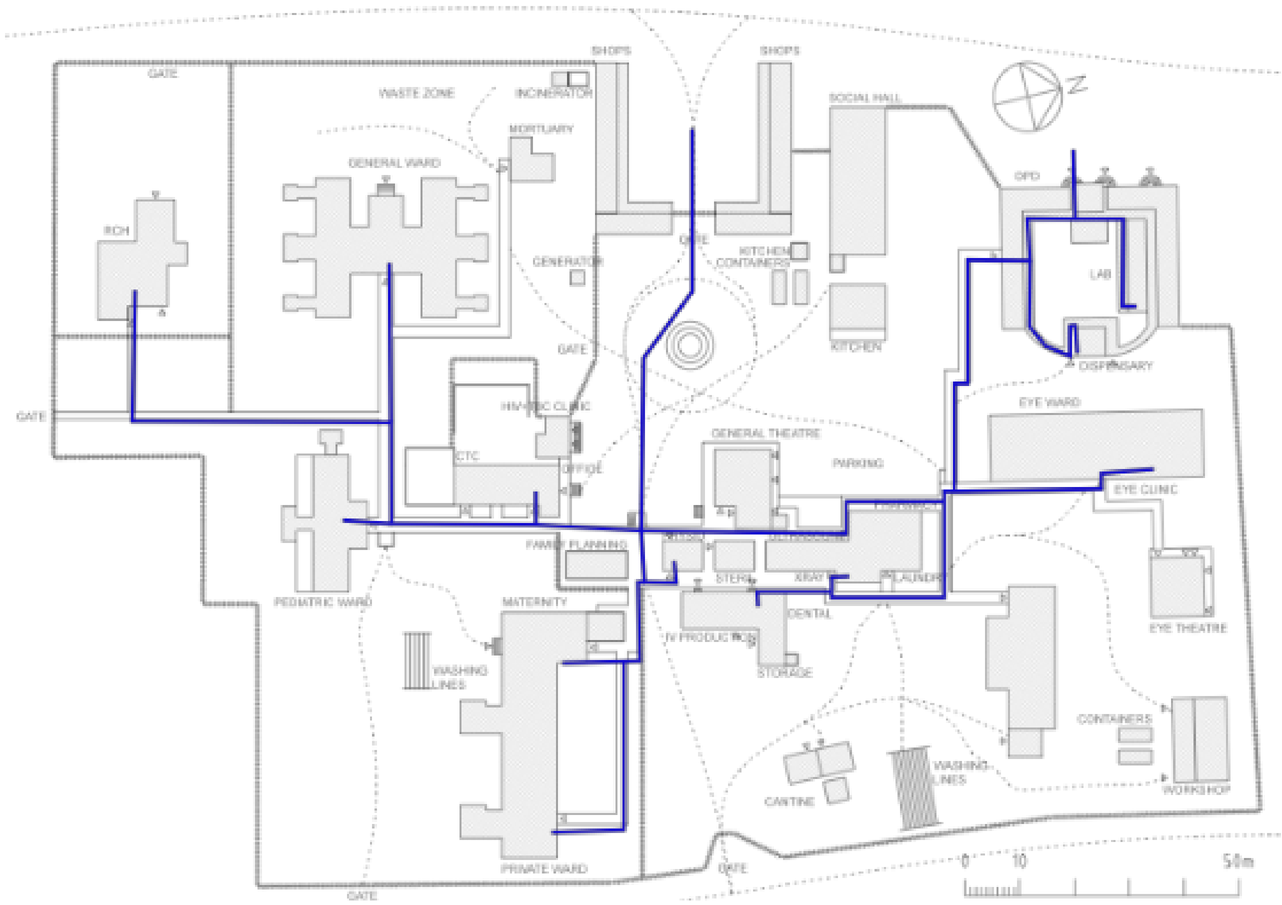

Figure 12: Outpatient flow

4.5.3 Emergency flow

The emergency flow, in Figure 13, is the most problematic at the hospital. The emergency patients sometimes arrive through the main gate and sometimes through the OPD. They can arrive by motorbike, car or ambulance depending on the transport available for them. It is not clear where someone from the staff will receive and assess the patient. Sometimes it can happen in the corridor at the OPD, sometimes on the open space in front of the family planning building, and sometimes in the different wards. Transporting patients on stretchers is especially troublesome as well. The doors at the OPD are not wide enough, and that is also the case with the x-ray department. This means that it happens that the staff has to gather enough people to carry the patient through the doors on a mattress.

The main issue is that the emergency flow is too inefficient to provide good emergency care, and has no assigned place as to where the care should take place.

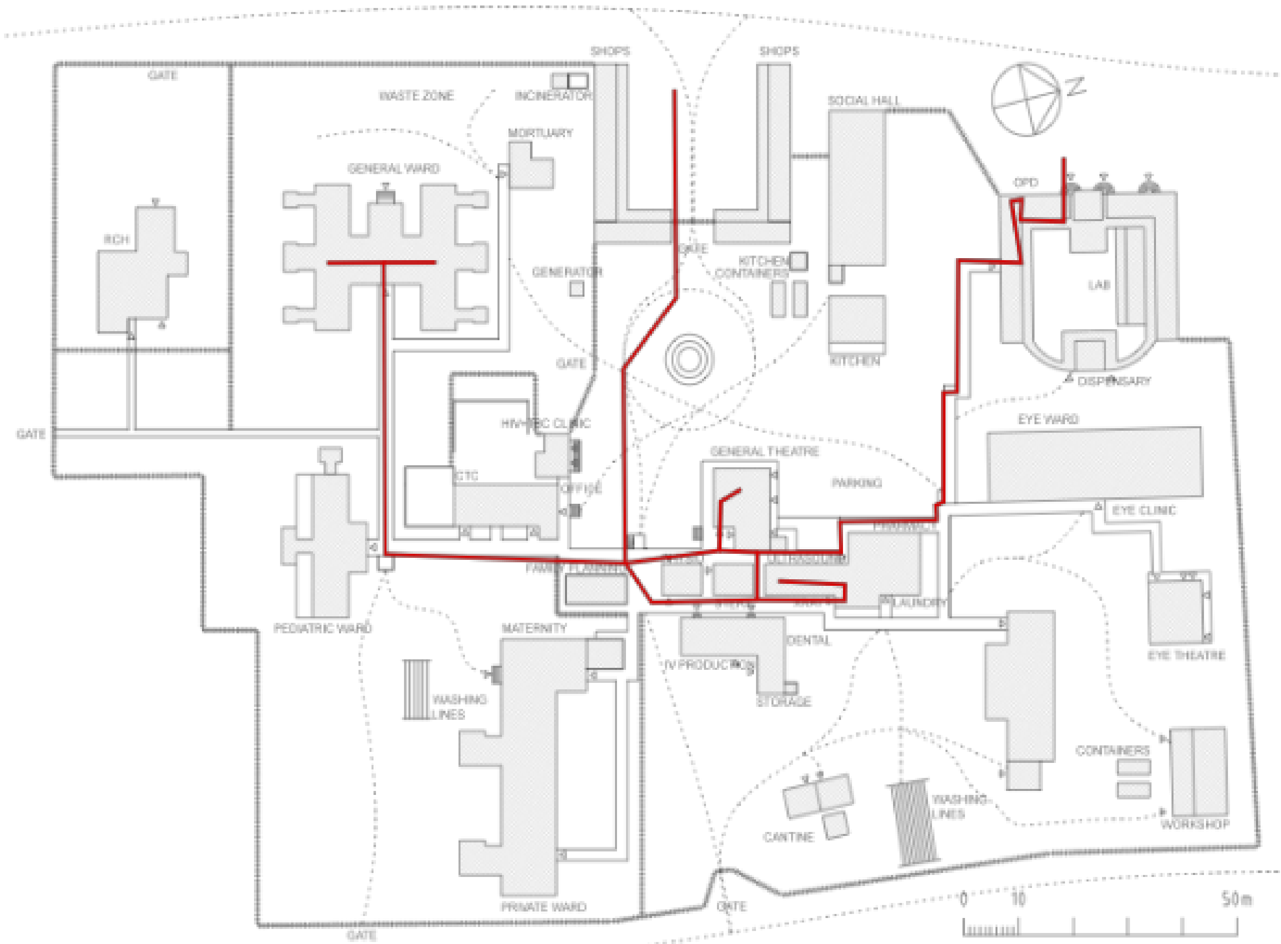

Figure 13: Emergency flow

4.5.4 Delivery flow

The delivery flow, in Figure 14, is that the pregnant mothers mainly come through the main gate and then they are taken to the maternity ward where they are examined. If the mother needs to wait before delivery, she might be admitted to the ward. If the delivery is on-going, she might immediately enter the delivery room in the maternity ward. However, if the mother needs a c-section she will be transported out from the maternity ward and on to the general ward where the c-section will be performed. There is an operating room for c-sections in the maternity building, but it is not in use at the moment since the staff feel they cannot ensure proper hygienic conditions due to the lack of a changing room, a scrub room and a sluice room.

An extension to the maternity operating theatre is under construction at the time of writing this report. This means that the operating theatre for c-sections will soon be in use and the pregnant mothers in need of c-section will no longer have to be transported out on the outdoor paths to get to the general theatre.

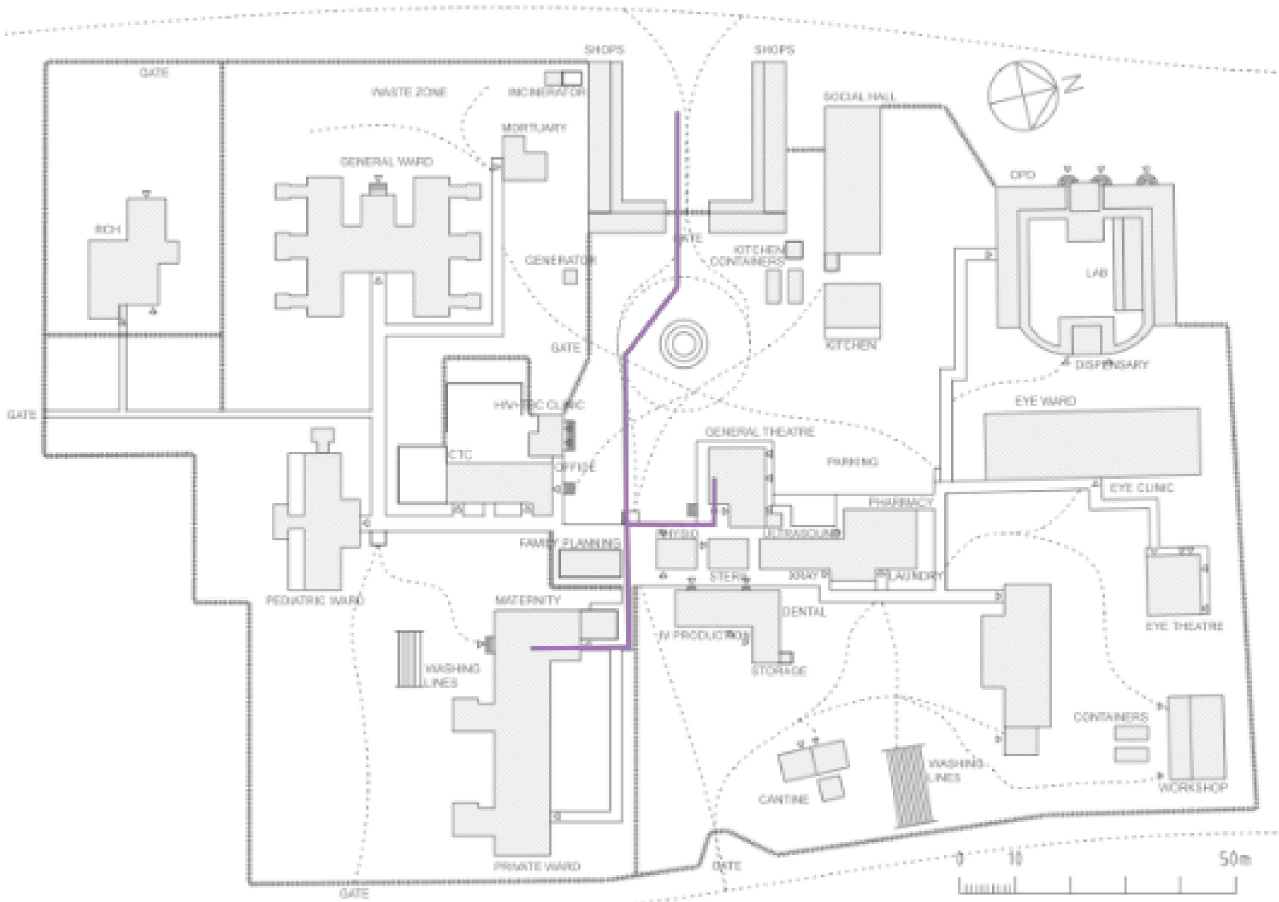

Figure 14: Delivery flow

4.5.5 Visitor flow

The patients at the hospital are not served food by the hospital. Instead, their relatives come to deliver food to the patients during visiting hours three times per day. This means that the visitor flow is quite high with peaks in the morning, around lunchtime, and in the late afternoon. Visitors enter through the main gate and then walk to the respective wards.

An issue with the visitors flow, see Figure 15, is that it is unnecessarily long. At the path in front of the family planning and the CTC the visitor flow is part of causing congestion where more clinical flows should not be restricted.

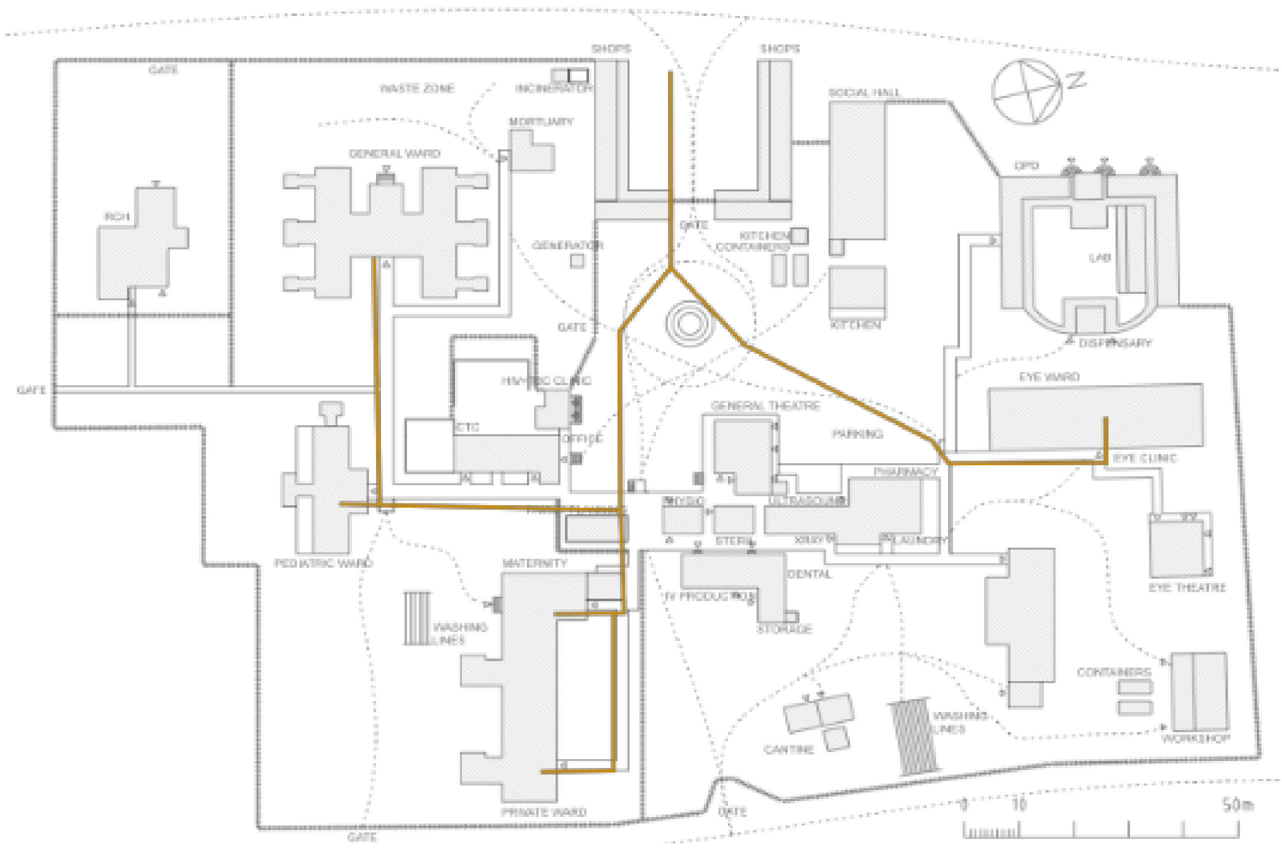

Figure 15: Visitor flow

4.5.6 Student flow

Kolandoto College of Health Sciences is located to the left outside the hospital site in the plan below, see Figure 16. The college and the hospital are closely related and collaborate on many areas. Part of the education for the students is done at the hospital taking part in the everyday care.

Two buildings that are used for purely college purposes are located within the hospital area - the kitchen and the social hall. This results in that 500 students pass through the hospital area three times per day to get their food at the kitchen and social hall. This flow is unnecessary and not related to the care provision of the hospital, hence it should not be there at all. The students are also part of creating congestion along the path in front of the care treatment clinic and family planning. The students also take the opportunity to exit in other directions than to the college, using the hospital area as a way of taking a shortcut to reach other parts of the village. Se an illustration in Figure 16.

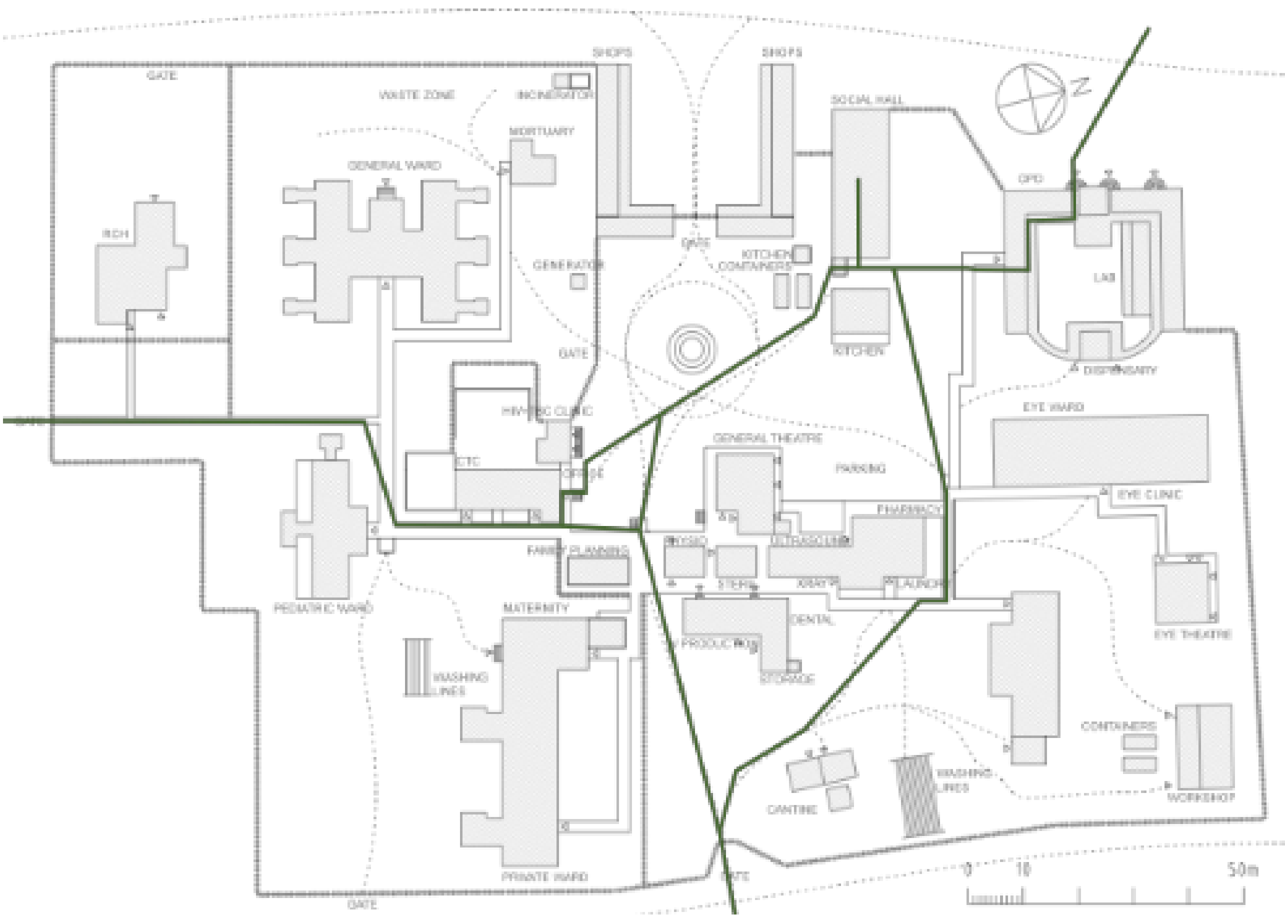

Figure 16: Student flow

4.5.7 Staff flow

What there is to say about the staff flow is that they enter from two gates and then the flow of staff is all over the hospital and is hence not mapped further, see Figure 17.

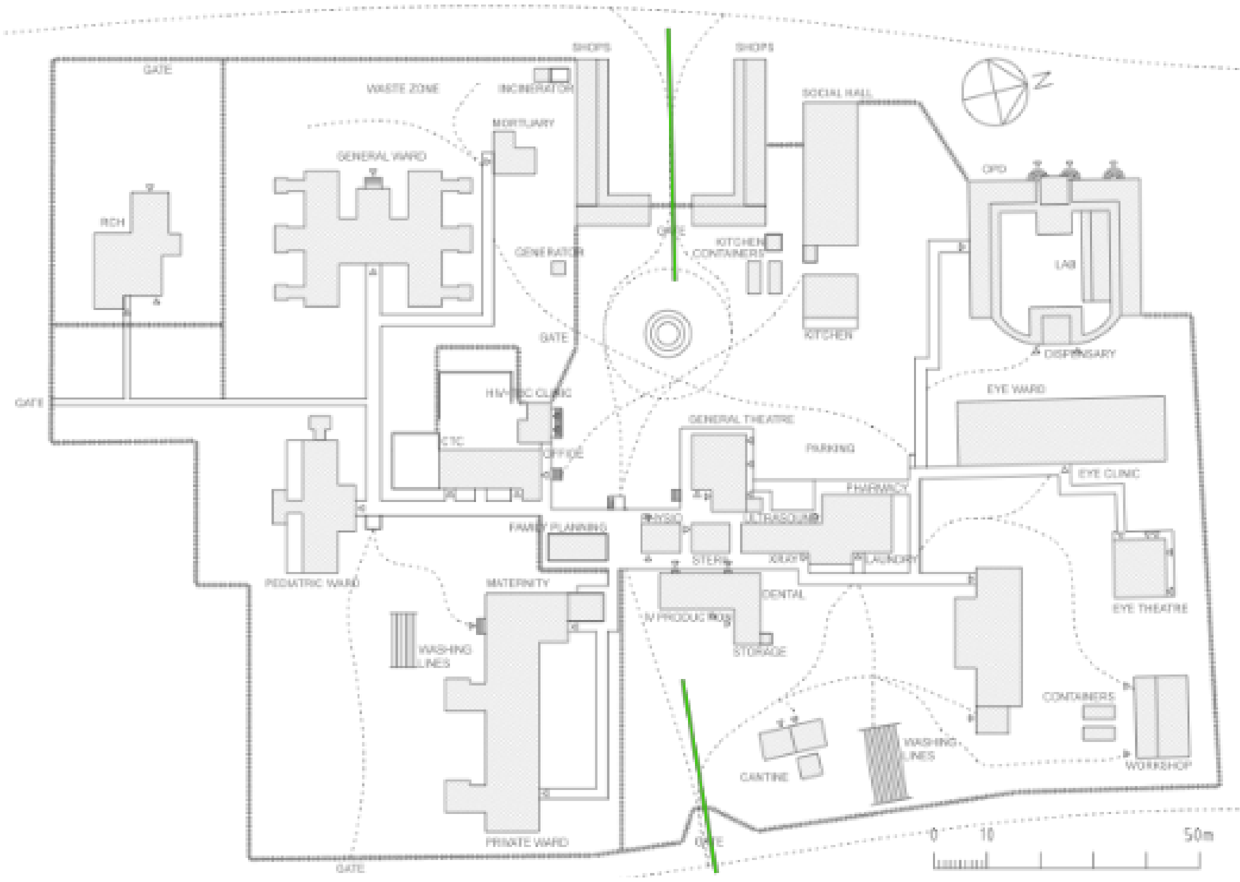

Figure 17: Staff flow

4.5.8 Equipment and consumables flow

The flow of equipment and consumables, illustrated in Figure 18, can be divided into the goods that arrive to the hospital, the goods that are considered waste from the hospital, and goods that are used and reused at the hospital.

The goods delivered to the hospital mainly arrive through the main gate to the pharmacy building. From there, medications for outpatients are taken to the dispensary in the outpatient department building, and medications for inpatients are collected by staff from the different wards. Medical supplies are kept in the supply store, from which staff comes to collect what is needed in the different departments. IV-fluids are produced in the infusion unit, and stored in the pharmacy.

Used equipment in need of sterilization is taken to the central sterilization room. Laundry moves from and to the wards.

Solid waste is carried in buckets to the waste zone, where it is either burnt in the incinerator or thrown in pits dug in the ground.

The illustration in Figure 18 is a simplification of the flows of equipment and consumables.

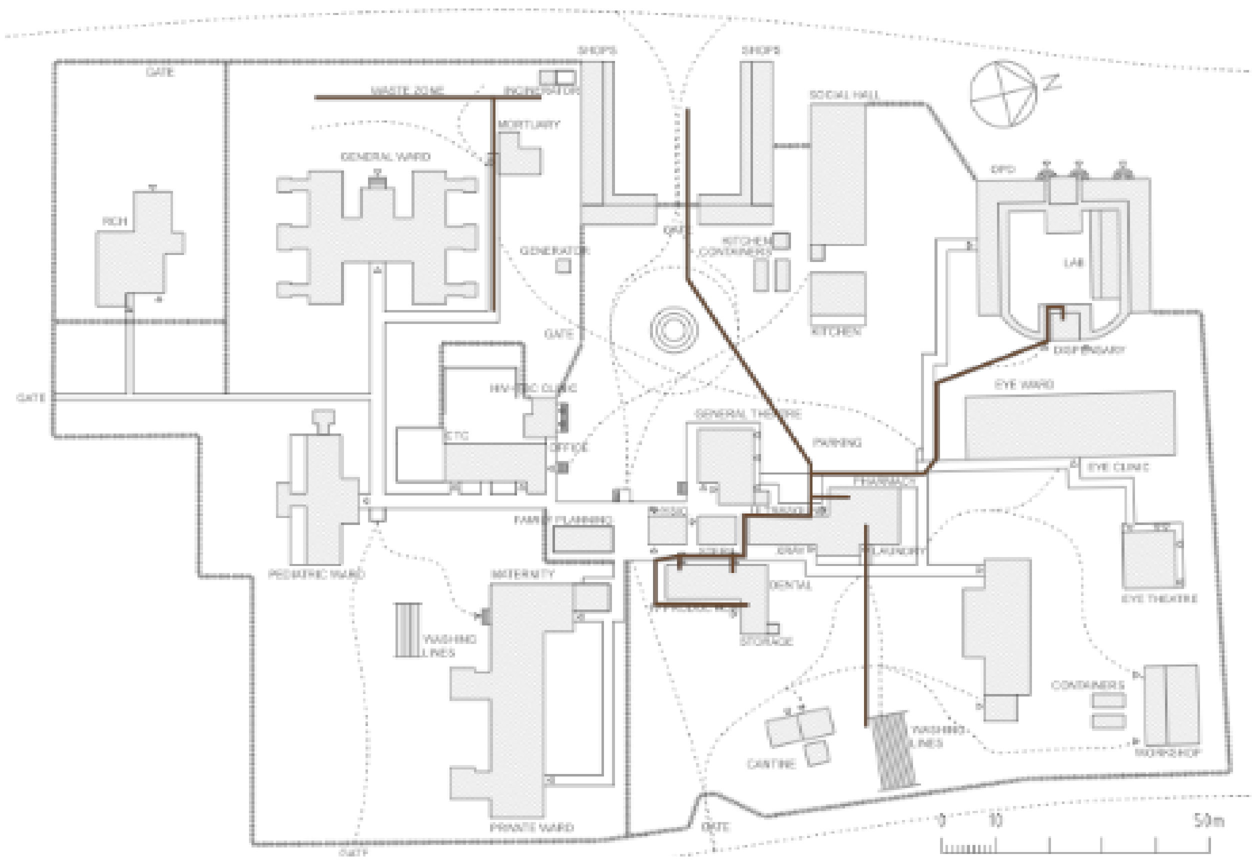

Figure 18: Equipment and consumable flow

4.5.9 Air flow

The prevailing wind is coming from northeast-northwest going to southeast-southwest across the hospital area. This affects the spread of smoke throughout the site. The main sources of smoke are the incinerator, the kitchen and the canteen. Two of them are situated toward the west side of the hospital area which means that the flow of smoke most often exits the hospital fast. However, the road immediately west of the hospital is highly affected by the smoke. The amount of smoke from the canteen is little in comparison to the smoke from the kitchen and the incinerator. See the complete air flow illustration in Figure 19.

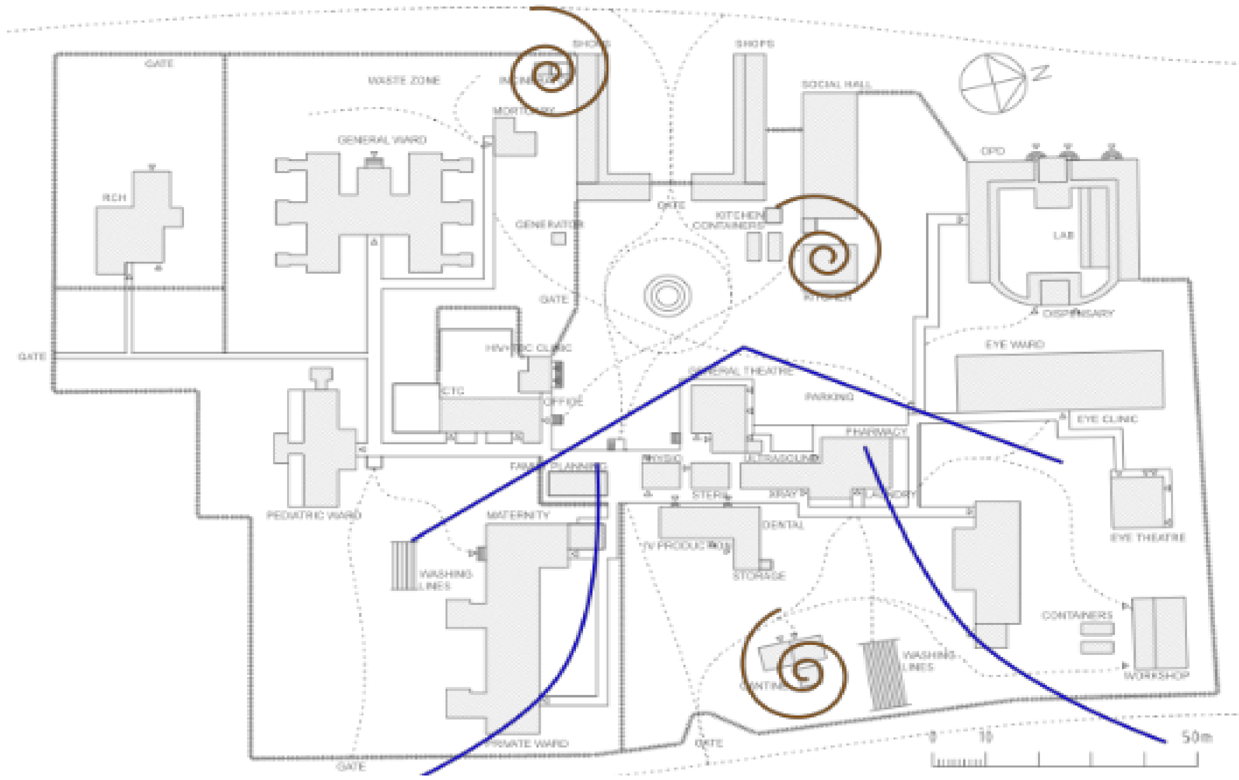

Figure 19: Air flow

4.5.10 Stormwater flow

The whole site has a slight slope towards the west. Hence the direction of storm water flowing on the ground is towards the west as well. This sometimes results in that the soil by the entrance is moved with the large amounts of water, and that there is a need to add new soil at times.

4.5.11 All the flows

Below, in Figure 20, is an illustration showing all the different flows at the same time. Looking at this illustration it becomes evident that there are high chances of congestion in some places - for example along the path from the family planning to the paediatric ward. One can also see that the inpatient and outpatient flows sometimes cross and are in the same buildings (for example in the eye department) - something that is not recommended due to a risk of spread of infections.

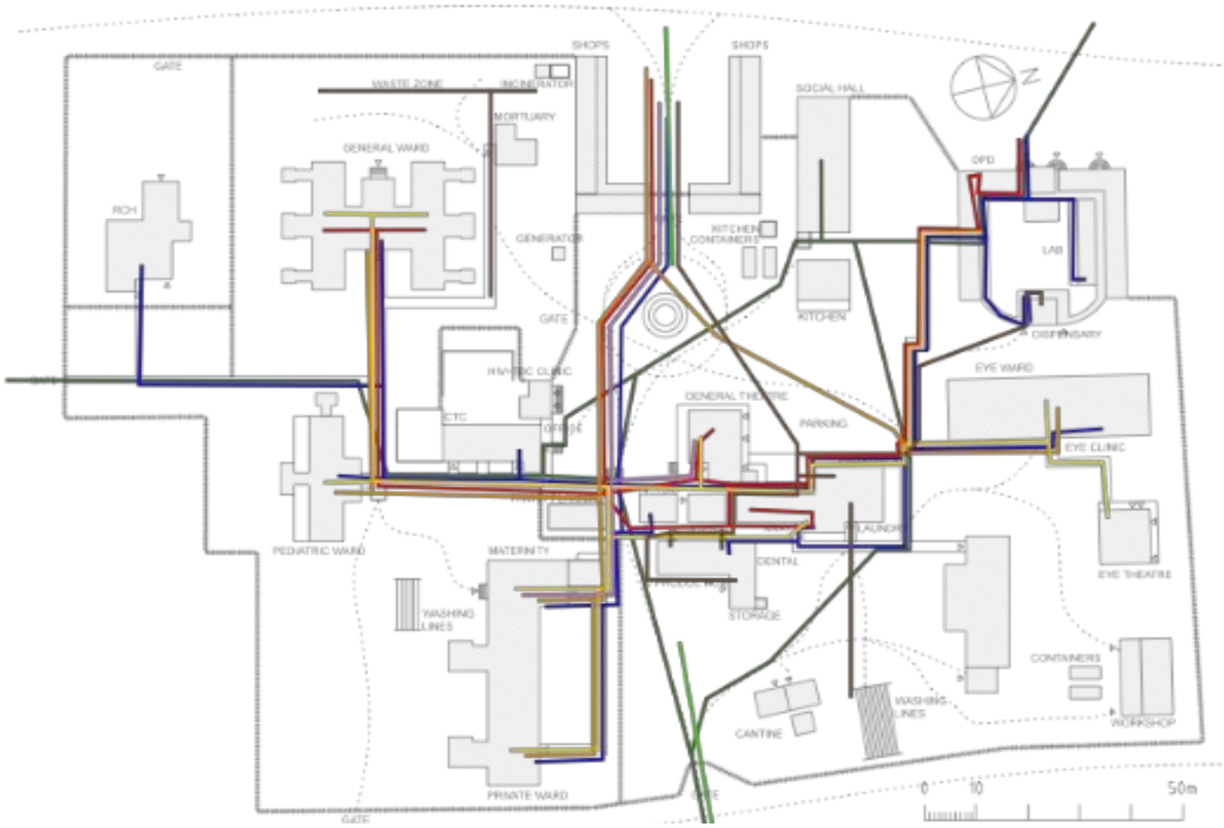

Figure 20: All flows

4.6 Medical zoning and structures

Six different medical zones have been categorized and identified. Those are: inpatient, outpatient, diagnostics & treatment, support & goods & materials, staff & administration, and public & non-hospital functions. In the hospital site layout, one should strive to differentiate between those zones to a reasonable extent. However, some functions will naturally be closely connected to functions belonging to other zones. The justification of not overlapping zones is to decrease the risk of transmission of communicable diseases and nosocomial infections, to safeguard the security and safety of patients, to differentiate between non-sterile spaces and sterile spaces, to ensure appropriate privacy to patients, to create an environment that minimizes room for errors, and to ensure a good working environment for the staff.

4.6.1 Zoning today

The illustration below is an analysis showing the current hospital site layout and its functions divided into the six identified zones.

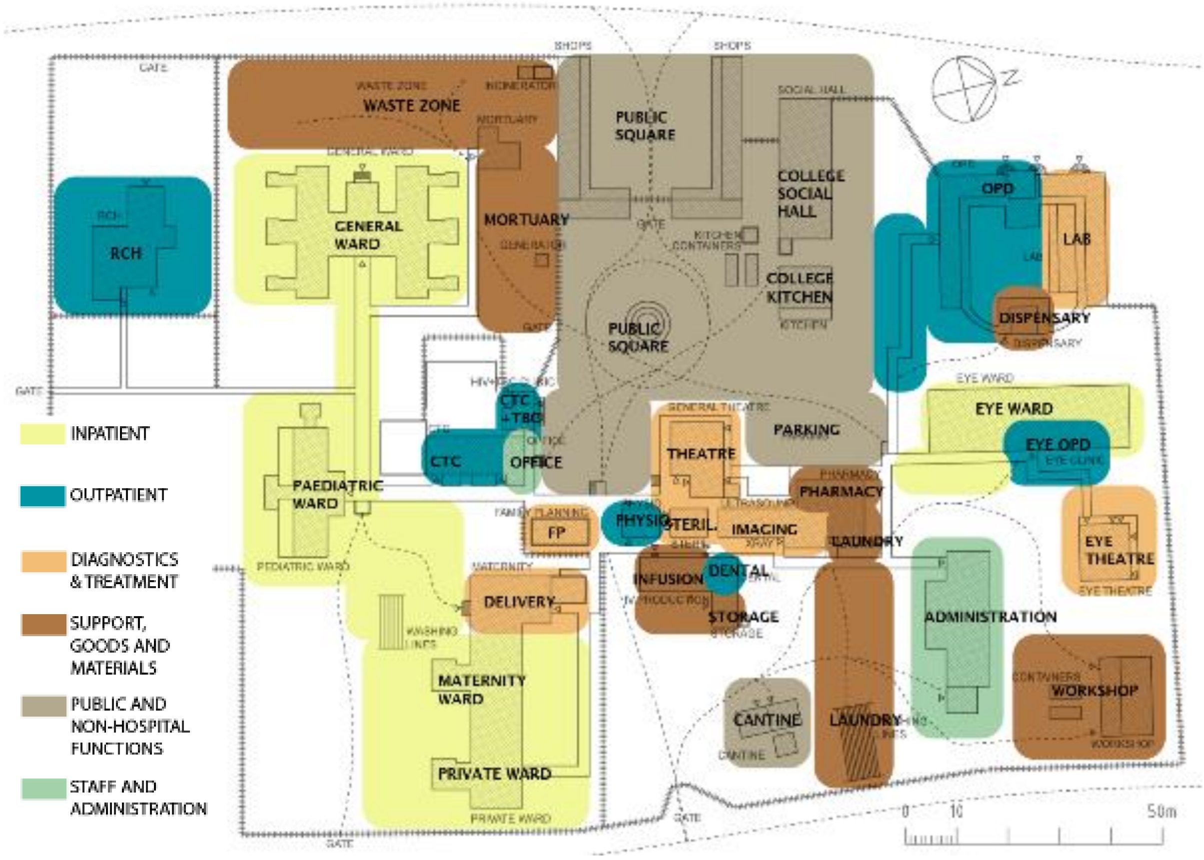

Figure 21: Zoning today

Problems with the current zoning at the hospital include:

- outpatient areas are spread out over the whole hospital

- easy public access to the diagnostics and treatment functions (excluding lab)
- support, goods and material functions are very spread out
- unnecessary public functions are located within the hospital site, such as the college kitchen, the college social hall
- inpatient and outpatient areas are overlapping

4.7 Needs for renovations, extensions and new constructions

In the following chapter, need for renovations, extensions and new constructions are presented.

4.7.1 Current structures

Below, in Figure 22, is a site plan drawing that shows the current buildings and their usage.

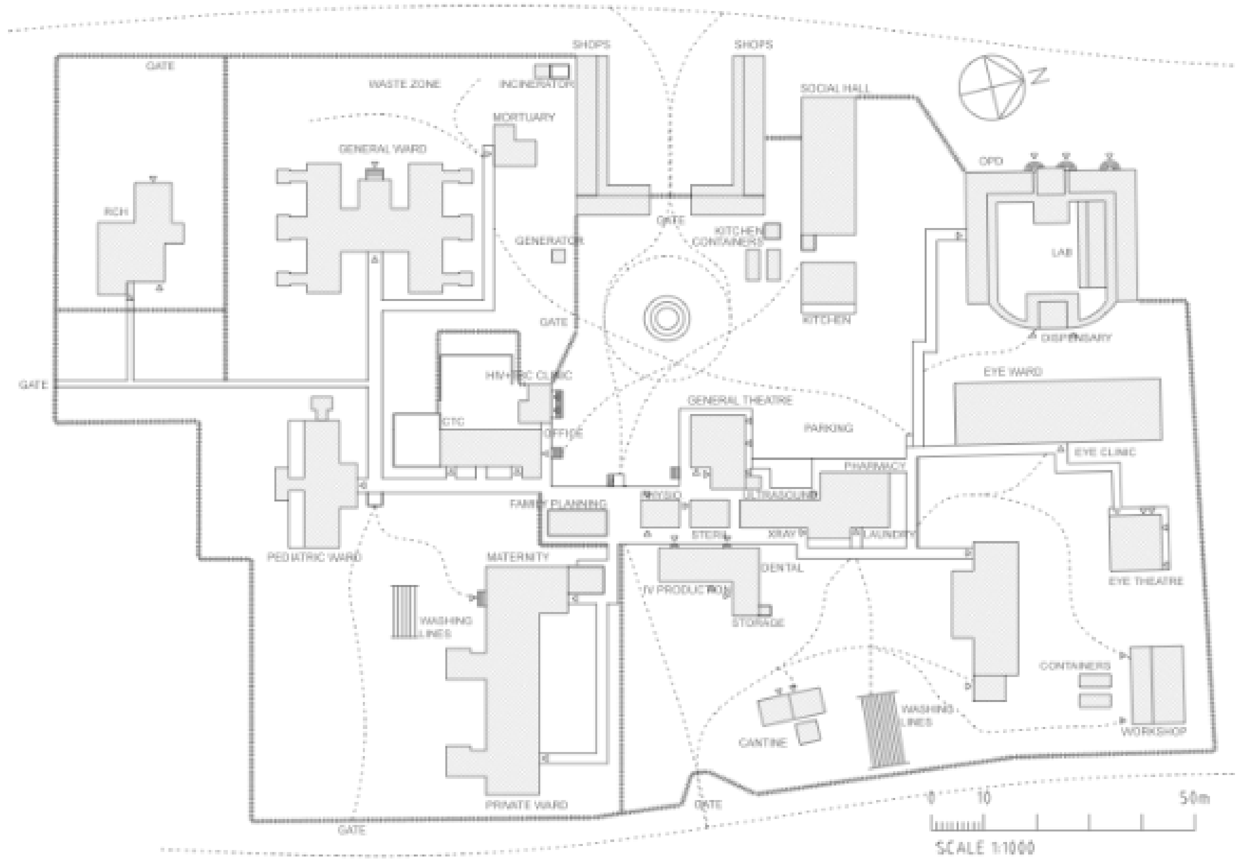

Figure 22: Current buildings and their usage

In the strategic plan for the development of the hospital during 2013-2018 the following table, Table 9, summarizes what Kolandoto Hospital previously has assessed as needs for actions concerning the building infrastructure.

Table 9: Strategic plan

Building	**Physical State**	**Action to take**
OPD	Poor and Inadequate space	Renovation and Extension
Administration Block	Poor	Renovation
Laboratory Block	Inadequate space	Renovation
Pharmacy	Poor and Inadequate space	Renovation and Extension
Laundry	Poor and Inadequate space	Renovation and Extension
Main Store	Poor and Inadequate space	Renovation and Extension
Medical Female and Male wards	Poor and Inadequate space	Renovation and Extension
Surgical Female ward	Poor and Inadequate space	Renovation and Extension
Surgical Male ward	Poor and Inadequate space	Renovation and Extension
Gynaecological ward	Poor and Inadequate space	Renovation and Extension
Paediatric ward	Poor and Inadequate space	Renovation
Grade I & II	Inadequate space	Renovation and Extension
Maternity wards	Poor and Inadequate space	Renovation and Extension
Premature Unit	Construction	Construction
Theatre	Poor and Inadequate space	Renovation and extension
RCH Clinic	Poor and Inadequate space	Renovation and extension
CTC	Inadequate space	Extension in progress
TB/HIV Clinic	New Buildings constructed	Construction
Dental building	Poor	Renovation and extension
Physiotherapy/ Eye Unit	Poor and Inadequate space	Renovation and extension
Mortuary	Inadequate space	Extension
X-ray Building	Poor	Renovation
Canteen/staff	No Building	Contraction of New Buildings
Kitchen	Small dilapidated building	Contraction of New Building
Resource Center	No Building	Contraction of New Buildings

Waiting Bay	No building	Contraction
Path ways	Poor	Renovation
ICU	No building	Contraction
Sewerage System	Renovated	Renovation

4.7.2 Programming the next 10 years

A workshop was held, see Figure 23, with the head of departments at the hospital in which they through a stepwise process got to discuss and list down the hospitals needs in terms of buildings/rooms/functions during the next 10 years. There are two outcomes from the meeting: 1) a comprehensive list with building/room/function needs for the next ten years including justifications for each need (see appendix 24), 2) a map with suggestions from the staff in terms of placement of the different needs on the hospital site, see Figure 24.

Figure 23: Workshop with hospital management

Below follows a summary of the building/room/function needs expressed during the workshop. See Appendix 24 for the full list including justifications.

Diagnostics and treatment:
Separate minor theatre from major
Extend maternity theatre
Causality unit
Recovery room at the theatre
Extend general theatre
Waiting space for laboratory department

Extend general theatre with sluice room
Separate water supply to the minor theatre
Connect the OT and the CSR buildings
Family planning
Modernize CSR
Labour room with 4-6 delivery beds

OPD:
Expand OPD: room for doctors, waiting room, and registration
Minor theatre at OPD
Eye OPD
Extend RCH: immunization, post-natal exam, waiting area
Move RCH closer to OPD
Waiting bay for patients

Wards:
ICU
Extend paediatric ward
Extend maternity ward
Place for patients to eat outside general ward
Renovate isolation rooms in general ward
Add office room for paediatric ward
New leprosy ward
Room for children at eye ward
New general ward
Playground
New private ward
Malnutrition room in paediatric ward

Support, goods and materials:
Kitchen
Extend mortuary
New modern main store / pharmacy

Staff and administration:
Social welfare office
Resource centre
Social hall
Resting room for doctors, clinicians and lab technicians on call
Administration office
Reception at the entrance

Below is a map with placement suggestion from the staff:

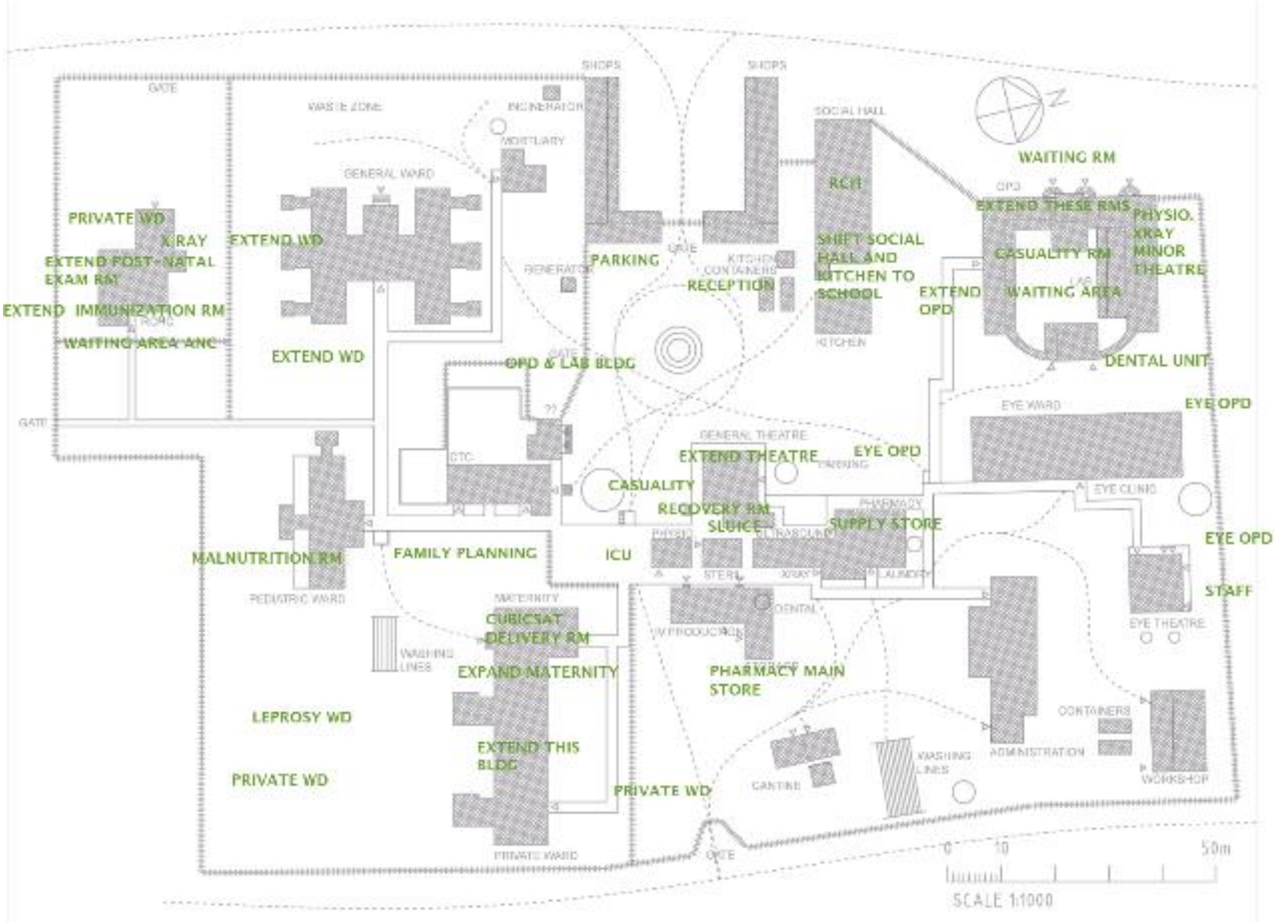

Figure 24: Suggestion from staff

4.7.3 Prioritization among the needs

A meeting with some of the management staff at the hospital was held to identify priorities among the needs for buildings/rooms/functions that were identified in the programming workshop. In the meeting the flow analysis and the zoning analysis was presented. After that the programme summary list was presented and discussed. The staff was asked to prioritize within certain categories of function needs. 1 being the highest priority to 5 being the lowest priority.

Figure 25: Meeting with hospital management

Below follows a list of the building needs and their priorities:

Diagnostics and treatment

1. Causality unit: for emergency cases and night time
2. Extend maternity theatre
3. Labour room with 4-6 delivery beds
4. Extend general theatre: recovery room, sluice, separate scrub and water supply for minor theatre, connect to sterilization room,

x. family planning is already under construction

OPD (+ lab)

1. Eye OPD
1. Waiting bay for patients: both outside OPD and inside OPD
2. Move RCH closer to OPD, and extend it with immunization room, post-natal exam, and waiting area
3. Surgical room at OPD: for minor injuries, bruises, cuts etc
4. Expand OPD: widen doors for accessibility of stretchers, room for doctors, registration room,
5. Parking at OPD: for both staff and visitors, safety is important

Wards
1. Extend maternity ward
1. New private ward
1. Room for children at the eye ward (will happen when the eye OPD is built)
2. Extend paediatric ward: more beds, malnutrition room, playroom, office
3. General ward: build one new which is for medical male and female, include proper isolation rooms with separate toilets in the new building, renovate the existing general ward to only be for surgical male and female, include extension of the existing one for area for leprosy patients,
4. ICU
5. Place for where visitors/relatives can meet the patients who are mobile, recreation/dining room/space for patients

Staff and administration
1. on call room for doctors, clinicians and lab technicians
2. Social welfare office
3. Resource centre
4. Social hall
5. New layout for the medical officer in charge in the administration office

Support, goods and materials
1. Extend mortuary
2. New modern pharmacy
3. Kitchen
4. Cement floor under the washing lines for laundry

4.7.4 Prioritization within larger and smaller projects

After the prioritization meeting with the staff, it became evident that another type of prioritization was needed as well - a prioritization based on the size and investment level of the projects instead of the type of the projects. A reorganized list including all the ’larger’ and ’smaller’ building intervention projects was made and given to Dr Katani to together with some staff fill in the priorities with this new division of larger and smaller.

Below follows a list of the priorities in ’larger’ and ’smaller’ building projects:

Larger:
1. New eye OPD
1. Build causality unit
2. New private ward
2. Extend maternity ward + labour room 4-6 beds
3. New RCH closer to OPD
4. New pharmacy
5. New general ward and reorganize the current general ward
6. Extend general theatre

7. Extend paediatric ward
8. Renovate and reorganize OPD
10. Build resource centre
11. Build social hall
12. Build ICU

Smaller:
1. Separate children's room at the eye ward (happens when the eye OPD is built)
1. Extend the maternity theatre, finish the building
2. Extend mortuary
2. Waiting areas for patients, both inside and outside OPD
3. New layout for OiC in the administration
4. Cement floor under the washing lines
5. Recreational area outdoor for general ward patients
5. New signs by the site entrances
6. Parking for staff and visitors outside OPD
6. New public path
6. Buy ISSB machine
7. Widen x-ray doors
8. Social welfare office

5 Report on implementations and improvements done in phase 1

During phase one, a small budget was available for small direct interventions. A new submersible water pump, a water quality test, a pump test and an extension of the maternity ward were implementations conducted during the first phase.

5.1 Purchase and installation of new pump

A new pump was purchased for the existing borehole, BH1, during phase 1, from the company Davis & Shirtliff. The new pump is a submersible Dayliff 17/10 and will discharge 17 m^3/h at a total head of 70 m, comparing with the present pump which discharges approximately 5-6 m^3/h at a total head of 70 m. A complete data sheet of the new pump is presented in Appendix 17. The pump was out of stock in Tanzania, but in order to obtain the pump before the engineering survey team left Kolandoto, an arrangement to collect the pump from Nairobi was made. This worked out well and the pump together with additional required equipment, installation material, and technician to carry out the installation reached Kolandoto at Saturday the 21th of March, see Figure 26.

Also, a new pump schedule was created together with the water staff, presented in Appendix 3.

Figure 26: Installation of new pump

5.1.1 Issues with new pump

The pump was installed correctly without any problems, but it was still unable to start. The pump control panel displayed "too low voltage", and thus it did not allow starting and running the pump. The voltage was sufficient before it was connected to the pump and its control panel (390V, three phase), but when turned on, the voltage dropped below the requirements to about 360V in two of the three phases. The installation was then rewired to bypass the control panel's alarm functions, and the pump was able to run without any issues. This however also disconnects the control panel's other alarm functions, such as protection against high voltages and dry running.

The technician initially localized the distance to closest transformer as a possible source for the issue. Further investigation on Sunday 22th however found out that the power line from the hospital to the pump house was of insufficient quality and size, and the technician considered this as the possible main reason for the electrical issues. The power line from hospital area to pump house was constructed in the 1970's by the hospital at the same time as the borehole was made. This three-phase power line is overall of poor quality, and the cables have too small cross-sectional areas which increases the electrical resistance.

5.1.2 Arrangements for the future

As this borehole is the only source of water for the hospital and the village, a prolonged period without any pump in use could not be allowed. This, together with the fact that the old pump had been damaged when dismounted, left the hospital with only one option: to run the pump without any protection with risk of motor damage as a consequence. In order for the technician to allow this, an invalidation of the warranty for the pump motor had to be arranged and was signed by Dr Katani on 25th of March. Despite this, the warranty is still valid for other equipment such as the pump, installation works and pipes etc.

Furthermore the hospital had to decide how to proceed with these issues; in both short and long term perspectives. For the nearest future the hospital had two choices; to continue to run the new pump without any protection or to reinstall the old pump until the power issues was solved. In the long term the cost of a sufficient source of power had to be compared to the risk of running the pump without any protection.

To run the pump without protection only entails a risk to the motor itself, other parts such as the pump and electrical installation are not exposed. According to the technician, the estimated life length of the motor could decrease from approximately 20 years to around 1-5 years, even though he was unable to give any guarantees at all. Based on this information, the hospital with advice from the engineer team and technician, decided to run the new pump in the nearest future, but with a conservative running schedule to protect the motor.

In longer perspective, a cost/benefit analysis for the expected lifecycle of the pump has to be made to aid the decisions.

5.1.2.1 Costs to provide sufficient TANESCO power supply and supply electricity

The cost for new power lines and installation is approximately 20 000 000 TZS according to information given to Dr. Katani in a meeting with TANESCO. The power consumption for the pump, with 5.5 kW motor and 7 % line losses in the new power line is 5.9 kW. Using the hospital's costs for power at 205 TZS/kWh gives a running cost on 1 210 TZS/h. Pumping on average 20 h/day gives a yearly cost of 8 833 000 TZS.

With new power lines, the supply should be enough according to the technician. This could however not be guaranteed and a new transformer station closer to the borehole could be necessary also. Dr Katani will continue to discuss with TANESCO to see if they are obliged to supply this to institutions such as the hospital.

5.1.2.2 Costs to buy and run diesel generator

When a submersible pump starts it needs more power compared to when running. Therefore, a generator producing 5.5 kW as the motor needs for running is not enough. Instead, a generator of 3-4 times that capacity is according to Davis and Shirtliff needed, and thus a sufficient generator has the be at 16.5-22 kW.

A sufficient diesel generator (at 21kW, see Appendix 18) would cost approximately 21 500 000 TZS and consume 4 l/h. Diesel cost in Tanzania at the moment is about 1 800 TZS, which gives running costs of 7 200 TZS/h. If the pump runs on average 20 h/day, this equals to 52 560 000 TZS TZS/year.

It should be noted that this option makes the pump completely independent from the failing TANESCO power supply as the pump can run regardless of power cuts. However, a drawback of this option is that the hospital has to set up a scheme for regular diesel collection and supply to the pump.

5.1.2.3 Estimated costs to run pump without protection

The power consumption for the pump, with 5.5 kW motor and 20 % line losses in the new power line is 6.6 kW. Using the hospital's costs for power at 205 TZS/kWh gives a cost of 1 353 TZS/h. If the pump is run in average 20 h/day, this corresponds to a yearly cost of 9 876 900 TZS.

This is however associated with risks, since the exact life length of a motor running on lower voltage electricity is unknown. What would break the motor would be heavy wearing of the motor when running on low voltage, and that the pump would not be able to start pushing the water but still use power which would heat the pump to malfunction. The latter risk could however be avoided by installing a flow meter on the outlet pipe from the pump and monitor the system manually.

Disconnecting the control panel's other alarm functions will leave the pump exposed to risks of high voltages and dry running. Running dry is estimated to be a lower risk since it is known that even in the dry season the borehole produces at least half of current extraction rate (the flow rate of the old pump). High voltage is a risk originating mainly from lightning strikes. A lightening rod would reduce this risk and the current cables are dug down. Buying one spare motor should be considered. This motor should have spare coals in case it will stay out of use for a longer period of time. However, since the technician estimates the motor to last for 1-5 years, the recommendations is to keep funds for a new motor available, but buy the motor in case of malfunction.

5.1.2.4 Summary on running costs

In Table 10 a short summary for the running costs for different power options is presented.

Table 10: Running costs for possible power sources. Run time 20 h/day

Power source	Cost (TZS)				
	Per hour	*Per half year*	*Per year*	*Per 10 years*	*Per 20 years*
Diesel	2 700	9 855 000	19 710 000	197 100 000	394 200 000
Electricity (6.6 kW)	1 353	4 938 450	9 876 900	98 769 000	197 538 000
Electricity (5.9 kW)	1 209.5	4 414 675	8 829 350	88 293 500	176 587 000

5.1.2.5 Lifecycle costs

Three lifecycle analyses for the expected costs associated with the above mentioned options are presented below. The technician's estimation of the pump's life length of 1-5 years is utilised in each analysis.

The first is made for a long term perspective, Table 11. The long term is set to 20 years, since this according to the technician is the expected life length for the pump when running protected under normal circumstances.

Table 11: Long term lifecycle costs

Cost 20 years – Long term (TZS)		
Provide sufficient Tanesco supply	20 000 000 + 176 138 050	196 138 050
Buy and use diesel generator	20 000 000 + 394 200 000	414 200 000
Run with current set up (no protection)	8 400 000 to 42 000 000 + 148 153 500	156 553 500 to 190 153 500

For the medium term, Table 12, lifecycle analysis, half of the long term duration is used.

Table 12: Medium term lifecycle costs

Cost 10 years – Medium term (TZS)		
Provide sufficient Tanesco supply	20 000 000 + 88 069 025	108 069 025
Buy and use diesel generator	20 000 000 + 197 100 000	217 100 000
Run with current set up (no protection)	4 200 000 to 21 000,000 + 74 076 750	78 276 750 to 95 076 750

Finally, a short term, Table 13, analysis has been made for a half year lifecycle. This represent the approximate time to which municipal supplied water might be available.

Table 13: Short term lifecycle costs

Cost half year lifecycle – Short term (TZS)		
Provide sufficient Tanesco supply	20 000 000 + 4 403 451.3	24 403 451.3
Buy and use diesel generator	20 000 000 + 9 855 000	29 855 000
Run with current set up (no protection)	0 to 2 100 000 + 3 703 837.5	3 703 837.5 to 5 803 837.5

5.2 Renovation of the general theatre doors

5.2.1 Background and description of problem

Three doors at the general theatre building were not air tight, and they let both air and dust enter through large gaps between the doors and the door frames. The air and the dust is a potential problem for the functioning of the machines in the operating theatres. And more importantly, it is a problem for the patients since the environment in the operating theatres are hard to keep clean. The air coming through also decreases the efficiency of the AC:s that are in place to keep a good indoor temperature for operations.

5.2.2 Goal of intervention

The goal of the intervention is that the indoor environment at the general theatre at Kolandoto Hospital is good for performing operations, and safe for the patients having the operations.

5.2.3 Intervention report

Material for renovating the general theatre doors were bought. The complete renovation of the general theatre doors was done by the 10th of April. Looking at the doors now, the huge air gaps are as closed as they can be with this type of wooden doors.

5.3 Extension of the maternity theatre

5.3.1 Background and description of problem

The hospital has a theatre at the maternity department, which is closely connected to the delivery room. The theatre is supposed to be used for doing c-sections. However, the theatre is not in use due to that the hospital does not feel like it can guarantee the needed hygienic conditions for performing safe c-sections. What is missing is an entry room, a proper changing room, a scrub room, and a sluice room. See preliminary drawing attached.

5.3.2 Goal of intervention

The goal of the intervention is that safe c-sections can be carried out at Kolandoto Hospital.

5.3.3 Output

Patient safety is improved and also efficiency. The c-sections can after this intervention be done under proper hygienic conditions in a place that is solely kept for doing c-sections. The pregnant mothers who are in delivery and need emergency c-sections will no longer have to be transported out of the building, and along an outdoor path, to go into the general operating theatre.

5.3.4 Current status of the intervention

Below follows a list of things that are done:

- foundation and groundwork
- walls
- roof
- ceiling

- floor
- walkway outside entrance
- adjustments to the roofs over the walkways
- installation of plumbing and water pipes
- installation of electrical wiring
- installation of door frames
- installation of scrubbing sink

Below follows a list of things that still needs to be done:
- installation of doors
- adjustment to the ceiling ventilation on the outer between the extension and the old part of the building
- installation of windows
- furniture
- installation of sluice sink
- building of inspection chamber
- painting the inside
- painting the outside
- furniture to the building
- buying and installing a new AC

Budget handover: See Appendix 25.

6 Proposals for phase 2

In the following chapter suggestions regarding improvements of water, electricity and buildings are presented. All suggestions are based on observations, tests and meetings during the field study at Kolandoto Hospital. All suggestions, including their estimated cost are summarized in Table 14.

Table 14: A summarization of all suggested improvements for phase two, including their estimated cost.

Intervention	Cost [TZS]
A new borehole	26 000 000 – 34 000 000
A new generator explicitly for water pump	21 494 000
Chlorination device	14 500 000
Chlorine-based disinfectant	59 000 for 5 kg
Hatches on septic tanks	20 000
Solar powered back-up system	50 000 000 – 90 000 000
Roof over waste area	No est.
New water tank	12 200 000
Air condition to pharmacy	800 000 – 1 000 000
A new public path	3 000 000

ISSB machine	2 000 000
Finish maternity theatre	4 000 000
Social areas outside general ward	3 765 600
Reorganization of imaging dep.	1 345 000
New/extend area at OPD	No est.
Plan for causality unit	No est.
Plan for new private ward	No est.
Plan for new pharmacy building	No est.
Plan for moving RCH	No est.
Plan for new Paediatrics ward	No est.
Plan for new general ward	No est.
Plan for renovation of OPD	No est.

6.1 A new borehole

Securing the water supply for the hospital in a long-term perspective is vital. Pipes from Shinyanga is planned to be finished in July, which will provide the hospital, college and surrounding village with a sufficient amount of water. However, the construction has already been delayed a few years and investigations of other sources have therefore been conducted.

Drilling a new borehole is an option which would produce more water and possible secure the water supply for the village. A full hydrogeological survey is needed in order to determine which location is most suitable for the new borehole. Negative aspects regarding the construction of a new borehole are the groundwater dependence on weather season. During the dry season the water supply could decrease rapidly. In order to determine the extent of the reduction of groundwater in the area, a hydrogeological survey should be conducted during the dry season. Discussions with Mr. Amani Nkulo, the hydrogeologist introduced by Wedeco Ltd, regarding a survey were made. The survey cost will range from 800 000 – 1 000 000 TZS.

Also, additional costs for the construction of a pipe network, electrical cables as well as purchasing a new pump must be considered.

The boreholes used today for water supply provides the hospital , college and surrounding village with approximately 23 m^3/h, which could be used as a guideline for a new water source. However, the current borehole is considered shallow and a more thorough investigation is needed.

Contacts with different drilling companies located in Tanzania have been established and complete tender sheets have been received. A depth of 100 m has been approximated in order to get a comparison between the companies. The required depth will be investigated in the hydrogeological survey. All tender sheets are presented in Appendix 19.

6.2 Generator for water pump

As described in chapter 5, problems regarding the power supply were detected during the installation of the new water pump. Purchasing and installing new power lines are a large investment and other options were investigated, see chapter 5.1.2. By purchasing a diesel generator, which is explicitly used by the water pump, the power supply could be secured. Tender sheets for a new generator are presented in Appendix 18.

6.3 Chlorination of the groundwater

Chlorination is one of the most effective disinfection processes available and has been in use for many years. There are different types of chlorine-based disinfectants and all the processes are pH dependent (WET, Chalmers, 2014). The design of the disinfection process is crucial in order to obtain the most efficient treatment. High concentration of chlorine will cause bad taste and odour in the drinking water.

Before using chlorination as a disinfection method, the present tanks must be emptied, cleaned and disinfected in order to remove contamination (WHO, 2004).

There are different methods for adding the chlorine to the drinking water, for example you can add chlorine directly to the tanks. An alternative is to use a device called a dosatron, which is connected to the water pipe. The device adds the correct amount of chlorine into the drinking water (Dosatron, 2015) allowing it to disinfect. A tender sheet for the model Dosatron D20S was provided from Davis & Shirtliff, see Appendix 20.

In addition to the investment cost for a disinfection device, a yearly cost for chloride has been approximated. Costs for HTH 65%, a chlorine based substance used for treatment rural areas, were received from Davis & Shirtliff, see Appendix 21. Usage of 1 kg HTH 65% per day were estimated, resulting in a yearly cost of 4 300 000 TZS.

During a meeting (20/3 - 2015) with the hospital staff, chlorination were expressed as a desire in order to prevent disease spreading for villagers, who lives without the possibility to boil the water.

6.4 Hatches on septic tanks

The hatches on the septic tanks in the hospital area are insufficient due to wear. Smell from the wastewater spreads adjacently to the tanks. Also, mosquito eggs have been observed in the septic tanks and since mosquitos in the area are carriers of different parasites, reparation of the hatches is of a health concern. A broken hatch, located outside the maternity ward, is illustrated in Figure 27.

Mosquito breeding in septic tanks is a wide-spread problem in the world, where the most effective prevention method is mosquito mesh and proper construction of septic tanks (Cameron & Lorenz, 2013).

There are two different hatches at the hospital, one in metal and one in concrete. A hatch made out of concrete is cheap and can be constructed at the hospital. The metal hatch is more expensive and need to be purchased from Shinyanga. However, the lifespan of the metal hatch is significantly longer, and Julius Omango, the staff responsible for wastewater issues, recommended the usage of metal. Julius Omango estimated the cost for a metal hatch to approximately 20 000 TZS.

Figure 27: Broken hatch on a septic tank, located close to the maternity ward.

6.5 Solar photovoltaic electricity back-up system

The hospital is connected to the national electric grid in Tanzania, managed by TANESCO. The grid is however unstable and the hospital severely suffers from common power cuts, which can at worst have devastating consequences. To mitigate such events, the hospital is in need of an autonomous back-up system which can supply electricity when the national grid is failing. A system with photovoltaic (PV) solar cells that charges batteries from sunlight is therefore suggested.

It is not practical or economic feasible to design a system which provides the whole hospital with PV-generated electricity at all times. Instead, the most critical parts of the hospital have to be equipped with such back-up systems in order to avoid the most harmful consequences of power losses. To point out the most critical functions at the hospital, a workshop was held by the engineering team together with affected medicinal and managerial staff. In the workshop, the staff had to assign a “critical level” 1-3 to each ward/unit at the hospital (see Table 15). Nine wards/units were selected as the most critical level, defined as “Risk for immediate life threat to patients”, see Table 16 below. (The values are taken from the inventory made by the engineering team, see Appendix 15).

Table 15: Results from workshop, including priorities of each ward and concerns raised by the management.

UNIT	Critical category	Time without power	Comments
General Ward	1	0 (for oxygen machines)	Eg oxygen machines, lighting to see for IV insert etc.
General Theatre	1	0	All equipment, including lighting important. 5-10 to start generator, sometimes more
Eye Ward	2	up to 6 hours (patient wait)	Prepare own eye drops. Sterilization
Eye Theatre	1	0	
Dental	2	up to 1 day	Needs electricity during working hours. Not in use during night
Laundry	3		
X-Ray	2	up to 8 hours	Solar panels strong enough?
IV-production	3	Up to 1 day (have stock)	Not in use during night, need power during working hours.
Physiotherapy	3	Up to 1 day	Need power during working hours.
Maternity	1	0	As in the theatre. For whole ward (premature health equipment)
Private Ward	1	0	Same as general ward
Paediatrician	1	0	As general ward, but more machines
RCH	1	The refrigerators has to keep cool	Danger if bad vaccines is used (refrigerator for vaccines)
OPD	2	Up to 1 day	Lights, headlamps (spotlights)
Laboratory	1	0 (microscopes, blood analyser)	Microscopes, Refrigerator and more.
Pharmacy	1	Refrigerators	Same as RCH. Medicines need cool storage
Administration	3	Up to 1 day	
Sterilization room	2	Up to 1-2 days (depends on stock)	During working hours. For general theatre
CTC	3	1 day	Only during daytime
Mortuary	3	4 (fridge temperature), 6 (body)	

Table 16: List of wards/units regarded as the most critical

Ward/Unit	Total Load [W]	“Slimmed” load [W]
General Ward	1 796	1 796
General Theatre	15 356	6 116
Laboratory	10 770	1 177
Eye Theatre	6 320	2 130
Private Ward	1 112	1 112
Maternity	5 394	3 089
Paediatrician	860	860
Reproductive and Child Health	876	876
Pharmacy	298	298
TOTAL	42 627	17 454

Additionally, the Table 16 states the total load (effect) demanded by each ward/unit. To optimise the system for a more feasible design, a “slimmed” load where the most relevant equipment is supplied for each ward/unit has also been produced. Furthermore, the design of the back-up system is governed by the amount of kWh needed, i.e. for how many hours the back-up system should be able to provide power without being recharged by sun light. A more extensive system is needed as more time is demanded. Four different scenarios, to supply for 15 minutes, 1 hour, 8 hours and 24 hours, have been used for total and slimmed load to compare costs and feasibility, see Table 17 below.

Table 17: Scenarios used for comparing costs for solar power system

	0.25 h	1 h	8 h	24 h
Total load (42.6 kW)	10.9 kWh	43.7 kWh	349.6 kWh	1048.8 kWh
Slimmed load (17.5 kW)	4.4 kWh	17.7 kWh	141.6 kWh	424.8 kWh

Cost estimations for respective scenario from two different companies are presented in Appendix 22.

After obtaining cost estimations for the scenarios mentioned above, there was an obvious need to further bring the costs down. In order to do this, the demands for the suggested backup power system had to be further reduced. Focus has to be with supplying power to the hospital functions to which a power cut would mean immediate life threats to patients, i.e. the theatres.

This also means that some parts regarded by the hospital to be critical had to be neglected. Lighting in the wards, laboratory functions, and medicine, vaccine and blood refrigerators is therefore not included in this suggestions.

The backup system should be designed as three separated systems: (1) general theatre, (2) maternity theatre (including delivery room), and (3) eye theatre, i.e. three decentralized systems with one set of solar panels, batteries and inverters at each site, see Figure 28.

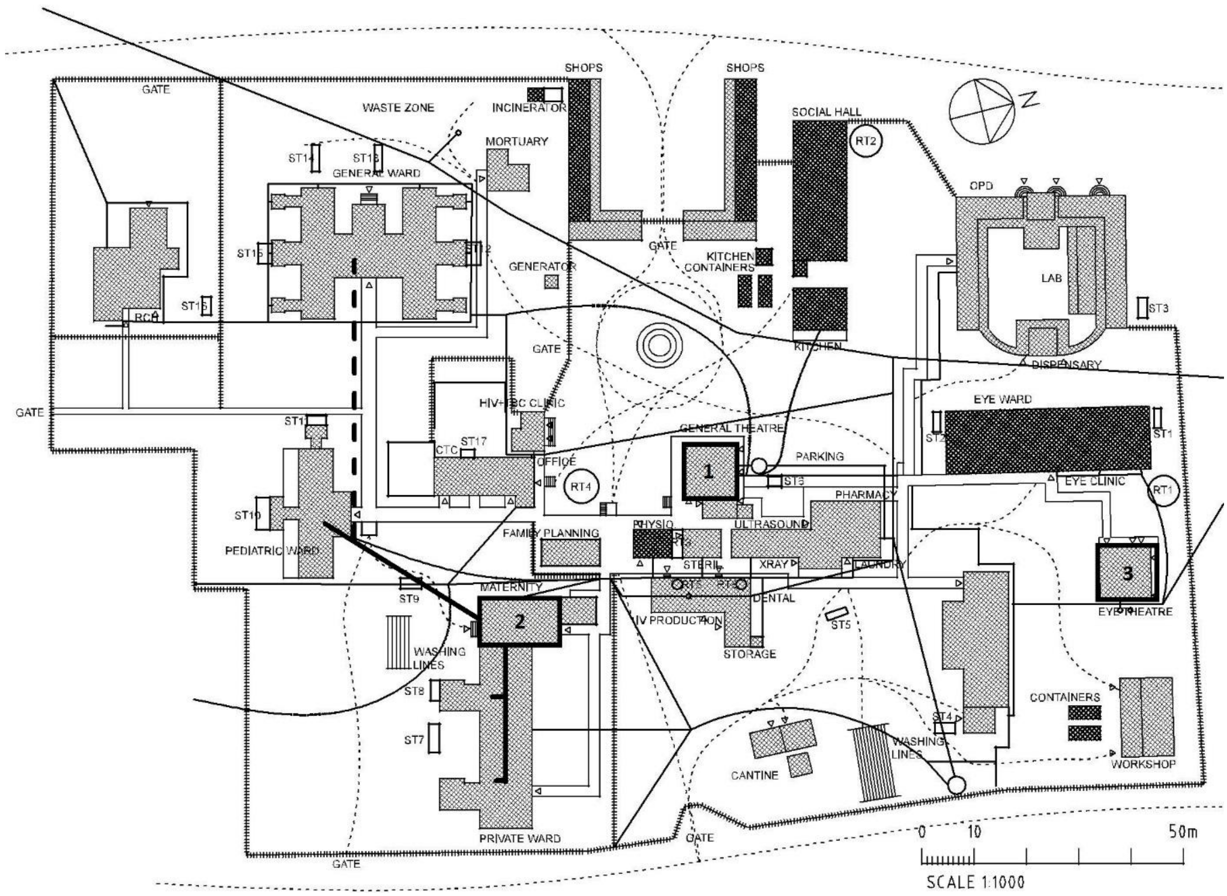

Figure 28: Overview map over Kolandoto Hospital with areas to be provided with solar power: (1) general theatre, (2) maternity theatre and delivery room and (3) eye theatre.

The long term intention is to provide all three areas with solar power backup. This should however be done incrementally and the cooperation with hired entrepreneurs and the system design should be evaluated after each step. The installed system should also be able to be upgraded in the future, so that it can accommodate upcoming power demands. It has to be prepared so that solar panels and battery banks can be expanded without unnecessary costs or work.

6.5.1 Suggested requirements for the backup systems

To make environmental and economical savings it is desired to be able use the generated solar power even when the batteries are fully charged and not in use. Power generated from the solar panels at these times should therefore be able to be used for other purposes (lighting or other regular use).

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The choice of battery type decides the requirements for storage and maintenance. The preferred type should be gelled batteries, since they need no maintenance and no special ventilated storage.

6.5.2 Special requirements for maternity theatre system

Even though the theatres are the most critical functions at the hospital, there are some urgent demands in the general, paediatric, maternity and private wards as well. There is one oxygen machine in each of these wards, and if possible the solar power system in the maternity theatre should be able to provide backup power for these as well. That would mean one 230V power outlet in each of these wards connected to the uninterrupted power supply.

6.5.3 Power demands

Please refer to Table 18 to see the specific power demands for each area. Three scenarios is presented for each area: to be able to provide solar energy for 0.25 h (15 min), 2 h and 8 h. The "Critical after" column shows the estimated time certain appliances can be without electricity before patient security is affected. Below each ward/unit is a sum of total kW and kWh from respective scenario, with an estimation on expected amount of batteries for that purpose (based on the battery type specified in Table 18).

Table 18: Specific power demands for each area including total power demand and amount of batteries. Area 1 general theatre, Area 2, maternity theatre including delivery room, Area 3, eye theatre.

AREA 1								
Appliance	Amount [Pcs]	Load [W]	Total load [W]	Critical after [min]	Solar power run time			
General Theatre					**0,25**	**2**	**8**	**h**
Light (tube)	21	36	756	0	756	756	756	
Operation lights (small)	1	150	150	0	150	150	150	
Operation lights (large)	1	250	250	0	250	250	250	
Operation bed	1	240	240	0	240	240	240	
Air condition	1	2000	2000	0	2000	2000	2000	
Electro surg. Generator	1	1000	1000	30		1000	1000	
Suction pump	1	220	220	20		220	220	
Anaesthesia machine	1	1500	1500	0	1500	1500	1500	
TOTAL			6116		4,896	6,116	6,116	kW
TOTAL					1,224	12,232	48,928	kWh
			SUM AREA 1		4,896	6,116	6,116	kW
			SUM AREA 1		1,224	12,232	48,928	kWh
			Batteries		1	6	23	Pcs
AREA 2								
Appliance	Amount [Pcs]	Load [W]	Total load [W]	Critical after [min]	Solar power run time			
Maternity					**0,25**	**2**	**8**	**h**

Light (tube)	25	36	900	0	900	900	900	
Light (bulb)	7	40	280	0	280	280	280	
Warming machine	2	800	1600	20		1600	1600	
Oxygen machine	1	320	320	0	320	320	320	
Suction pump	1	90	90	0	90	90	90	
Oxygen machine	1	320	320	0	320	320	320	
Fridge	1	75	75	240			75	
Operation lights (small)	1	150	150	0	150	150	150	
Operation lights (large)	1	250	250	0	250	250	250	
Operation bed	1	240	240	0	240	240	240	
Electro surg. Generator	1	1000	1000	30		1000	1000	
Suction pump	1	220	220	20		220	220	
Anaesthesia machine	1	1500	1500	0	1500	1500	1500	
TOTAL			6945		4,05	6,87	6,945	kW
					1,0125	13,74	55,56	kWh
Private Ward					**0,25**	**2**	**8**	**h**
Oxygen machine	1	320	320	0	320	320	320	
TOTAL			320		0,32	0,32	0,32	kW
					0,08	0,64	2,56	kWh
Paediatrics					**0,25**	**2**	**8**	**h**
Oxygen machine	1	320	320	0	320	320	320	
TOTAL			320		0,32	0,32	0,32	kW
					0,08	0,64	2,56	kWh
General Ward					**0,25**	**2**	**8**	**h**

Oxygen machine	1	320	320	0	320	320	320	
TOTAL			320		0,32	0,32	0,32	kW
					0,08	0,64	2,56	kWh
			SUM AREA 2		5,01	7,83	7,905	kW
			SUM AREA 2		1,2525	15,66	63,24	kWh
			Batteries		1	8	30	Pcs
AREA 3								
Appliance	Amount [Pcs]	Load [W]	Total load [W]	Critical after [min]	Solar power run time			
	Eye Theatre				**0,25**	**2**	**8**	**h**
Operation light	1	150	150	0	150	150	150	
Anaesthesia machine	1	280	280	0	280	280	280	
Light (tube)	10	36	360	0	360	360	360	
Light (bulb)	3	40	120	0	120	120	120	
Microscope	1	20	20	0	20	20	20	
Air condition	1	1320	1320	0	1320	1320	1320	
TOTAL			2250		2,25	2,25	2,25	kW
					0,5625	4,5	18	kWh
	Battery spec.							
	12	V	SUM AREA 3		2,25	2,25	2,25	kW
	200	Ah	SUM AREA 3		0,5625	4,5	18	kWh
	2,4	kWh	Batteries		1	3	9	Pcs
	10%	Losses						
	2,16	kWh						

6.6 Roof over waste area

The incinerator is located in connection to an area which is planned to be used for storing the collected waste. Storing the waste, would allow the staff to burn wastes from all wards at the same time. However, since the area lacks a roof, the wastes are burned directly when collected from each ward.

A new roof over the waste area could result in a more limited use of the incinerator, decreasing the black smoke created from the burning. Having a storage area would also allow the hospital to burn the waste at a more convenient time, for example the afternoon, when the number of patients in the area is less significant.

There are other improvements connected to the waste area. Staff who are managing the incinerator are exposed to dangerous smoke on a daily basis. Exposure could have a negative impact on his health. Purchasing a mask, boots and appropriate clothing is therefore recommended.

6.7 New water tank

The construction of a new water storage tank is at the moment not regarded as a priority, and the construction costs of such a tank has therefore not been closer investigated. However, when demand increase in the future a new storage may be needed.

In 1997, when the Regional Water Engineer's office made an assessment over possible improvements to the Kolandoto Hospital water supply, a design for a new 20 m^3, 6 m high storage tower was prepared, see Appendix 23. The cost was estimated to 3 000 000 TZS, which adjusted for inflation would be equal to about 12 200 000 TZS in today's values. (The World Bank, 2015) This can be used as a rough guideline for the expected cost of a new water tower.

6.8 Air Condition to Pharmacy

All drugs provided to patients in the hospital are stored in the pharmacy, see location in Figure 1. The pharmacy contains of a large storage room, including one fridge, where the most fragile medicines are stored. The temperature in the storage room often exceeds 25° C which could harm the drugs and decrease the desired effect of the medicine. Installing an air condition in the pharmacy will control the temperature level and secure the usage of correct medicine. Cost for an air condition ranges from 800 000 – 1 000 000 (Dave & G Electricals's store, 2015).

During the possible installation of an air condition the status of the current fridge should be investigated. Medicine which requires a low temperature are stored in the fridge and extensive power cuts could harm the drugs. There are three alternatives to improve the current system; buy an additional fridge where ice can be stored, connect the current fridge to the solar powered back-up system or buy a new solar powered fridge. Connecting the fridge to the back-up system is however not recommended since this will only provide the fridge with approximately two hours of extra power.

6.9 A new public path

This proposal originates from the analysis of flows through the hospital. The aim of the proposal is to have less congestion around the paths in front of the family planning and care treatment clinic (CTC). Today all visitors that to the general ward, the paediatric ward, the maternity ward and the private ward start by walking up to the family planning building, and then from there go to the different wards. A new piece of a public path from the entrance square towards the general ward (left in the illustration in Figure 29) would be useful for all visitors to the general ward and the paediatric ward. The visitors going to the eye ward today pass over the parking area where the hospital is planning to build a new eye clinic building. A new public path from the entrance square towards the outpatient areas (right in the illustration in Figure 29) and the path connecting to the eye ward would be useful for visitors going to the eye ward. Both of these paths would also be useful for staff walking between the general ward and the laboratory in the main outpatient area.

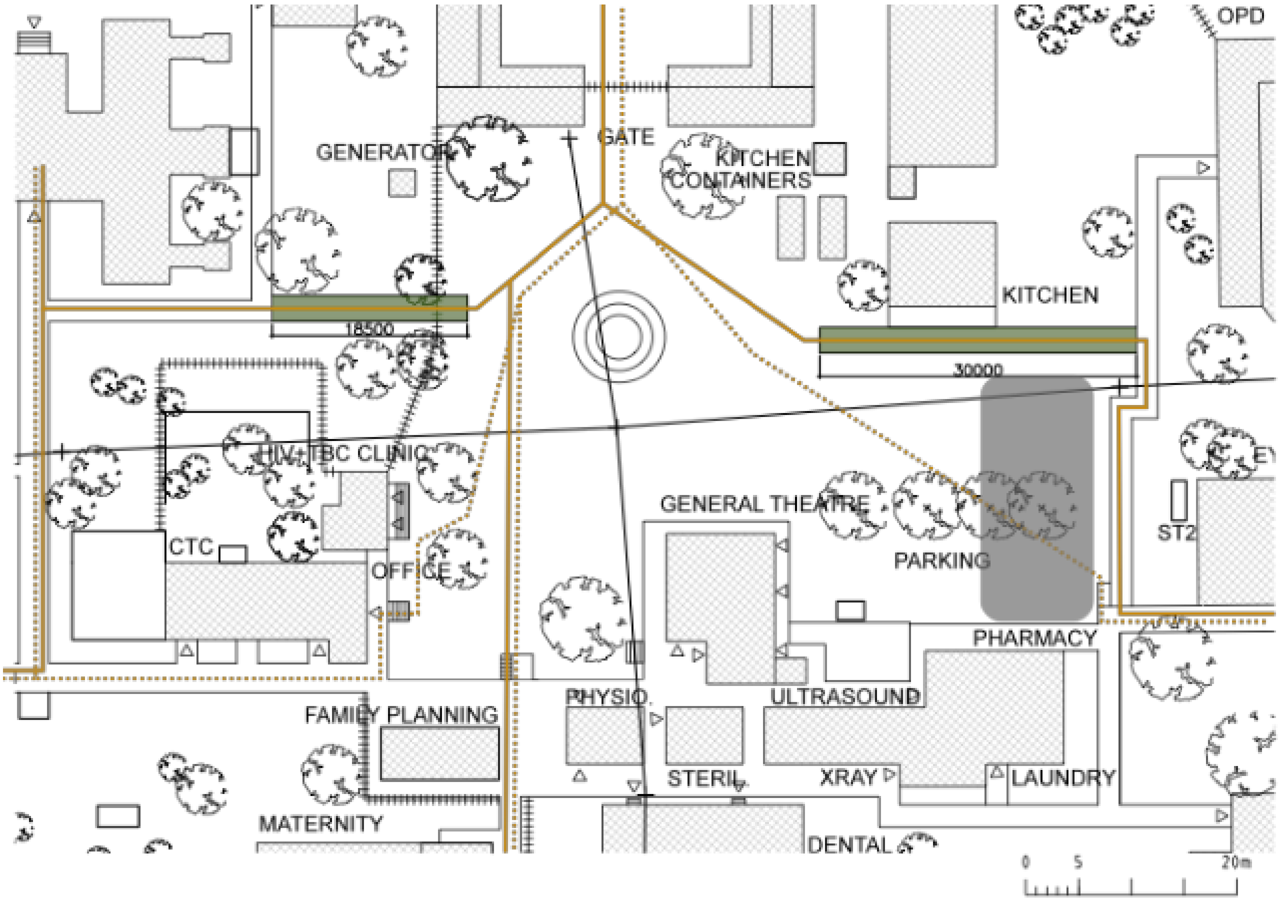

Figure 29: New public path

New public path

Current visitor flow

New eye clinic buildings

Future visitor flow

6.10 Buy an ISSB machine

There is a possibility of introducing a new building technique to the hospital.

In Nairobi, I (Annika), went on a study visit to an engineering company that makes block presses used for producing interlocking stabilized soil blocks (ISSB), called Makiga Engineering. There are several benefits with using the ISSB blocks and machine illustrated in Figure 30. First, is that the cost of the building will be drastically less than when building with for example cement blocks, due to that the soil block technique will require much less cement to make, and the interlocking building technique requires very little mortar in comparison to non-interlocking. Second, the material used for construction of a building can most often be the soil existing on the site, which also reduces the cost of construction as well as minimizes transport of materials. Third, the machine takes four people, with a little bit of training, to operate which means that you bring an income generating activity to the local community using the technique. A complete brochure from Makiga Engineering is attached in Appendix 26. The price list from Makiga Engineering is in Appendix 27. In addition to the cost of buying the machine, one also has to budget for transport and import costs, as well as training costs in operating the machine.

Figure 30: ISSB machine

Before buying one of these machines a lot of questions has to be answered. Who will own the machine? Who will be responsible for manufacturing the blocks? Who should be trained in manufacturing the blocks? Who should be trained in building using the blocks?

During the last week on site I found out that Allan Kiberiti (working at the pharmacy in the hospital) knows a place that sells such machines in Tanzania. He also has plans to use his own machine and produce similar blocks nearby Kolandoto.

Proposal: Since there already is a way for the hospital to buy this type of blocks locally, maybe it is no longer needed to buy a separate machine for the hospital, but to support the hospital in using blocks already produced close to the village.

6.11 Finish the maternity theatre extension

The maternity theatre extension is already under construction. In case the hospital does not have the money needed to finish the construction within a reasonable timeframe, a suggestion is to fund the remaining parts of the construction as well.

Budget: approximately 4 000 000 TZS

See Appendix 25 for the budget situation on the maternity theatre extension the 10th of April 2015.

6.12 Social areas outside general ward

6.12.1 Problem description

Problem description: The general ward accommodates both patients who are immobile and mobile. The more mobile patients sometimes get bored from trying to stay in bed the whole day and are hence often walking outside the ward to sit along the walkway. Relatives bring food for the inpatients three times per day. Patients sometimes eat the food by their bed, but many also walk outside to sit along the walkway, on the walkways or on the ground to eat.

Proposal: The proposal is to build social areas for inpatients in connection to the general ward. The social areas should facilitate for sitting under a roof. Some of the activities that would take place in the social areas include: looking at nature, breathing fresh air, playing games, talking/socializing, watching other people passing by, and eating the food brought by relatives. It has been shown that patients recover/heal faster if they have regular contact with family and nature.

Figure 31 is a section sketch showing the current walkway leading to the general ward in the middle. The suggestion is to add two new roofs along that walkway, one on each side, under which benches and tables are built. A closer assessment of exactly where along the path this is suitable, and how many seating places can be included, along with a more detailed design, should be made before implementation is started.

Cost estimation: A preliminary cost estimation for a section of benches and roof on one side of the existing walkway for 10 meters is provided in Appendix 28. The total cost estimated for those 10 meters is 1 046 000 TSH. A guess is that it would be good to provide such social areas for approximately 30 meters in total, which means that a budget on approximately 3 138 000 TSH is advisable. While budgeting for such an intervention it is however advisable to maybe increase the budget with minimum 20%, which makes for 3 765 600 TSH.

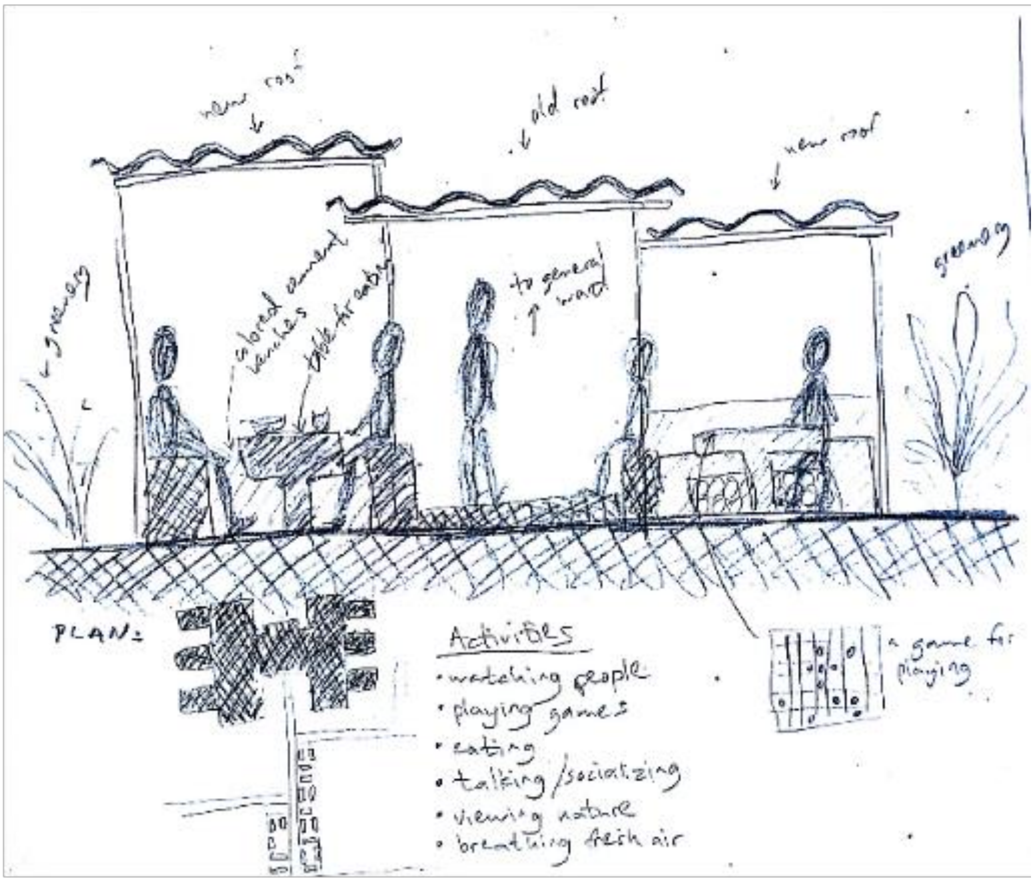

Figure 31: Sketch of social areas

6.13 Reorganization of the imaging department

Problem description: The layout of the imaging department today, Figure 32, is a problem since the doors for entering the department are too narrow for a stretcher to go through without trouble. This means that there are situations in which patient who cannot walk have to be carried on his/hers mattress to be able to enter the x-ray room. This is troublesome, dangerous and painful for the patients who sometimes are severely injured. The current entrance situation also causes the patients going for x-ray to have to enter and then turn back 180 degrees in the building which makes taking an x-ray even more troublesome for the patient and the staff.

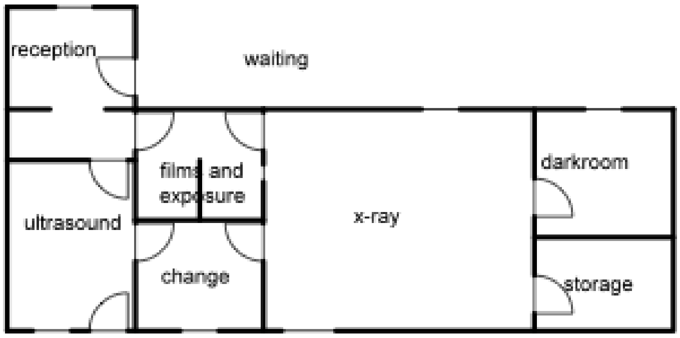

Figure 32: Current layout

Proposal: The proposal, in Figure 33, includes changing the layout of the imaging department to facilitate for an easier and not dangerous entrance situation for patients. The proposal includes three modifications to the building: 1) Exchanging a current window in the x-ray room to become a door. This window is 1260 mm wide, and the staff express that a door this size would also be enough for patients on stretchers. The door has to be thick with metal protection. 2) Remove one old piece of a wall in the current reception room to make the room have enough space for accommodating ultrasound examination activities. Before making this one has to ensure that the stability of the building structure is not affected. 3) Building a floor and roof for the new waiting area. It is an area of 2.8 m times 5.1 m. This probably requires four new pillars.

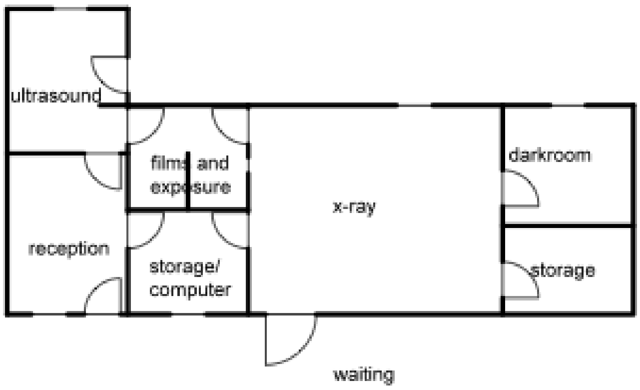

Figure 33: Proposed reorganization

Cost estimation: A preliminary cost estimation is provided in Appendix 30. The total preliminary cost is 1 345 000 TZH.

6.14 New/extended waiting areas for patients at the OPD

Problem description: The area for waiting at the outpatient department building, see Figure 34, is often overcrowded - both before registration outside the outpatient (OPD) building, and after registration waiting for the seeing the doctor inside the OPD.

Proposal: The suggestion is to build new and/or extended waiting areas for patients both inside and outside the OPD building. However, this need was not fully identified until late during the study visit and hence there is no design proposal for how to do this. To make new waiting areas at the OPD requires a process of size estimation, assessment of technical preconditions of the building, design proposals, detailed budget and then implementation.

Figure 34: Current waiting areas at OPD

6.15 Plan for a causality unit, a short stay ward and an extension of the general theatre

Problem description: One of the most troublesome flows at the hospital today is the flow of patients arriving in a state of emergency. The main issue is that the emergency flow (see section 4.5.3) is too inefficient to provide good emergency care, and has no assigned place as to where the care should take place. Highest up on Kolandoto Hospital's list of priorities for larger building projects is to build a causality unit (see section 4.7.4). Kolandoto Hospital has also expressed that such a causality unit should include some observation places for patients who might not need to stay at the hospital for long or for patients who need a bit of closer attention for a while before being able to receive care in the general wards. This could be called a 'short stay ward'. In addition, the hospital has also expressed that there is a need of renovating and extending the general theatre. Looking at the draft masterplan (not included in this report, but will be done and ready to read in June 2015), the area for building a causality unit is around the current general theatre. Due to the closeness of the areas and the needed proximity of these units, it is recommended to plan for the causality unit at the same time as planning for a short stay ward and an extension of the general theatre.

Proposal: The proposal is to use phase 2 to make a detailed plan concerning the design, funding and construction of a causality unit, a short stay ward and an extension of the general theatre. And at the same time plan for a phase 3 of the collaboration project between Kolandoto Hospital, I Aid Africa, Engineers without Boarders and Architects without Boarders to include the construction of the causality unit, the short stay ward and the extension of the general theatre.

Preliminary programme description (to be reassessed during the planning):
Causality unit and short stay ward should include:

- A drop off area for ambulances
- A waiting room
- Reception room approximately: with examination bed, IV drip stand, cupboards etc
- Consultation room: with examination bed, desk etc
- A space for attending minor injuries: with bed, shelves, trolley etc
- A storage room: for drugs and medical supplies
- One female observation room: with space for 2 patients
- One male observation room: with space for 2 patients
- Easy connection to the walkway outside the current physiotherapy building for further transport of patients to general theatre, the maternity theatre, or the wards.
- WCs

Renovation of the general theatre should include:

- A recovery room
- Separate water supply to minor theatre
- A sluice room for the minor theatre
- A larger sluice room for the major theatre

- Possible closer connection between the central sterilization room and the general theatre

6.16 Plan for a new private ward and an extended maternity ward

Problem description: The current maternity ward has 22 beds and two delivery beds in the delivery room. Once Kolandoto Hospital fully becomes a Council Designated Hospital maternal health care should be provided for free and then a large increase in the number of pregnant mothers coming to give birth at Kolandoto Hospital is expected. When that happens, the current amount of inpatient beds and delivery beds will not be enough.

The private ward today has 16 beds divided in two levels: private I and private II. Patients who choose to get admitted to the private ward pay more than other patients in the other wards. This provides for a good opportunity for income to the hospital. An idea from that Kolandoto Hospital has is to build a new private ward to even better standards in terms of toilets, washrooms, and indoor climate. This would make it attractive for several companies to use Kolandoto Hospital as their standard hospital if their employees need hospital care, and would hence also be an even better income opportunity for Kolandoto Hospital.

Proposal: The private ward and the maternity ward are currently located in the same building. The proposal is to use phase 2 to make a detailed plan concerning the design, funding and construction of building a new private ward and extending the maternity ward to use whole existing building.

Preliminary programme description (to be reassessed during the planning):
Private ward:

- Private I to have 10 single patient bed rooms with separate toilets and washrooms
- Private II to have 5 twin patient bed rooms with separate toilets and washrooms
- Nursing station
- Medication room
- Store room for bed sheets etc
- Store room for tables and other bigger things
- Preparation room with equipment for dressing, injections etc
- Sluice room
- Counselling room

Maternity ward:

- Include 50 beds
- A delivery room with 4-6 delivery beds
- An antenatal room with 20 beds
- A post-natal room with 15 beds
- A premature room with 10 beds
- A post-caesarean room with 5 beds
- Toilets and washrooms
- An examination room
- A C-section operating theatre including changing room, scrubbing room and sluice room.
- Nursing station

* Medication room
* Store room for bed sheets etc
* Store room for tables and other bigger things
* Preparation room with equipment for dressing, injections etc
* Sluice room

6.17 Plan for a new pharmacy building

Problem description: The current pharmacy department is made up of 4 units: the main-store/pharmacy, the supply store, the dispensary, and the infusion/IV-production unit. The main store is where most medications are kept and also other supplies. Staff from the different departments and wards come here to collect medications. Medical supplies are transferred from the main store to the supply store, from which staff from different departments and wards can collect medical supplies. The dispensary room is located in the outpatient department, and is only used for dispensing medications to outpatients. The staff from the dispensary comes to the main store to collect medications. The infusion unit produces IV-fluids that are then stored in the main store.

The main-store/pharmacy is in the most urgent need of improvement. The current problems with the facilities for the main store today are:

* Too small
* Shelves are attached to the walls and get attacked by insects
* Too warm for storage of medication
* Windows leads light into areas that should be dark
* Not enough space for walking with a trolley in the pharmacy
* Difficult to clean due to the small spaces and the floor inclinations
* Lack sinks for washing hands
* Too small doors to bring in larger items

The dispensary unit is identified as too small for Kolandoto Hospital to act as a Council Designated Hospital. The supply store is assessed to be too small for its current amount of material/supplies to be kept there.

Proposal: The proposal is to use phase 2 to make a detailed plan concerning the design, funding and construction of a new main-store/pharmacy building.

Preliminary programme description (to be reassessed during the planning):
Main-store/pharmacy building:

* Total size needed is estimated to be approximately 180 sqm.
* Storage room with AC, no sunlight reaching the medications, free standing 2 m high shelves, space for trolley to be used in the room,
* Fridges to keep certain medications extra cool
* One office for dispensing to the wards
* One office for management of the pharmacy department
* Sink for hand washing

- Floor should be easy to clean

6.18 Plan for moving the RCH

Problem description: The current Reproductive and Child Health Clinic (RCH) is located in the south end of the hospital site, while the main outpatient areas and the laboratory department are in the north of the hospital site. This forces expectant mothers, the mothers and children to first walk across the whole hospital to the reach the clinic, and then back to the laboratory if any tests are needed, and then sometimes back to the RCH for consultations. See section 4.5.2 for a flow illustration of the outpatient flows. The building in which the RCH clinic is today, is also in quite poor condition at the moment.

Proposal: The proposal is to plan for moving the RCH closer to the outpatient department area. A suggestion is to renovate the current social hall used by the college students to become the RCH clinic instead. The proposal includes to make a close assessment of the spatial needs of the RCH, a design for renovating the social hall to host the RCH, and a cost estimation for implementing the proposed renovation.

Preliminary programme description (to be reassessed during the planning):

- waiting areas
- education room
- place for weighing babies
- room for room for information for preventing mother-to-child transmission of HIV (PMTCT)
- a room for HIV early infant diagnosis (HEID)
- an evaluation room
- a couple of storage rooms including space for a refrigerator
- a tea room
- and a room for examinations and a place for the doctor nurse
- a post-natal exam room
- an immunization room

6.19 Plan for a new paediatric ward

Problem description: The current paediatric ward has 23 inpatient beds. Once Kolandoto Hospital fully becomes a Council Designated Hospital health care for children below five years of age should be provided for free and then a large increase in the number of patients coming to the paediatric ward is expected. When that happens, the current amount of inpatient beds will not be enough.

Proposal: The proposal is to make a close assessment of the spatial needs of the paediatric ward, make a design and cost estimation for building a new paediatric ward and renovating the existing one at the same time.

Preliminary programme description (to be reassessed during the planning):

- At least 50 inpatient beds in total
- 5 beds for patients in need of isolation, with separate toilets and bathrooms
- 30 beds for medical patients: including diarrhoea case room and malnutrition room
- 15 beds for surgical patients
- Nursing station
- Medication room
- Store room for bed sheets etc
- Store room for tables and other bigger things
- Preparation room with equipment for dressing, injections etc
- Sluice room
- Counselling room
- Toilets and washrooms

6.20 Plan for a new general ward and reorganizing the current one

Problem description: The general ward is divided into male and female sections. There are 28 beds for females - 13 surgical, 13 medical and 2 for isolation. There are 30 beds for males - 14 surgical, 14 medical and 2 for isolation. One problem is that at the peaks of amount of patients it happens that some patients have to stay on mattresses on the floor. Staff expresses that the general wards often are congested and overcrowded. Another problem is that the isolation patients who have infectious diseases share toilets and bathrooms with the patients in the medical wards. This can cause transmission of infectious diseases to other patients.

In addition to the current problems, the hospital is also expecting an increase in patients the coming years when the hospital fully becomes a Council Designated Hospital. Then the amount of inpatient beds in the general wards will be too few.

Proposal: The proposal is to make a close assessment of the spatial needs of the general wards, make a design and cost estimation for building a new general ward and renovating the existing one at the same time. The proposal is to build a new general medical ward on the site of the current RCH building, and reorganize the current general ward to be only a general surgical ward.

Preliminary programme description (to be reassessed during the planning):
General medical ward - a new building on the site of the current RCH building:

- A general medical female ward with 25 beds, including toilets and bathrooms
- 5 isolation rooms for female medical patients, including separate toilets and bathrooms
- A general medical male ward with 25 beds, including toilets and bathrooms
- 5 isolation rooms for male medical patients, including separate toilets and bathrooms
- Nursing station
- Medication room
- Store room for bed sheets etc
- Store room for tables and other bigger things
- Preparation room with equipment for dressing, injections etc

- Sluice room
- Counselling room
- Toilet and washroom for staff

General surgical ward - reorganization of the current general ward:

- A general surgical female ward with 30 beds, including toilets and bathrooms
- A general surgical male ward with 25 beds, including toilets and bathrooms
- Nursing station
- Medication room
- Store room for bed sheets etc
- Store room for tables and other bigger things
- Preparation room with equipment for dressing, injections etc
- Sluice room
- Counselling room
- Toilet and washroom for staff

6.21 Plan for renovation/reorganization/extension of the OPD

Problem description: The outpatient department is in the same building as the laboratory. It is a nicely designed building, with lots of light and air. It has a central courtyard in which patients wait. Taking care of the rainwater falling on the roofs is integrated in the building design. However some of the roofs are leaking and rainwater end up in places it should not be.

There is a reception room with storage of patient files. There are two doctors' rooms, and two rooms for clinical officers. There is also a small indoor waiting area. There is a room for the cashier, a room for administration of the national health insurance fund, an evaluation room, a room split in two for dressing and injections, toilets, and one room for an outpatient dispensary for drugs. Several of these rooms are too small for their activities, for example the reception room and the dispensary.

The area for waiting at the outpatient department building is often overcrowded - both before registration outside the OPD building, and after registration waiting for the seeing the doctor inside the OPD.

Another problem is that the building is not adapted for people who have trouble walking and need wheelchairs. There are stairs leading up to the reception at the entrance. And inside the building, many doors and the half-outdoor corridors are not wide enough for easy navigation.

Proposal: The proposal is to analyse a needed extension, renovation and reorganization of the outpatient department and what that should include. This need to include an assessment of the technical conditions of the current building, and the spatial needs for outpatient care the next 10 years. The goal is to create a design proposal with a cost estimation for renovation/reorganization/extension of the OPD.

Preliminary programme description (to be reassessed during the planning):

- Spacious waiting areas for patients, both outside OPD and inside OPD

- Surgical room at OPD for minor injuries, bruises, cuts etc
- Widen doors for accessibility of wheelchairs and stretchers,
- Expand the dispensary room,
- Expand the reception/registration room
- Include parking outside OPD for both staff and visitors
- Payment office,
- Dressing room
- Injection room
- Toilets
- Several consultation rooms
- Space for the dental unit
- Space for physiotherapy

7 Suggestions for the future regarding project management

The survey team suggests that the project in the future should be run as it has during phase one; as a cooperation between the involved NGOs I Aid Africa, Engineers Without Boarders and Architects Without Boarders, together with the Kolandoto Hospital management. Furthermore, it is recommended that I Aid Africa together with Dr. Katani still remains as leaders of the project to ensure a frictionless continuation and to maintain and improve the communication with the hospital. It is also important that the involvement of the hospital management staff increases even more so that Kolandoto Hospital owns the project and are entitled to guide the project in the direction they desire.

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Appendix 1

~~EMILIA~~ Ti MAJI

77

GEOPHYSICAL SITE SURVEY RESULTS SUMMARY FORM

Name of site: KOLANDOTO HOSPITAL

Recommended for construction: (Circle) Yes / No

Client: MEDICAL INCHARGE KOLANDOTO HOSPITAL

District: SHINYANGA URBAN

Village: KOLANDOTO

Grid-references: — / —

Ward: KOLANDOTO

Date of survey(s): 5.5.95 to 5.5.95 .... to ....

Location recommended for construction: along profile number: 2 – 2'

VES no: 2.1

....m from VES .....to VES.....

marked as VES 6.1

Recommended type of construction: (circle) Hand digging / Machine drilling / Hand drilling

Concrete benchmark with blue mark + indication on tree

Estimated required depth: 75 m

Recommended maximum depth: 75 m

Estimated depth to unweathered rock: 100 m

Expected groundwater salinity: (tick)

- low (EC < 1000 mmho/cm) .....
- medium (<EC 1000-2000 mmho/cm) ✓
- high (EC > 2000 mmho/cm) .....

Soil type at recommended construction location: LOOSE FINE SAND/SILT

Rock type at recommended construction location: SANDSTONE & WEATHERED GRANITE

Aquifer type at recommended construction location: (tick)

- Weathered rock ✓
- Fault / Fractured zone ✓
- Geological contact zone ....
- Sediments ✓

Construction location bench-marked in presence of client's representative:

Name: MRS RUTH MUGUH Designation: DWSP FACILITATOR Signature: ....

Remarks: NIL.

Original: Geophysical Site Investigations file Copies to: RWE......DWE....RWSE....RPA....

Appendix 2

WEDECO LTD
YOUR PARTNER IN RURAL DEVELOPMENT

WATER & ENVIRONMENTAL DEVELOPMENT CO. LTD

P.O BOX 125 SHINYANGA TANZANIA TEL +255-28-2762197
Tel/Fax +255-28-2762767 Email: Wedeco @ africaonline. co. tz.

Branch office SHINYANGA P.O Box 125

VRN 27-012088-B TIN 100-705-869

TAX PROFORMA INVOICE No A 0390

Date 19/02/15

M/S KOLANDOTO HOSPITAL

VRN TIN

Qty	Description	Unit Price	Amount T. Shs	Cts
	Being Total cost for pumping Test for 8hB at Kolandoto Hospital in Shinyanga Municipal.		1,128,000	=
	Sub Total		1,128,000	=
	Add Vat ~~20%~~ 18%		203,040	=
	Grand Total		1,331,040	=

Branches: Bariadi, Kahama, Meatu, Bukombe, Maswa, Morogoro.

LPO\ORDER No Date

DELIVERY NOTE No Date

WEDECO LTD
YOUR PARTNER IN DEVELOPMENT
P .o. Box 125, SHINYANGA, Tel: 028-2762767 Fax: 028-2762197.

Water & Environmental Development co. Limited

Cost Breakdown For Pump Test in Kolandoto Hospital

Item No.	Descriptions	Amount in Tshs
1	Pump test Unit Hiring cost	500,000.00
2	Transport cost go & return (Equipments) 60kms x 1,500/=	90,000.00
3	Fuel for Generator 50litres @ 2,000/=	100,000.00
4	Labor Charge (Causal Labor)	50,000.00
5	Professional fee	200,000.00
	SUB TOTAL	**940,000.00**
6	Add 20% Profit Margin	188,000.00
7	Add 18% VAT	203,040.00
	GRAND TOTAL	**1,331,040.00**

WATER AND ENVIRONMENTAL DEVELOPMENT Co. LTD. WEDECO LTD P. O. Box 125 SHINYANGA

Appendix 3

Swahili	12	1 a.m	2 a.m	3 a.m	4 a.m	5 a.m	6 a.m	7 a.m	8 a.m	9 a.m	10 a.m	11 a.m	12	1 p.m	2 p.m	3 p.m	4 p.m	5 p.m	6 p.m	7 p.m	8 p.m	9 p.m	10 p.m	11 p.m
24 hours	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00	01:00	02:00	03:00	04:00	05:00
OUTLET																								
Hospital tank																								
Small																								
Large																								
Lepra																								
INLET																								
Hospital tank						PUMP OFF					PUMP OFF							PUMP OFF					PUMP OFF	PUMP OFF
Small																								
Large																								
Lepra																								

OUTLET	**SWAHILI**		**24-hour**	
Hospital tank	12-1 p.m		06-19	
Small	12-3.am	10 a.m -1 p.m	06-09	16-19
Large	12-3.am	10 a.m -1 p.m	06-09	16-19
Lepra	12-3.am	10 a.m -1 p.m	06-09	16-19

INLET	**SWAHILI**			**24-hour**		
Hospital tank	12-3 a.m	8 a.m-10 a.m	6 p.m-9 p.m	06-09	14-16	00-03
Small	3.am-5 a.m	6 a.m-8 a.m	11 a.m-5 p.m	09-11	12-14	17-23
Large	3.am-5 a.m	6 a.m-8 a.m	11 a.m-5 p.m	09-11	12-14	17-23
Lepra	9 p.m-10 p.m			03-04		

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Appendix 4

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TFN. WD. & ID. H26A (Rev. '70)

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF AGRICULTURE, FOOD AND CO-OPERATIVES—WATER DEVELOPMENT AND IRRIGATION DIVISION

PROJECT PLANNING AND RESEARCH STATION UBUNGO

SOIL AND WATER LABORATORY,
P.O. BOX 9291,
DAR ES SALAAM

Date 25.6 19 71

Lab. Ref. DWS/781/71

WATER EXAMINATION REPORT

Analysis of sample of water of Kolandoto BH. 3/71

Name and address of site

Collected on 21/5/71 at - by SHINYANGA depth 20'

Sample received on 3/6/71 Purpose of analysis DOMESTIC

Analysis requested by SHINYANGA REGION Ref. No. D/63/21

Physical Examination

Appearance	clear	Taste	-
Turbidity	8 mg. $(SiO_2)/l$	Colour	30 mg. (Pt)/l
Sediments	- ml/l	Odour	-
pH	7.4	Conductivity at 25°C	1450.0 micromhos/cm.

Chemical Examination *in milligrams per litre*

Ammoniacal Nitrogen	0.555	Alkalinity (as $CaCO_3$)	
Albuminoid Nitrogen	-	Phenophtalein	-
Nitrite Nitrogen	trace	Total	602
Nitrate Nitrogen	0.30	Hardness (as $CaCO_3$)	
Sodium	315	Carbonate	105.0
Potassium	1.4	Non-carbonate	-
Iron	1.0	Total	105.0
Manganese	-	Calcium	38.2
Fluoride	14.8	Magnesium	2.53
Chloride	197.0	Sulphate	-
Oxygen absorbed (from 0·125N $KMnO_4$ in ½ hour at 100°C)			8.0
Total Filtrable Solids	900	Suspended Solids	-

Remarks: Water unsuitable for drinking because of excessive fluoride content.

Necessary/recommended Treatment:

Appendix 5

Tel: + 255 282762895

Water Quality Laboratory
SHINYANGA REGIONAL
P.O.Box 147,
SHINYANGA.

Ref. No. A.39/ ....

Date 02/03 2005.

To: KOLANDOTO
HOSPITAL
P.O.BOX 1 SHINYANGA

Pay to MR JULIUS BUJIKU (who will render the service).

Dear Sir/Madam,

REF: BILL FOR 2 **Water Samples**
For Physical, chemical and Bacteriological.

PARTICULARS	AMOUNT SHS	AMOUNT CTS
Physical and chemical test 2 samples		
150000 x 2	300000/=	
Bacteriological test 2 samples		
50000 x 2	100000/=	
TOTAL	400000	

Head of the Laboratory

MKUU WA MAABARA Y.
S.L.P.147
SHINYANGA.

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Appendix 6

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER

Telegrams ....
Telephone: 028 –2762895
In reply please quote

Water Quality Laboratory,
Shinyanga Region,
P.O. Box 147,
SHINYANGA.

In replay please quote: 15/2015

Date: 16/03/2015

BACTERIOLOGICAL WATER ANALYSIS REPORT

Analysis requested by KOLANDOTO HOSPITAL

REGION SHINYANGA DISTRICT: MUNICIPAL WARD: KOLANDOTO

SOURCE: BOREHOLE (OLD)

Dated collected for analysis: 13/03/2015 Date analyzed: 13/03/2015

Sample collected by Laboratory Personnel______YES √ NO ________ ☐

Lab. No	Source of Sampling	Site of Sampling	Total Coliform Count/100ml (35°C)	Fecal Coliform Count/100ml (44.50°C)	Residue Chlorine mg/l	Comments
15/2015	SAMPLE 01 BOREHOLE	KOLANDOTO HOSPITAL	20	14	ND	Unsatisfactory
	SAMPLE 2	-"-	40	6		-"-

ND – Not Determined

REMARKS: The water is clean but contaminated with faecal and Total coliform bacterias. Disinfection is recommended

16/03/2015 .... Date

.... Reporting Officer

.... Head of Water Quality Laboratory

MKUU WA MAABARA YA MAJI
S.L.P.147
SHINYANGA.

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Appendix 7

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER

Telephone: MIO – SHINYANGA
Telephone: 028 – 2762066
028 – 2762895

WATER QUALITY LABORATORY
P.O. Box 147,
SHINYANGA

In replay please quote:

Lab. No: 15/2015

Date: 16/03/2015

PHYSICAL AND CHEMICAL WATER ANALYSIS REPORT

(1) ORIGIN OF THE SAMPLE

Analysis requested by KOLANDOTO HOSPITAL Ref. No

Dated Date received at the Laboratory 13/03/2015

Date collected for analysis 13/03/2015 Time

Temp 20.9 °C water source BOREHOLE (OLD)

Region SHINYANGA District MUNICIPAL Ward KOLANDOTO.

Purpose of sampling DOMESTIC USE

Sampling position KOLANDOTO HOSPITAL/PUMP HOUSE - 01

Preservative added/type of treatment to water before sampling NONE

Ministry of Water

(2) PHYSICAL EXAMINATION

Appearance:

Turbidity 85.00 N.T.U.	Color 0.00 mg Pt/l
Settle able matter 0.00 Ml/l	Odour NIL
Taste GOOD	pH 7.12
Total Dissolved Solids 622.00	Conductivity at 1269 µS/cm.
	Total Nonfiltrable Residue a t 25°C -

3) CHEMICAL EXAMINATION (In milligrams per liter)

Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)	Calcium
Phenophthalein	Carbonate	Magnesium
Total	Non Carbonate	Sodium
	Total 135.00	Potassium

Cadmium ____	Total Nitrogen ____	Chloride 44.00
Chromium ____	Ammonia Nitrogen 0.53	Fluoride 7.00
Copper ____	Organic Nitrogen -	Permanganate Value ____
Iron 0.01	Nitrate Nitrogen 0.885	(as mg $KMnO_4$ / l) 3.34
Lead -	Nitrite Nitrogen 0.001	B.O.D. (5 days) -
Manganese 1.16	Total Phosphorous -	Others: Nitrate 3.90
Mercury ____	Orthophosphate -	Nitrite 0.002
Zinc ____	Sulphate 6.00	Salinity 0.6
		Ammonium 0.68

(4) REMARKS

the water is alkaline and slightly hard with high contents of FLOURIDE.

(5) RECOMMENDATION

According to the parameters analysed the water is acceptable for domestic use. (Human consumption)

16/03/2015		
Date	Reporting Officer	Head of Water Quality Laboratory

MKUU WA MAABARA YA MAJI
S.L.P.147
SHINYANGA.

I Aid Africa®

90 KONTO SVENSK INSAMLINGS KONTROLL

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER

Telephone: MIO – SHINYANGA
Telephone: 028 – 2762066
028 – 2762895

WATER QUALITY LABORATORY
P.O. Box 147,
SHINYANGA

In replay please quote:

Lab. No: 15/2015

Date: 16/03/2015

PHYSICAL AND CHEMICAL WATER ANALYSIS REPORT

(1) ORIGIN OF THE SAMPLE

Analysis requested by KOLANDOTO HOSPITAL Ref. No

Dated Date received at the Laboratory 13/03/2015

Date collected for analysis 13/03/2015 Time

Temp 21 °C water source BOREHOLE (OLD)

Region SHINYANGA District MUNICIPAL Ward KOLANDOTO

Purpose of sampling DOMESTIC USE

Sampling position KOLANDOTO HOSPITAL/PUMP HOUSE-02

Preservative added/type of treatment to water before sampling

(2) PHYSICAL EXAMINATION

Appearance:		Color	0.00 mg Pt/l
Turbidity	84.00 N.T.U.	Odour	NIL
Settle able matter	0.00 Ml/l	pH	7.13
Taste	GOOD	Conductivity at	1268 µS/cm.
Total Dissolved Solids	621.00	Total Nonfiltrable Residue a t 25°C	

3) CHEMICAL EXAMINATION (In milligrams per liter)

Alkalinity (as $CaCO_3$)		Hardness (as $CaCO_3$)		Calcium	
Phenophthalein		Carbonate		Magnesium	
Total		Non Carbonate		Sodium	
		Total	150.00	Potassium	

Cadmium	Total Nitrogen	Chloride 42.00
Chromium	Ammonia Nitrogen 0.57	Fluoride 7.00
Copper	Organic Nitrogen -	Permanganate Value
Iron 0.01	Nitrate Nitrogen 0.468	(as mg KMnO₄/l) 2.79
Lead -	Nitrite Nitrogen 0.00	B.O.D. (5 days) -
Manganese 0.97	Total Phosphorous -	Others: Nitrate 2.06
Mercury -	Orthophosphate -	Nitrite 0.00
Zinc -	Sulphate 6.00	Salinity 0.6
		Ammonium 0.74

(4) REMARKS

The water is alkaline and slightly hard with high contents of FLOURIDE.

(5) RECOMMENDATION

According to the parameter's analysed the water is acceptable for domestic use (Human consumption)

16/03/2015

Date

Reporting Officer

Head of Water Quality Laboratory

MKUU WA MAABARA YA MAJI
S.L.P.147
SHINYANGA.

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Appendix 8

ID	Description	ID	Description
WO80	Junction in Main line	WO79	Inlet to General Ward
WO81	Tank used by Morgue (1m^3)	WO80	Junction in Main line
WO82	Elbow	WO81	Tank used by Morgue (1m^3)
WO83	Inlet to General Ward	WO82	Elbow
WO84	Inlet to General Ward	WO83	Inlet to General Ward
WO87	Inlet to RCH	WO84	Inlet to General Ward
WO88	Elbow	WO87	Inlet to RCH
WO89	Inlet to RCH	WO88	Elbow
WO90	Inlet to RCH	WO89	Inlet to RCH
WO91	Elbow	WO90	Inlet to RCH
WO92	Inlet to three staff houses	WO91	Elbow
WO93	Junction	WO92	Inlet to three staff houses
WO94	Inlet Private Ward	WO93	Junction
WO95	Inlet Maternity	WO94	Inlet Private Ward
WO96	Inlet Paediatrics	WO95	Inlet Maternity
WO97	Elbow	WO96	Inlet Paediatrics
WO98	Junction to College	WO97	Elbow
WO104	T-Junction	WO98	Junction to College
WO105	Elbow	WO104	T-Junction
WO106	Junction	WO105	Elbow
WO107	Junction to Male Dorm at College	WO106	Junction
WO108	Inlet to Laundry machine at Maternity	WO107	Junction to Male Dorm at College
WO109	Inlet to Maternity	WO108	Inlet to Laundry machine at Maternity
WO110	T-Junction	WO109	Inlet to Maternity
WO111	Elbow	WO110	T-Junction
WO112	Elbow	WO111	Elbow
WWTE1	Tank outside Eye Theatre (1m^3)	WO112	Elbow
WWTE2	Tank outside Eye Theatre (1m^3)	WWTE1	Tank outside Eye Theatre (1m^3)
WS1	Location of Pump	WWTE2	Tank outside Eye Theatre (1m^3)
WS2	Change of size in Main Line	WS1	Location of Pump
WS3	T-Junction	WS2	Change of size in Main Line
WS6	Leprosy Tank (20m^3)	WS3	T-Junction
WS7	Valve with leakage on Main Line	WS6	Leprosy Tank (20m^3)
WS8	Junction in Main line	WS7	Valve with leakage on Main Line
WS9	Hospital tank (20m^3)	WS8	Junction in Main line
WS12	Junction in Main line	WS9	Hospital tank (20m^3)
WS14	Main tank (75m^3)	WS12	Junction in Main line
WO77	Elbow	WS14	Main tank (75m^3)
WO78	Inlet to General Ward		

Appendix 9

Pipe ID	Diameter (mm)	92	25.4
48	76.2	93	25.4
49	50.8	94	25.4
50	50.8	95	25.4
51	50.8	96	25.4
52	50.8	97	25.4
53	50.8	98	25.4
54	50.8	99	25.4
55	50.8	100	25.4
56	50.8	101	25.4
57	50.8	102	25.4
58	50.8	103	25.4
59	50.8	104	25.4
64	76.2	105	25.4
65	50.8	106	25.4
66	50.8	107	25.4
67	38.1	108	25.4
68	38.1	109	25.4
69	38.1	110	25.4
70	38.1	111	25.4
71	38.1	112	25.4
72	38.1	113	25.4
73	19.05	115	25.4
74	25.4	116	25.4
75	25.4	117	50.8
76	25.4	118	25.4
77	25.4	119	25.4
78	25.4	120	38.1
79	25.4	121	25.4
80	25.4	122	25.4
81	25.4	123	25.4
82	25.4	125	25.4
83	25.4	127	25.4
84	25.4	128	25.4
85	25.4	130	25.4
86	25.4	134	50.8
87	25.4	135	19.05
88	25.4	136	19.05
89	25.4	137	38.1
90	25.4	138	25.4
91	25.4	139	25.4

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Appendix 10

TZS 789:2008
ICS: 67.060.20

TANZANIA STANDARD

Drinking (potable) water – Specification

TANZANIA BUREAU OF STANDARDS

Second Edition 2008

TZS 789:2008

This Tanzania Standard was published under the authority of the Executive Council of Tanzania Bureau of Standards in 2008 – 05 – 20 .

The Tanzania Bureau of Standards (TBS) is the statutory national standards body for Tanzania established under the Standards Act No. 3 of 1975, amended by Act No. 1 of 1977.

The Chemicals Divisional Standards Committee under whose supervision this Tanzania Standard was prepared consists of representatives from the following organizations:

Tanzania Oxygen Limited (TOL)
General Tyre (EA) Ltd. Arusha
Ministry of Industry, Trade and Marketing
Mansour Daya Chemicals
Muhimbili University of Health and Applied Sciences (MUHAS)
*Government Chemist Laboratory Agency (GCLA)
Genesis Investments Ltd.
Emunio Tanzania Limited
Petro-Products Testing and Chemical Laboratory
Tanzania Industrial Study and Consulting Organization (TISCO)

The organization marked with an asterisk (*) in the above list, together with the following were directly represented on the Technical Committee entrusted with the preparation of this Tanzania Standard:

National Environment Management Council (NEMC)
Dar es Salaam Water and Sewerage Corporation (DAWASCO)
Ministry of Water
Vice President's Office–Department of Environment (VP-DOE)
Dar es Salaam Water and Sewerage Authority (DAWASA)

Tanzania Bureau of Standards
P. O. Box 9524
Dar es Salaam
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ISBN 9974 64 854 – 5

Drinking (potable) water – Specification

0 Foreword

Water constituents may affect the taste, colour, general appearance and smell of water and the user will evaluate the quality and acceptability essentially on these criteria.

This Tanzania Standard was part of TZS 574:1999, *Method of test for the quality of drinking water*. The standard gave requirements for both drinking waters and bottled drinking waters. This Tanzania Standard will cover only requirements for drinking (potable) water. This Tanzania Standard is a revision of the first version finalized in 2004.

This Tanzania Standard has been prepared with assistance from:

> KS 05-459 Part 1-1996, *Specification of drinking water – Requirements for drinking water*, published by the Kenya Bureau of Standards (KEBS).
>
> EAS 12: 2000, *Drinking (potable) water – Specification*, published by the East African Standards Committee.
>
> Maji Review Vol.1, 1974, *Temporary Standards of Domestic (Potable) Waters*, published by the Ministry of Water Development and Energy.
>
> *Guidelines for drinking water quality Vol.1 – Recommendation*, published by the World Health Organization (WHO) (1984).

This second edition cancels and replaces the first edition (TZS 789:2004) which has been technically revised.

In reporting the result of a test or analysis made in accordance with this Tanzania Standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with TZS 4 (see clause 3).

1 Scope

This Tanzania Standard prescribes the quality requirements for drinking (potable) water.

It does not include the requirements for natural mineral water.

2 Field of application

This Tanzania Standard prescribes the quality requirements for drinking (potable) water distributed in the food industry, domestic and catering purposes. It applies to bacteriological, biological, virological, physical, chemical and radiological quality criteria. It is intended also for community piped water supplies i.e. those water systems serving cities, municipalities and townships, community standpipes and wells and drinking water distributed by tankers. This Tanzania Standard does not apply to bottled mineral waters.

3 References

This Tanzania Standard makes reference to the following standards:

TZS 574 (Part 1): 2002, *Method of test for the quality of drinking water – Part 1: Physical methods of test for the quality in drinking water*

TZS 574 (Part 2): 2002, *Method of test for the quality of drinking water – Part 2 – Methods for biological and microbiological test for drinking water*

TZS 574 (Part 3): 2002, *Method of test for the quality of drinking water – Part 3: Methods for determining metal contaminants in drinking water*

TZS 575:1997, *Code of hygiene for collecting, processing and marketing of natural mineral water*

TZS 573:1997, *Specification for natural mineral water*

TZS 390:1988, *Carbonated soft drinks – Specification*

TZS 564 (Part 2): 1997, *Methods of sampling water quality – Part 2: Guidance on sampling techniques*

TZS 574 (Part 5):2002, *Method of test for the quality of drinking water – Part 5: Gases, organic compounds and radioactive tests for drinking water*

TZS 605:2000, *Unplasticised polyvinyl chloride (PVC-U) pipes for cold potable water*

4 Definitions

4.1 drinking water

Shall mean potable water intended for human consumption.

NOTE – Carbonated bottled drinking waters flavoured or unflavoured shall be covered in TZS 390 (see clause 2) and carbonated bottled mineral waters shall be covered in TZS 573 (see clause 2).

5 Requirements

Drinking water shall conform to the requirements given in the following tables and clauses:

5.1 Water that is intended for human consumption is supposed to be free from micro-organisms and
from chemical substances which may be hazardous to health.

5.2 All supplies of drinking water are required to be pleasant and safe to drink. Absence of turbidity and absence of colour, palatable and acceptable, taste and odour are of the utmost importance in public supplies of drinking water. The situation, construction, operation and supervision of water supply, its reservoirs and its distribution systems shall be such that they exclude any possible contamination of the water.

5.3 Pipes for potable water supply shall conform to TZS 605 (see clause 3).

5.4 The requirements for quality of potable water are divided into three categories as shown below:

5.4.1 *Microbiological quality requirements*
Drinking water should not contain any organisms of faecal origin. The presence of coliform organisms should be considered as an indication of remote faecal pollution. The presence of Escherichia coli (faecal coliform) indicates recent faecal pollution, and hence dangerous condition if found in consecutive sample of water tested. Coliform organisms are those organisms which are capable of fermenting lactose with production of acid and gas at 35°C – 37°C in less than 48 hours, and are indole negative. Escherichia coli (faecal coliform) are those organisms which are capable of fermenting lactose with the production of acid and gas at 44°C in less than 24 hours, and which are indole positive. The microbiological standard to be aimed at is the same as the WHO one which demands that there be no coliform (E.coli) in each 100 ml portions (piped water supplies).

5.4.2 *Microbiological requirements and classification of non-chlorinated piped water supplies*

Table 1 – Microbiological requirements

Class of piped water/Type of test count	Coliform count per 100 ml at 37°C	E. Coli (faecal coliform) count per 100 ml at 44°C
Excellent	0	0
Satisfactory	1 - 3	0
Suspicious	4 - 10	0
Unsatisfactory	More than 10	1 or more 2

For each individual sample coliform should be estimated in terms of the "Most Probable Number" in 100 ml of drinking water, which is often designated as MPN index or Coli index. Occurrence of E.coli (faecal coli) in consecutive samples, in less than 100 ml of drinking water is an indication of faecal pollution and hence a dangerous situation needing urgent rectification.

5.4.3 *Physical and chemical requirements*

Table 2 – The chemical and physical limits for quality of drinking water supplies

Group	No. Substance	Unit	Lower limit	Upper limit
Toxic	1. Lead Pb 2. Arsenic As 3. Selenium Se 4. Chromium (6+) Cr 5. Cyanide CN 6. Cadmium Cd 7. Barium Ba 8. Mercury Hg 9. Silver Ag	mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L	- - - - - - - - -	0.1 0.05 0.05 0.05 0.20 0.05 1.0 0.001 n.m
Affecting human health	1. Fluoride F 2. Nitrate NO_3	mg/L mg/L	- 10.0	4.0 75.0
Organoleptic	1. Colour 2. Turbidity 3. Taste 4. Odour	TCU NTU - -	1.5 5 n.o n.o	50 25 - -
Salinity and hardness	5. pH 6. Total filterable residue 7. Total hardness ($CaCO_3$) 8. Calcium (Ca) 9. Magnesium Mg 10. Magnesium + Sodium SO_4 11. Sulphate (SO_4) 12. Chloride (Cl)	- mg/L mg/L mg/L mg/L mg/L mg/ mg/	6.5 500 500 75 50 500 200 200	9.2 2000 600 300 100 1000 600 800
Less toxic metals	13. Iron (Fe) 14. Manganese (Mn) 15. Copper (Cu) 16. Zinc (Zn)	mg/L mg/L mg/L mg/L	- - - -	1.0 0.5 3.0 15.0
Organic pollution of natural origin	17. BOD (5 days at 30°C) 18. PV (Oxygen abs KMNO4) 19. Cadmium, 20. Ammonium ($NH_3 + NH_4$) 21. Total Nitrogen (Excluding NO_3)	mg/L mg/L mg/L mg/L	- - - -	6.0 20 2.0 1.0
Organic pollution introduced artificially	21. Surfactants (Alkyl Benzyl Sulphonates) 22. Organic matter (as Carbon in Chloroform extract) 23. Phenolic substances (As Phenol)	mg/L mg/L mg/L	- - -	2.0 0.5 0.002

n.o – not objectionable
n.m – not mentioned

Table 3 – Radioactive materials

Material	Limit
Gross alpha activity	0.1 Bq/l
Gross beta activity	0.1 Bq/l

5.4.4 *Standards of sanitary protection of water intake and surrounding land*

5.4.4.1 *Distance to source of contamination*: The following distances from sources of pollution should always be taken into account and be an integral part of every water supply system:

- 50 metres for pit preview, septic tanks, sewers
- 100 metres from borehole latrines, seeping pits, trenches and sub surface sewage disposal fields
- 150 meters from cesspools, sanitary land field areas and graves

In addition to the above minimum distances, the following precautions must also be observed:

a) Domestic livestock and other animals should be kept away from the intake by fencing the area of a minimum radius of 50 metres from the installation.

b) Defecation and urination around the intake should be completely prohibited, by law.

c) Drainage and run-off waters should be led away from intakes.

d) The water source should be guarded against inundation by the flooding of nearby rivers.

e) Soil erosion should be prevented by reforestation and other methods.

f) Algal growth should be prevented by draining swamps and pools around the intake or reservoir.

5.4.4.2 *Frequency of sampling*: Irrespective of the size of the population, all types of waters should be tested at least two times per year – once under dry conditions and once under rainy conditions.

5.4.4.3 *Surface water intakes*: When water is drawn from rivers, streams, lakes and reservoirs, the following shall be observed in respect of intakes:

a) Intake should be so placed and designed as to draw water that is as clean and palatable as the source of water supply can provide.

b) River intake should be constructed upstream from villages and industrial factories, and the intake should be in deep water close to a stable bottom.

c) Small stream intake should comprise a take-pool which can also act as a settling "basin".

d) Lake intake should as much as possible avoid shore water, avoid stirring up of sediments, and seek the clean bottom water.

5.4.4.4 *Sanitary protection:* Chlorination of newly built water supplies is advisable before handing over the water supply to the public.

6 Sampling

Frequency and location of sampling

a) Distances from the source to the testing laboratory should be such as to enable effective supervision of the bacteriological quality of the water supply.

b) Frequency of sampling should be based on (i) size of the population served, (ii) risk of pollution i.e. distance from and nature of pollution source, (iii) nature and extent of sanitary protection of the source.

c) All rural water supplies should be examined at the following intervals:

Table 4 – Frequency of sampling

Type of source/population served	Up to 1,000	Up to 2,000	Up to 5,000
Borehole deeper than 8 m	6 months	4 months	3 months
Well less than 8 m	2 months	1 month	1 month
Surface water, lakes, rivers, springs, dams	1 month	2 weeks	2 weeks

d) The minimum number of samples to be taken from a distribution system is calculated at the rate of one sample per 500 population in addition to the intake or source.

e) The above-prescribed frequency of sampling refers to those water supplies, which on previous examination showed total absence of faecal coli, if the result of bacteriological examination indicates faecal pollution, the water supply in question should be re-examined within a fortnight, at the latest, irrespective of the type of source or population served.

f) Supplier/authority should determine key points on the distribution system from which samples should be collected. On each occasion samples should be taken from different points.

7 Test methods

The test methods shall be carried out according to TZS 574 (Part 1-5) (see clause 2).

Appendix 11

CONTRACT FOR KOLANDOTO BORE HOLE PUMP TESTING
CONTRACT NO. KNH/ WEDECO /2015.01

1.0 AGREEMENT

This AGREEMENT is made on the ..10.....day of Feb 2015 BETWEEN the Kolandoto Hospital (KNH) of P.O BOX 1 SHINYANGA (hereinafter called "the client") of one part

AND

Water and Environmental Development Company (WEDECO Ltd), P. O. Box 125, Shinyanga (hereinafter referred to as "contractor") of the other part.

WHEREAS, the client assigns the contractor to undertake the work of borehole pumping test. The borehole is situated at **Kolandoto** village in Shinyanga Municipality - SHINYANGA REGION. In this particularly assignment three important procedures shall be considered;

- Step - Drawdown Test
- Constant Rate Test and
- Aquifer Recovery Test

Three important variables shall be accurately recorded namely pumping rate; depth to water; and time. All measurements shall be carried out manually and well archived for the future use.

2.0 THE SCOPE OF WORK

Thus, the scope of this assignment is limited to;

- Step draw down test, 4 steps and in each step 1.5 hrs
- Recovery test after step-draw down test
- Constant rate pumping test for 24 hrs
- Recovery test after constant rate test
- Perfect and accurate filling of pumping test forms
- Submission of the pumping test report

3.0 EXPECTED OUTPUTS

At the end of the field work the contractor will produce the final report providing the details of pumping test results. The report shall include the followings:

- Date of start, location of the borehole
- Details of the well
- Drawdown measurements, time of measurement and flow rate

4.0 CONDITIONS OF CONTRACT

4.1 General Conditions.

1. THAT the contractor shall pursue and complete the work in the manner as prescribed in the scope of work.
2. THAT both parties acknowledge and agree that the relationship between the Client and the Contractor is that of Client and an independent contractor.
3. THAT the Contractor will supply all materials and equipment required for performing the work, and the Contractor warrants that all materials for the assignment will be of the best quality and good workmanship.
4. THAT the Contractor must devote sufficient time and attention to ensure proper performance of the job and complete the work on the Completion Date.
5. THAT the client will effect payment to the contractor upon both parties signed the contract and according to the mode of payment.
6. That all works are to be pursued or executed in line with given scope of work as per item 2.0 above.
7. That all disputes that may arise in connection with this agreement and that cannot be settled in a normal mutual discussion shall then be judged through the Tanzanian laws.
8. THAT neither party may terminate this Agreement without cause and in written.

4.2 Prerequisite conditions;

i. The long-term test shall not commence until the water level in the pumped well has fully recovered from the step-drawdown test. The static water level in the pumped well shall also be measured.
ii. The pump rate for the long term test shall be an amount as determined by the step-drawdown test.
iii. Depth to water levels shall be measured at set intervals.
iv. A sufficient number of water level measurements shall be made in the pumped well following termination of the long-term continuous test to establish water-level recovery. Immediately upon termination of the test, the depth to water in the pumped well shall be measured at a frequency that corresponds to the pattern required during the pumping period and for such a period of time required for the water level in the well to recover to within 80 - 90% of the water level observed at the beginning of the test.
v. Water levels in the pumping well will be recorded as per standard forms.

5.0 Contract Period

1. THAT the work shall take one week only to completion as from 21st February to 28th February 2015.
2. THAT this agreement shall become effective when signed by both parties

THE MODE OF PAYMENT

1. The Client shall pay the amount of One million three hundred thirty one thousand forty only Tanzanian Shillings (VAT inclusive) (Tshs 1,331,040/=).
2. The cost includes remunerations, company profits, equipment costs, overhead cost, social charge, insurance, taxes and other costs.
3. There shall be no cost variations allowed for escalation, inflation or any other reasons.
4. The payment shall be made within thirty days (30) after signing the contract
5. The payment will be performed by transferring to the contractor's bank account.

<The contractor's Bank Account>

Name of Account: WEDECO LTD
Account No.: 3073500010
Name of Branch: MANONGA
Name of Bank: National Microfinance Bank
Address of Bank: P.O Box 811, Shinyanga
Swift Code of the Bank: NM1BTZTZ

IN WITNESS WHEREOF, the parties have read this Agreement and approved as an official true binding document for the mutual benefit of both and hereunder substantiated by their hands to legalize the bond.

KOLANDOTO HOSPITAL (CLIENT)

Signed by DR. ELIMELEKI KAFANI

Signature EK Kattani

TITLE MEDICAL OFFICER INCHARGE

Date 20/02/2015

STAMP AFRICA INLAND CHURCH TANZANIA KOLANDOTO COUNCIL ... HOSPITAL BOX 1 KOLANDOTO SHINYANGA TANZANIA

WEDECO LTD (CONTRACTOR)

Signed by Eng. Mwanasha T. Ally

Signature

TITLE General Manager

Date 20/02/2015

STAMP WATER AND ENVIRONMENTAL DEVELOPMENT Co. LTD. WEDECO LTD P.O. Box 125 SHINYANGA

Appendix 12

WEDECO LTD

Your Partner in Development

KOLANDOTO HOSPITAL BOREHOLE PUMPING TEST REPORT

Final Report

WEDECO LTD

Your Partner in Development

P.O. Box 125
Shinyanga
Tel 255 028—2762767
E-mail—wedeco@africaonline.co.tz

MARCH, 2015

ABREVIATIONS/ACRONNOMY

Dr.	=	Doctor
Co	=	Company
Hr	=	hour
LTD	=	Limited
m	=	M
M^3	=	Cubic M
PWL	=	Pumping Water Level
SWL	=	Static Water Level
WEDECO	=	Water and Environmental Development

TABLE OF CONTENTS

Acknowledgement:-

This report is the outcome of efforts of number of individuals and institution. First and foremost WEDECO Ltd acknowledges gratefully the Kolandoto hospital for availing opportunity to participate on its behalf in doing pumping test of the borehole for their water supplies.

WEDECO Ltd is convinced that full cooperation and cooperation of Kolandoto hospital that catalyzed the process of pumping test. We are thankful for their time and information towards the exercise. Their contributions were valuable and contributed to fruitful outputs.

Great appreciations go to the medical officer in charge (Dr. Elimeleki Katani), Mr. Andreas Berg, Mr. Daniel Kallus and Kassim Said who worked with the team during pumping test.

Special appreciations go to the pump test unit experts who worked tirelessly and other who contributed for the whole period of pumping test. Special thanks go to Mr. Yusuf Charamanda and Abdi Adam the operators and Mr. Andrew Kwezi the supervisor.

To all others we did not mentioned but helped in one way or another to make pumping test work been success, please accept our thanks.

1.0 INTRODUCTION:

1.1 Background Information

Kolandoto borehole pumping test report is a result of execution of Contract between WEDECO Ltd (Contractor) and Kolandoto Hospital (Client) for pumping test of the borehole that situated at Kolandoto village which was signed on 20/02/2015 by both two parties (WEDECO Ltd of P. O. Box 125, Shinyanga and Kolandoto Hospital of P. O. Box 1, Shinyanga.

The objective of doing pumping test of the borehole is to determine the capacity of the entire borehole if it can suffice the community around the area (Hospital patients, staff and villagers) demand. This borehole was constructed and put into operations in early 1970s, having total depth of 20 m from the ground level. The borehole had no reference on static water level, quantity of water (yield), maximum water level draw down and recovery after pumping off.

At this moment the borehole is fitted with mono-pump and electric motor which can deliver 10.8m³/hr (according to client test) to the hospital community and neighborhood village communities which are estimated to be 10,000 people, with this population you need to have an average of 250m³/day to suffice their water requirement.

1.2 Location

The borehole is located in Kolandoto village of Shinyanga Municipality in Shinyanga Region; it is about 1 km South West of Kolandoto hospital premises. The hospital is situated at about 14kms North East of Shinyanga Municipal town centre along Shinyanga – Mwanza high way.

1.3 Information from the study

1.3.1 Status of the borehole:

Total borehole depth: 20.0m below ground level.
Static water level: 6.90m below ground level.
Borehole lining size: steel 6 inches diameter.
Pumping water level: 11.62m
Drawdown: 4.72m
Average Yield (discharge rate): 13,000l/hr (first pump) and
Average Yield (discharge rate): 23,290l/hr (Second pump)

1.3.2 Status of the mono pump and pump riser and rods:

The pump and motor are in good working conditions, it delivers 10.8m³/hr which is equivalent to 259.2m³/day if pumping for 24 hrs nonstop.

2.0 DATA COLLECTION AND ANALYSIS

2.1 PUMPING TEST DATA COLLECTION

A pumping test was conducted on 21st February 2015; using a pumped well as an observation well. The discharge rate of the well was monitored using a 22 litres bucket and stopwatch. A calibration test was used to determine the step test from which a constant rate discharge was established by changing pumps of different capacities (from $13m^3/hr$ to $23.29m^3/hr$.

2.2 CONSTANT RATE DISCHARGE TEST:

During the pumping test water level drawdown was monitored in the pumped well and the drawdown data was collected using a sound transducer electric well sounder. After about 8.15 hours of pumping the borehole with $23.29m^3/hour$; noticeable drawdown was observed and hence establishing a maximum pumping water level (**Max.PWL**). The two hours duration each to determine the discharge of the constant rate discharge for the pump with 13,000l/hr and 6.15hrs duration each to determine the discharge for the pump with 23,290l.hr. All the data collected from the well during the test are attached. The water level recovery for this borehole resume up to 7.50m in one hour time against the static water level of 6.90m, which signifies that the well has determined sufficient yield.

3.0 CONCLUSIONS AND RECOMMENDATIONS:

3.1 CONCLUSIONS:

i) The Kolandoto hospital borehole is at about 50m from the river valley whereby the former abandoned water source (shallow well) situated which was fitted with surface pump. In Shinyanga these months of December to April are the rain season; therefore the results of the pumping test observed are termed as of rain season; in this case we suggest another well pumping test to be done during dry season to determine average well yield (ground water recharge) for the all two seasons.

ii) The present results from the pumping test analysis indicate that the borehole area is suitable for water supply development and it is anticipated that if sited more down to the river valley you may strike more water. This comment was built up since the borehole depth of 20m is too shallow, the tapped aquifer (formation) might be dried up if there is long drought (short rain season).

iii) Due to estimated population at the entire area; new pump of big capacity may be purchased and installed after a comprehensive survey, system redesigning of the transmission main and distribution network.

iv) Chemical analysis and bacteriological tests are recommended for in-future borehole record and for disinfections whenever required.

CONSTANT RATE PUMPING TEST DATA SHEET

Well number	:____________________	Aquifer	:____________m -gl
Name of well	:____________________	Casing	:__________________m -gl
Location (coordinates)	:__________E/__________N	Screen	:__________________m -gl
Sub Village	:KOLANDOTO	Open Hole	:__________________m -gl
Village	:KOLANDOTO	Diameter Casing	: 6 "
Ward	:KOLANDOTO	Diameter Screen	: 6 "
District	:SHINYANGA (MC)	Pump Type	: SUBMERSIBLE
Total depth of well	:20 M	Depth Pump Inlet	: 19 M m -gl
Abstraction well		Initial Water Level	: 6.90 M m -rl
Elevation ground level	:_______M	Reference Level	: 0.3 M m+gl
Date	**: 21/02/2015 to 21/02/2015**		

PUMPING RATE 13 m^3/hr					**RECOVERY**				
Time	**Elapsed Time (t) Minutes**	**Water Level Below Ref. level m**	**Draw Down (s) m**	**Discharge (Q) l/h**	**Time**	**Elapsed Time (t) Minutes**	**Water level Below Ref level**	**Residual Draw down (s)m**	**Calculated Recovery**
13.00	0.0	6.90		13m^3/h		0.0			
	0.5					0.5			
	1.0					1.0			
	1.5					1.5			
	2.0					2.0			
	2.5					2.5			
	3.0					3.0			
	3.5					3.5			
	4.0					4.0			
	4.5					4.5			
	5	8.70		13m^3/h		5			
	6					6			
	7					7			
	8					8			
	9					9			
	10	9.02		13m^3/h		10			
	12					12			
	14					14			
	16					16			
	18					18			
	20	9.21		13m^3/h		20			
	25	9.30				25			
	30	9.52		13m^3/h		30			
	35					35			
	40					40			
	45					45			
	50					50			
14.00	60					60			
	70					70			
	80					80			
	90					90			
	100					100			
	110					110			
15.00	120	9.69		13m^3/h		120			

Remarks:

.

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SVENSK INSAMLINGS KONTROLL 90 KONTO

CONSTANT RATE PUMPING TEST DATA SHEET

Well number	:______________________	Aquifer	:_____________m -gl
Name of well	:______________________	Casing	:____________________m -gl
Location (coordinates)	:__________E/__________N	Screen	:____________________m -gl
Sub Village	:KOLANDOTO	Open Hole	:____________________m -gl
Village	:KOLANDOTO	Diameter Casing	: 6 "
Ward	:KOLANDOTO	Diameter Screen	: 6 "
District	:SHINYANGA (MC)	Pump Type	: SUBMERSIBLE
Total depth of well	:20 M	Depth Pump Inlet	: 19 M m -gl
Abstraction well		Initial Water Level	: 8.50 M m -rl
Elevation ground level	:________M	Reference Level	: 0.3 M m+gl
Date	**: 21/02/2015 to 21/02/2015**		

PUMPING RATE 23.29 m^3/hr					**RECOVERY**				
Time	**Elapsed Time (t) Minutes**	**Water Level Below Ref. level m**	**Draw Down (s) m**	**Discharge (Q) l/h**	**Time**	**Elapsed Time (t) Minutes**	**Water level Below Ref level**	**Residual Draw down (s)m**	**Calculated Recovery**
15.45	0.0	8.50		23.29m^3/h	22.00	0.0	11.62	4.72	
	0.5					0.5			
	1.0					1.0			
	1.5					1.5			
	2.0					2.0			
	2.5					2.5			
	3.0					3.0			
	3.5					3.5			
	4.0					4.0			
	4.5					4.5			
	5	10.25		23.29m^3/h		5	8.50	1.60	
	6					6	8.29	1.39	
	7					7	8.20	1.30	
	8					8	8.13	1.23	
	9					9	8.09	1.19	
	10	10.27		23.29m^3/h		10			
	12					12			
	14					14			
	16					16			
	18					18			
	20					20	7.81	0.91	
	25	10.42		23.29m^3/h		25	7.74	0.83	
	30					30			
	35					35	7.64	0.50	
	40	10.71		23.29m^3/h		40			
	45					45	7.57	0.67	
	50	11.28				55	7.50	0.60	
16.45	60	11.28		23.29m^3/h	23.00	65	7.46	0.56	4.16
	70					70			
Remarks:									

CONSTANT RATE PUMPING TEST DATA SHEET

Well number	:______________________	Aquifer	:______________m -gl
Name of well	:______________________	Casing	:____________________m -gl
Location (coordinates)	:__________E/__________N	Screen	:____________________m -gl
Sub Village	:KOLANDOTO	Open Hole	:____________________m -gl
Village	:KOLANDOTO	Diameter Casing	: 6 "
Ward	:KOLANDOTO	Diameter Screen	: 6 "
District	:SHINYANGA (MC)	Pump Type	: SUBMERSIBLE
Total depth of well	:20 M	Depth Pump Inlet	: 19 M m -gl
Abstraction well		Initial Water Level	: 6.90 M m -rl
Elevation ground level	:________M	Reference Level	: 0.3 M m+gl
Date	**: 21/02/2015 to 21/02/2015**		

PUMPING RATE 23.29 m^3/hr					RECOVERY				
Time	**Elapsed Time (t) Minutes**	**Water Level Below Ref. level m**	**Draw Down (s) m**	**Discharge (Q) l/h**	**Time**	**Elapsed Time (t) Minutes**	**Water level Below Ref level**	**Residual Draw down (s)m**	**Calculated Recovery**
	80	11.28		23.29m^3/h		80			
	90	11.62		23.29m^3/h		90			
	100					100			
	110					110			
17.45	120	11.62		23.29m^3/h		120			
	150					150			
18.45	180	11.62		23.29m^3/h		180			
	210					210			
19.45	240	11.62		23.29m^3/h		240			
	270					270			
20.45	300	11.62		23.29m^3/h		300			
21.45	360	11.62		23.29m^3/h		360			
22.00	420	11.62		23.29m^3/h		420			
	480					480			
	540					540			
	600					600			
	660					660			
	720					720			
	780					780			
	840					840			
	900					900			
	960					960			
	1020					1020			
	1080					1080			
	1140					1140			
	1200					1200			
	1260					1260			
	1320					1320			
	1380					1380			
	1440					1440			

Remarks:

.

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SVENSK INSAMLINGS KONTROLL 90 KONTO

PUMPING TEST SIGN OFF RECORD SHEET

Borehole No.: ______________ **Village:** KOLANDOTO **District:** SHINYANGA MC

Site Supervisor: __________________________

Pump Test by: WEDECO LIMITED **On Site Personnel:** YUSUPH CHARAMANDA

Weather: RAIN

BOREHOLE DATA

Depth of Open Borehole (m) ____________

Casing Depth (m): From:_______________ To:________________

Casing Diameter (m):________________ 6 ”.

Screen Depth (m) : From:_______________ To:_______________

Screen Diameter:_________________ 6 ” .

S.W.L (m). :__________________ 6.90m.

(before start of test)

PUMPING TEST DATA

Type of Test

Step test √	Constant Discharge √	Others

If other, Explain:____

Pump Type: **SUBMERSIBLE** Pump Diam(m): 1.5

Pump intake Depth (m):________ 19m.

Discharge measured using:

Flow meter	v-Notch	44 gallon Drum / Bucket

Discharged pipe used:

YES √ NO	Length (m) 15m

TESTING INFORMATION

Start Date: 21/02/2015 Finish Date: 21/02/2015

Pumping Test

Start Time: 13.00 Finish Time: 15.00

Test Length (hrs) 1 hrs

Recovery Test

Start Time: 15.00 Finish Time: 15.45

Test Length (hrs): 0.45 hr.

COMMENTS / PROBLEMS

____

____

Hydrogeologist / Supervisor: __________________Contractor Incharge_______________

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SVENSK INSAMLINGS KONTROLL 90 KONTO

PUMPING TEST SIGN OFF RECORD SHEET

Borehole No.: ______________ **Village:** KOLANDOTO **District:** SHINYANGA MC

Site Supervisor: __________________________

Drilling Company: WEDECO LIMITED **On Site Personnel:** YUSUPH CHARAMANDA

Weather: RAIN

BOREHOLE DATA

Depth of Open Borehole (m) ____________

Casing Depth (m): From:_______________ To:________________

Casing Diameter (m):_______________6".

Screen Depth (m) : From:_______________ To:_______________

Screen Diameter:__________________6".

S.W.L (m). :_________________8.50m.

(before start of test)

PUMPING TEST DATA

Type of Test

Step test √	Constant Discharge √	Others

If other, Explain:____

Pump Type: **SUBMERSIBLE** Pump Diam(m): 1.5

Pump intake Depth (m):________19m.

Discharge measured using:	**Flow meter**	**v-Notch**	**44 gallon Drum / Bucket**
Discharged pipe used:	**YES** √ **NO**	**Length (m) 15m**	

TESTING INFORMATION

Start Date: 21/02/2015 Finish Date: 21/02/2015

Pumping Test

Start Time: 15.45 Finish Time: 22.00

Test Length (hrs) 6.15 hrs

Recovery Test

Start Time: 22.00 Finish Time: 23.00

Test Length (hrs): 1 hr.

COMMENTS / PROBLEMS

____

____

Hydrogeologist / Supervisor: ____________Contractor Incharge______________

Appendix 13

Amani M. Hkulo
0754 484965
amanihkulo@gmail.com

DATA sheet: Enter general info and data of constant rate pumping test and recovery (optional)

Country:	Tanzania	Geology:	Sedmentary
Region:	Shinyanga	Depth of BH:	20
Owner:	Kolandoto	Water strikes:	12 and 16
X-coord:		Date of Test:	Feb-15
Y-coord:		Contractor:	WEDECO

CONSTANT RATE TEST DATA : enter values in cells which are coloured light yellow

Borehole: **BACL**

Distance from Rest WL to main water strike (m) = 16 | S_{max}= 11.6 | Recom. AD = 13.6

AD= available drawdown for managing the borehole

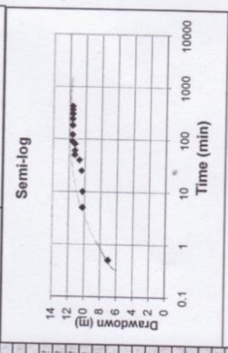
AD = 12 | Time (y) = 2

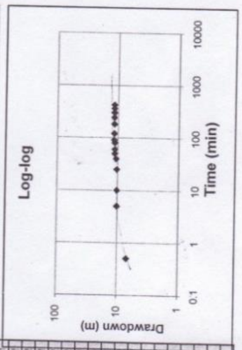
T (m^2/d) : Logan eq. 58.1 | time = extrapolation time

Q (l/s)= 6.4

Recovery data

t (min)	s (m)	avg s'	avg s"	avg T	avg S	Time t'	Res_s	t/t'	Wl rise	s'	Rec_T
0.50	7					0.5	11.62	5401	0		
1.00						1		2701	11.62	25.89	
1.50		#####	#NUM!			1.5		1801	11.62	0.00	
2.00		#####	#NUM!	#NUM!	0.00E+00	2		1351	11.62	0.00	#DIV/0!
3.00		#####	#NUM!	#NUM!	0.00E+00	2.5		1081	11.62	0.00	#DIV/0!
4.00		#####	#NUM!	#NUM!	0.00E+00	3		901	11.62	0.00	#DIV/0!
5.00	10.25	#####	#NUM!	#NUM!	0.00E+00	4		676	11.62	-36.51	#NUM!
6.00		#####	#NUM!	#NUM!	0.00E+00	5	8.5	541	3.12	-48.57	#NUM!
7.00		#####	#NUM!	#NUM!	0.00E+00	6	8.29	451	3.33	2.07	#NUM!
8.00		#####	#NUM!	#NUM!	0.00E+00	7	8.2	386.7	3.42	1.28	72.8
9.00		#####	#NUM!	#NUM!	0.00E+00	8	8.13	338.5	3.49	1.01	21.3
10.00	10.27	#####	#NUM!	#NUM!	0.00E+00	9	8.09	301	3.53	82.27	5.1
11.00		#####	#NUM!	#NUM!	0.00E+00	10		271	11.62	94.30	#NUM!
12.00		#####	#NUM!	#NUM!	0.00E+00	11		246.5	11.62	0.00	#NUM!
14.00		#####	#NUM!	#NUM!	0.00E+00	12		226	11.62	0.00	#NUM!
20.00		#####	#NUM!	#NUM!	0.00E+00	15		181	11.62	-36.49	#NUM!
25.00	10.42	#####	#NUM!	#NUM!	0.00E+00	20	7.81	136	3.81	-36.19	#NUM!
30.00		#####	#NUM!	#NUM!	0.00E+00	25	7.74	109	3.88	42.75	#NUM!
35.00		#####	#NUM!	#NUM!	0.00E+00	30		91	11.62	3.61	#NUM!
40.00	10.71	#####	#NUM!	#NUM!	0.00E+00	35	7.64	78.14	3.98	-2.92	#NUM!
45.00		#####	#NUM!	#NUM!	0.00E+00	40		68.5	11.62	3.55	#NUM!
50.00	11.28	#####	#NUM!	#NUM!	0.00E+00	45	7.57	61	4.05	-2.90	#NUM!
55.00		#####	#NUM!	#NUM!	0.00E+00	50		55	11.62	3.69	#NUM!
60.00	11.28	#####	#NUM!	#NUM!	0.00E+00	55	7.5	50.09	4.12	-57.99	#NUM!
70.00		#####	#NUM!	#NUM!	0.00E+00	65	7.46	42.54	4.16	59.56	#NUM!
80.00	11.28	#####	#NUM!	#NUM!	0.00E+00	70		39.57	11.62	72.85	#NUM!
90.00	11.62	#####	#NUM!	#NUM!	0.00E+00	80		34.75	11.62	0.00	#DIV/0!
100.00		#####	#NUM!	#NUM!	0.00E+00	90		31	11.62	#####	#DIV/0!
110.00		#####	#NUM!	#NUM!	0.00E+00			#####	#####	#####	#DIV/0!
120.00	11.62	#####	#NUM!	#NUM!	0.00E+00			#####	#####	#####	#DIV/0!
140.00		#####	#NUM!	#NUM!	0.00E+00			#####	#####	#####	#DIV/0!
160.00		#####	#NUM!	#NUM!	0.00E+00			#####	#####	#####	#DIV/0!
180.00	11.62	#####	#NUM!	#NUM!	0.00E+00			#####	#####	#####	#DIV/0!
210.00		#####	#NUM!	#NUM!	0.00E+00			#####	#####	#####	#DIV/0!
240.00	11.62	#####	#NUM!	#NUM!	0.00E+00			#####	#####	#####	#DIV/0!

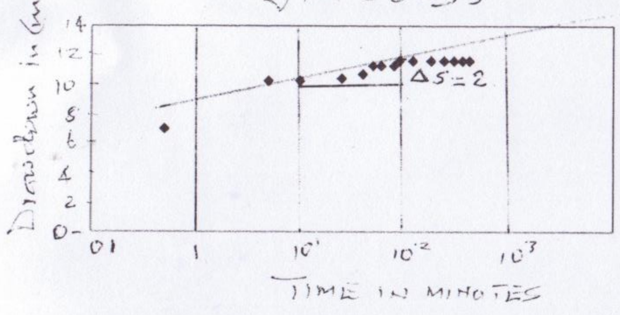




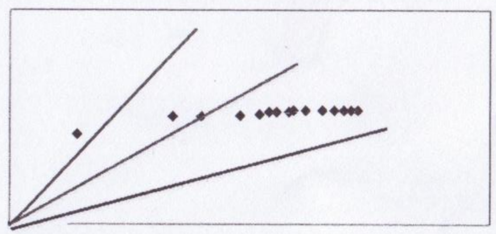
KULANDOID HOSPITAL BH. 21st FEB 2015

DIAGNOSTIC PLOTS

JACOBS



THEIS



$$kD = T = \frac{2.30Q}{4\pi\Delta s}$$

$$\text{Transmissivity} = \frac{2.30 \times 23}{4 \times \pi \times 2} = \frac{52.9}{25.12} = 2.11\,m^2/day$$

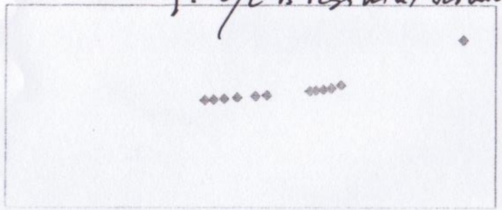
∴ Permeability = KD

In our case D = 12 ms.

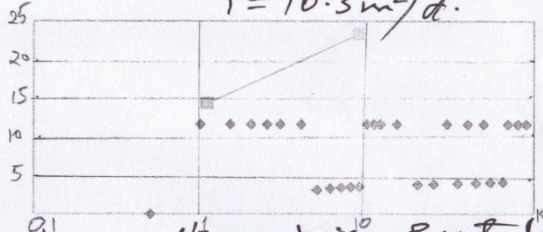
Thus $kD = 2.11\,m^3/D$

$$K = \frac{2.11}{12} = 0.176\,m/Day$$

Recovery: t/t' vs residual drawdown



Recovery Transmissivity
T = 10.3m²/d.



t' against rise of water level.

NB The recovery Transmissivity value is fairly high, which gives a range of 10.3m²/d. This indicate a very good aquifer material which releases its water very easily.

This is a high capacity well. However, Considering other factors such as rainfall reliability (ie unpredictable recharge potential) we may recomend the long term pumping rate to be bellow 20m³/hr.

17th M-2015

Appendix 14

PROFOMA ~~TAX~~ INVOICE

No. 0256

Date: 13/2/15

M/S: KOLANDOTO HOSPITAL
BOX 1 KOLANDOTO

SHY BUILDERS

P.O. BOX 187 - SHINYANGA.
Phone/Fax: 028 – 2763361 Cell: 0788 – 038888/ 0713 – 310111
TIN: 101 – 669 – 939 VRN: 27 – 011808 – K

Qty	Particulars	@	TShs
	Mobilization & Flushing Of Borehole at Kolandoto Hospital.		900,000/-
	900,000/-		
	SUB TOTAL		
	VAT 18%		
E&O.E	GRAND TOTAL		900,000/-

Appendix 15

Inventory list for hospital's electric appliances:

Appliance	Amount	Load [W]	Total load [W]		Critical level
General Theatre					**1**
Sterilization Unit	1	1600	1600		
Sterilization for caps	1	500	500		
Light (tube)	21	36	756		
Operation lights (small)	2	150	300		
Operation lights (large)	2	250	500		
Operation bed	2	240	480		
Air condition	2	2000	4000		
Electro surg. Generator	2	1000	2000		
Suction pump	1	220	220		
Anastacia machine	2	1500	3000		
Water boiler	1	2000	2000		
TOTAL			15356		
Sterilization Room					**2**
Circuit for sterilization unit	1	18000	18000		
Destillator	1	1650	1650		
Light (tube)	2	36	72		
Rainwater pump	1	550	550		
TOTAL			20272		
Dental care					**2**
Autoclave	1	2200	2200		
Dental chair	1	2000	2000		
X-Ray	1	1150	1150		
X-Ray Box	1	840	840		
Under chair	1	535	535		
Drill wash	1	40	40		
Light (tube)	3	36	108		
UV-light	1	57,5	57,5		
Compressor	1	1560	1560		
TOTAL			8490,5		
Eye Theatre					**1**
Operation light	1	150	150		
Anastacia machine	1	280	280		
Light (tube)	10	36	360		

Light (bulb)	3		0		
Microscope	1	20	20		
Air condition	1	1320	1320		
Sterilization unit	1	1600	1600		
Water boiler	1	2400	2400		
Flat screen TV	1	190	190		
TOTAL			6320		
Eye Ward					**2**
Sterilization Unit	1	1600	1600		
TV	1	150	150		
Microscope	1	20	20		
Extra lamp	1	60	60		
Bokstavsskylt	2	20	40		
Light (tube)	10	36	360		
TOTAL			2230		
OPD Pharmacy					**3**
Lights (tube)	2	36	72		
Water boiler	1	1000	1000		
TOTAL			1072		
Laboratory					**1**
Hot oven	1	550	550		
Centrifuge	1	660	660		
Analyser	1	100	100		
Air condition	2	980	1960		
Battery	1	670	670		
UPS Battery	1	1495	1495		
Fridge	1	57	57		
Sterilization Unit	1	1250	1250		
Centrifuge	1	308	308		
Biochemical analyser	1	90	90		
Microscope	4	60	240		
Incubator	1	500	500		
Water boiler	1	2200	2200		
Fridge	2	180	360		
Freezer	1	114	114		
Lights (tube)	6	36	216		
TOTAL			10770		
Social Hall					**3**
Lights (tube)	16	36	576		
Lights (bulb)	1		0		
TV	1	150	150		

TOTAL			726		
Pharmacy					**1**
Fridge	1	118	118		
Light (tube)	5	36	180		
TOTAL			298		
Ultrasound					
Ultrasound unit	1	1200	1200		**2**
Light (tube)	1	36	36		
Light (bulb)	1		0		
TOTAL			1236		
X-Ray					**2**
Unit	1	100	100		
Lift	1		0		
Light (tube)	1	36	36		
Light (bulb)	2		0		
Fan	1	45	45		
TOTAL			181		
IV-Production					**3**
Sterilization unit	1	1250	1250		
Purifier	1	370	370		
Compressor	1	120	120		
Autoclave	1	2000	2000		
Autoclave	1	2000	2000		
TOTAL			5740		
Laundry					**3**
Laundry machine	2	12800	25600		
Light (tube)	8	36	288		
TOTAL			25888		
Administration					**3**
Light (tube)	6	36	216		
Computer	5	100	500		
Screen	5	30	150		
Cooking plate	1	2200	2200		
Printer	4	10	40		
Scanner	2	25	50		
Fan	2	45	90		
Phone system	1	120	120		
Router	2	12	24		
TOTAL			3390		
Maternity					**1**
Light (tube)	19	36	684		

Light (bulb)	7		0		
Warming machine babies	2	800	1600		
Oxygen machine	1	320	320		
Suction pump	1	90	90		
Washing machine	1	470	470		
Water boiler	1	2000	2000		
Fridge	1	75	75		
Oxygen machine	1	320	320		
TOTAL			5239		
Private Ward					**1**
Oxygen machine	1	320	320		
Light (tube)	22	36	792		
TOTAL			1112		
Care Treatment Clinic					**3**
Light (tube)	13	36	468		
Fan	2	45	90		
Computer	2	100	200		
Screen	2	30	60		
Printer	1	10	10		
Router	1	12	12		
TV	1	150	150		
TOTAL			990		
Paediatrics					**1**
Light (tube)	15	36	540		
Oxygen machine	1	320	320		
TOTAL			860		
General Ward					**1**
Lights (tube)	41	36	1476		
Oxygen machine	1	320	320		
TOTAL			1796		
Reproductive and Child Health					**1**
Lights (tube)	16	36	576		
Fridge for vaccines	1	300	300		
TOTAL			876		
Mortuary					**3**
Lights (tube)	3	36	108		
Fridge for three bodies	1	600	600		
TOTAL			708		
Outside					**3**
Lights (tube)	17	36	612		
TOTAL			612		

Stores outside entrance					**3**
Lights (tube)	21	36	756		
Fridge	12	57	684		
Freezer	7	114	798		
Copy machine	2	10	20		
Fan	1	45	45		
Computer	1	100	100		
TV	1	150	150		
Stereo	1	150	150		
TOTAL			2703		
Total for hospital			116865,5		W
			116,9		kW

SVENSK INSAMLINGS KONTROLL 90 KONTO

I Aid Africa®

Appendix 16

GENERAL THEATRE

Appliances	*Critical time*
Sterilization Unit	24 hours
Sterilization for caps	8 hours
Light (tube)	0 min
Operations lights (small)	0 min
Operations lights (large)	0 min
Operation bed	0 min
Air condition	0 min
Electro surg. Generator	30 min
Suction pump	20 min
Anastacia machine	0 min
Water boiler	8 hours

EYE THEATRE

Appliances	*Critical time*
Operation light	0 min
Anastacia machine	0 min
Light (tube)	0 min
Light (bulb)	0 min
Microscope	0 min
Air condition	0 min
Sterilization unit	0 min
Water boiler	0 min
Flat screen TV	8 hours

LABORATORY

Appliances	*Critical time*
Hot oven	0 min
Centrifuge	0 min
Analyser	0 min
Air condition	1 hour
Battery	0 min
UPS battery	20 min
Fridge	4 hours
Sterilization Unit	6 hours
Centrifuge	0 min
Biochemical analyser	0 min

Microscope	0 min
Incubator	0 min
Water boiler	45 min
Fridge	4 hours
Freezer	6 hours
Lights (tube)	0 min

PHARMACY

Appliances	*Critical time*
Fridge	0 min
Lights (tube)	30 min

MATERNITY

Appliances	*Critical time*
Lights (tube)	0 min
Lights (bulb)	0min
Warming machine babies	20 min
Oxygen machine	0 min
Suction pump	0 min
Washing machine	12 hours
Water boiler	30 min
Fridge	4 hours
Oxygen machine	0 min

PRIVATE WARD

Appliances	*Critical time*
Lights (tube)	0 min
Oxygen machine	0 min

PEDIATRICS

Appliances	*Critical time*
Lights (tube)	0 min
Oxygen machine	0 min

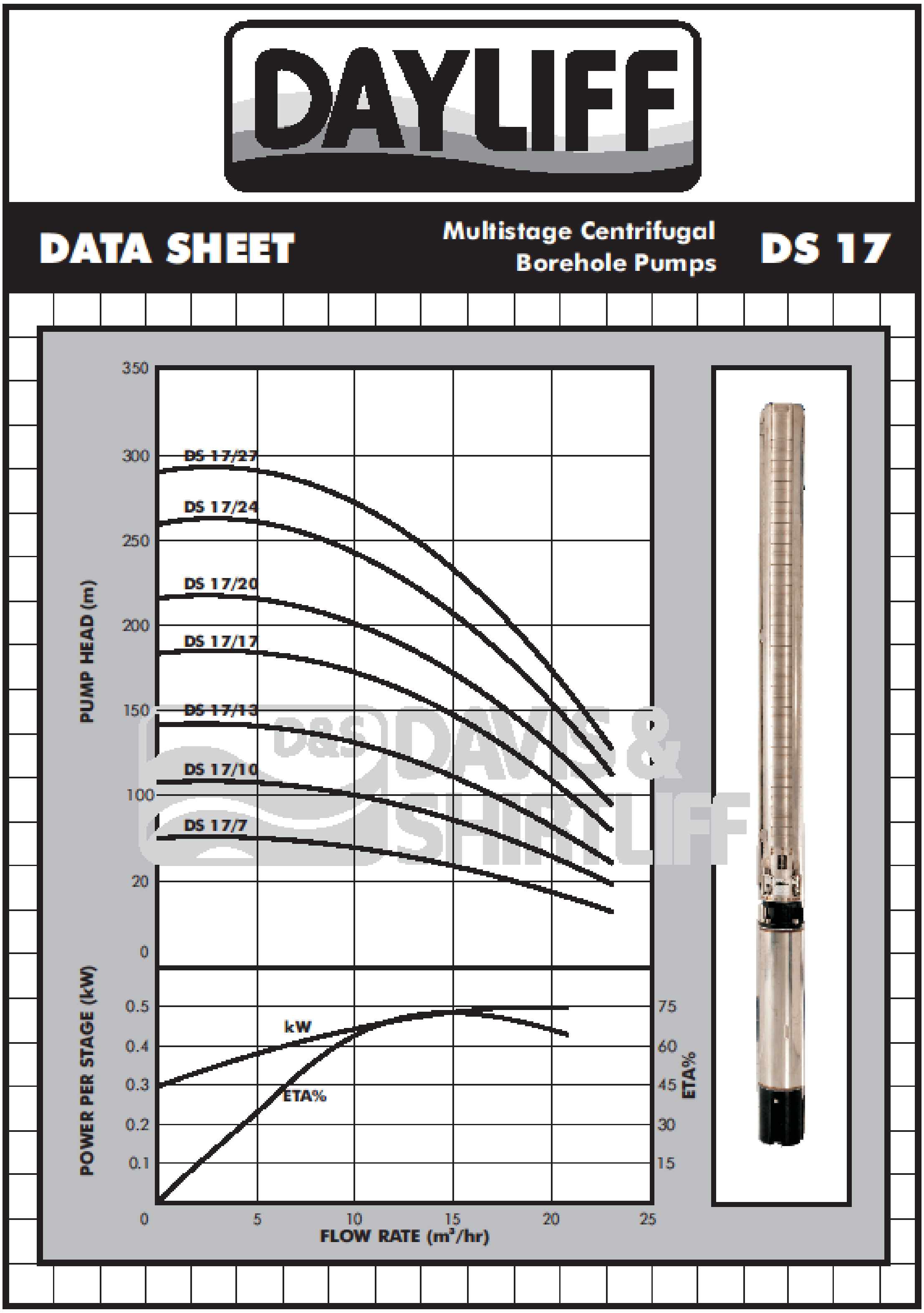
GENERAL WARD

Appliances	*Critical time*
Lights (tube)	0 min
Oxygen machine	0 min

REPRODUCTIVE AND CHILD HEALTH

Appliances	*Critical time*
Lights (tube)	0 min
Fridge for vaccines	0 min

Appendix 17


DAYLIFF
DATA SHEET
Multistage Centrifugal Borehole Pumps
DS 17
PUMP HEAD (m)
350
300
250
200
150
100
20
0
DS 17/27
DS 17/24
DS 17/20
DS 17/17
DS 17/13
DS 17/10
DS 17/7
POWER PER STAGE (kW)
0.5
0.4
0.3
0.2
0.1
0
kW
ETA%
75
60
45
30
15
0
5
10
15
20
25
FLOW RATE (m³/hr)
D&S DAVIS & SHIRTLIFF

PUMP

DAYLIFF DS submersible pumps are designed specifically for borehole supply applications. They are of multistage centrifugal impeller design and all parts are made from stainless steel with water lubricated rubber bearings. A submersible motor is fitted beneath the pump and suction is effected through a strainer between the pump and motor.

MOTOR

The pump is coupled to a sealed liquid cooled 2-pole asynchronous squirrel cage motor constructed from stainless steel. The motor requires a remote starter and if unstable supply voltage is likely, an additional quick tripping control relay is recommended. Note that due to low starting torques of submersible motors, it is recommended that DOL starters are used.

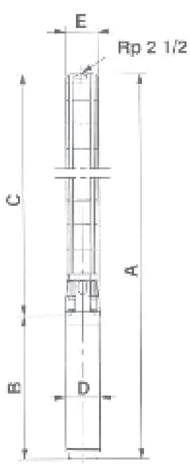
Enclosure Class: IP68 ***Insulation Class:*** F ***Speed:*** 2900rpm

OPERATING CONDITIONS

Pumped Liquid: Thin, clean chemically non-aggressive liquids without solid particles or fibres.
Max. Liquid Temperature: +40°C
Max. Water Depth: 300 m
Min. Borehole Diameter: 150 mm

ELECTRICAL DATA

Model	Motor		Full Load Current (A)	I start / I
	kW	HP		
DS 17-7	4	5.5	10.2	5.4
DS 17-10	5.5	7.5	13.1	5.3
DS 17-13	7.5	10	16.9	5.0
DS 17-17	9.2	12.5	22.8	4.2
DS 17-20	11	15	26	4.8
DS 17-24	15	20	34.2	5.0
DS 17-27	15	20	34.2	5.0



DIMENSIONS AND WEIGHT

Model	Dimensions (mm)				Weight (Kg)
	A	B	C	E*	
DS 17-7	1320	614	706	131	36.7
DS 17-10	1571	684	887	131	44.6
DS 17-13	1833	764	1069	142	53
DS 17-17	1996	685	1311	142	77.2
DS 17-20	2222	730	1492	142	85.5
DS 17-24	2519	785	1734	142	97.3
DS 17-27	2701	785	1916	142	101.7

E*=Maximum diameter of the pump inclusive of cable guard and motor

 DS148B-10/12

KENYA

KENYA COAST

ETHIOPIA

RWANDA

UGANDA

TANZANIA

ZAMBIA

SOUTH SUDAN

Appendix 18

DAVIS & SHIRTLIFF

know HOw through experience

Water Pumps
Borehole Service
Swimming Pools
Water Treatment
Generators
Solar Equipment

DAVIS & SHIRTLIFF (TZ) LTD • PO Box 2877, Mwanza, TANZANIA • Tel. (+255 28) 2541071/2 • Fax. (+255 28) 2541071 • Dmwanza@dayliff.com

PROFORMA INVOICE

Ref.P/MM/046/15
March 9, 2015

OUR VAT REG. No.:10-005498-I
OUR TIN No.:100-147-785

Andreas Berg
P.O. Box
Shinyanga

RE: QUOTATION FOR SUPPLY ONLY OF DIESEL GENERATOR

Reference is made to your request regarding the supply of Diesel generator to use as a backup of electricity, and now we have the pleasure in fowarding our quotation, terms and conditions as follows;

ITEM	DESCRIPTION	QTY	UNIT PRICE	DISC.	NETT (Tshs)
01	Yanan DGY 17F, 21kVA, 3ph diesel generator	1	20,240,000	10%	18,216,000
			SUB TOTAL		18,216,000
			VAT 18%		3,278,880
			TOTAL (Tshs)		21,494,880

Availability: 8 to 10 working weeks from date of confirmation of order (Subject to Date of confirmation of order)
Payment: 70% with order, 30% on collection
Validity: Subject to confirmation on the date of payment.
Warranty: Subject to our standard terms of warranty.

We trust you find our proposals of interest and look forward to your further instructions in due course.

Yours faithfully,
for Davis & Shirtliff (T) LTD,

Mringi Msangi
0757 997842
Mringi.Msangi@dayliff.com

,

I Aid Africa®

Appendix 19

WATER SOLUTIONS
DRILLING COMPANY LTD.

New Safari Hotel (Commercial Wing), First Floor, Room 202 & 221, P. O. Box 2780, Arusha - Tanzania.
Tel: +255 27 2545444 | Fax +255 27 2545693 | E-Mail: info@watersolutionstz.com | Website: www.watersolutionstz.com

PROFORMA INVOICE NO. 247

TIN No.102 - 386 - 094

VAT Reg. No. 11 - 012441 - G

DATE: 05.03.2015

Messrs:
Kolandoto Hospital
P. O. Box
Shinyanga.

Item no.	Description	Unit	Qty	Unit price Tshs	Total price Tshs
1.0	Mobilization and demobilization of staff and drilling equipment.	Numb.	1	5,000,000.00	5,000,000.00
2.0	Drilling a 8" pilot hole down to 100 meters (by both DTH and mud methods)	Mts	100	85 000.00	8 500,000.00
3.0	Reaming an 8" production hole down to 100 meters (by both DTH and mud methods)	Mts	100	30,000.00	3 000,000.00
4.0	Reaming a 10" production hole and installing permanent still casings (by both DTH and mud methods)	Mts	0	55 000.00	
5.0	Costs for 9" permanent steel casings	Mts	0	105,000.00	-
6.0	Costs for 6" OD upvc plain casings	Mts	75	55,000.00	4,125,000.00
7.0	Costs for 6" OD upvs screen casings	Mts	25	60,000.00	1,500,000.00
8.0	Installation costs of UPVC casings	Mts	100	3,000.00	300,000.00
9.0	Drilling materials	Numb.	1	800,000.00	800,000.00
10.0	Gravel surrounding borehole	Kgs	7 000	90.00	630,000.00
11.0	Borehole development till clean water is observed	Hrs	4	80,000.00	320,000.00
12.0	Step drawdown test	Hrs	4.5	100,000.00	450,000.00
13.0	Water level recovery	Hrs	4	100,000.00	400 000.00
14.0	Constant discharge pumping test	Hrs	12	100,000.00	1,200 000.00
15.0	Cement grouting	Numb.	1	150,000.00	150 000.00
16.0	Well head construction	Numb.	1	150,000.00	150 000.00
17.0	Water chemical analysis	Numb.	1	200 000.00	200 000.00
18.0	Completion report	Numb.	1	50 000.00	50 000.00
19.0	Security of equipment at site	Numb.	1	200 000.00	200 000.00
				Total	26.975.000.00
				VAT 18%	4,855.500.00
				Grand Total	31,830.500.00

your partner in underground water exploration

I Aid Africa®

SVENSK INSAMLINGS KONTROLL

Momella Road
PO Box 189
USA River, TZ

MAJI TECH ENGINEERING LTD

QUOTATION

MAJI-TECH ENGINEERING LTD. P.O Box 189 USA River, Tanzania		
Client: Kolandoto Hospital Shinyanga Address: Shinyanga	Location: At the hospital in Shinyanga Est. Depth: 100 Meters Casing: 5" PVC	Date: 06/03/2015 Quote #: 03/03/DR/15 Reference: Andreas Berg berg.andreaas@gmail.com

BILL OF MATERIALS AND LABOR

	Description of Work			Total ($)	
1	**Mobilization**			2,100	
2	**Drilling** - Drilling to Depth, Development, Yield Estimate, Completion Report & Water Analysis			7,685	**
3	**Materials** - Surface Casings, Screen, Casings, Gravel Pack & Drilling Additives 1.5 meters of surface casing left in ground			3,145	*
	Standby time caused by another entity	1 day	400		
			Sub Total	12,930	
			Discount	-542	
			18% VAT	0	
	TOTAL AMOUNT QUOTED			12,389	***

QUOTATION VALID FOR 30 DAYS

* If Galvanized Steel Pipe is required to case there will be an additional charge of 3,720 USD to cover the additional cost.

**Denotes a variable cost that could increase or decrease Final Bill

***Can be payed in Tsh at the USD Buying Rate on the date of payment.

By signing the quotation and/or paying the 60% deposit, the client agrees to MTE terms & conditions and the fees quoted.

Company Name: ____________________

Date and Signature: ____________________

	BILL OF QUANTITIES FOR BOREHOLE DRILLING SPARR DRILLING				
Client Name:	Andreas Berg		***Date :***	5.3.2015	
B/Hole Contract:	Shinyanga		***File Ref:***		
Item	**Description**	**Qty**	**Unit**	**Rate USD**	**Total USD**
1	Allow for the cost of transporting all equipment, and personnel to site and demobilisation at completion of contract	1	Sum	1 000,00	1 000,00
2	Shifting between sites	0	Sum	150,00	0,00
3	Setting up and dismantling of the rig at the drilling site.	1	Sum	150,00	150,00
4	Drilling 8.5" diameter borehole from 0-100m depth	100	m	80,00	8 000,00
4,1	Drilling 8.5" diameter borehole from 100-200m depth	0	m	90,00	0,00
4,2	Drilling 8.5" diameter borehole from 200-300m depth	0	m	100,00	0,00
4,3	Drilling 8.5" diameter borehole above 300m depth if necessary.	0	m	0,00	0,00
5	Water for drilling and				

	camp use, maintenance of storage tanks, water injection systems and usage of drilling foam	1	Sum	65,00	65,00
6	Supply and Install 160mm dia plain uPVC casings	70	m	10,00	700,00
7	Supply and Install 160mm screen uPVC casings	30	m	15,00	450,00
8	Supply and Install gravel pack in the borehole	8	Ton	20,00	160,00
9	Allow for borehole development work (surging by air of completed well until the water is clean (Approx. 3 hrs)	3	Hr	50,00	150,00
10	Allow to the cost of:-				
	(a) Reaming and boring.	2	M	60,00	120,00
	(b) Insert, remove temporary casing etc.	0	Hr	60,00	0,00
	(c) Insert 9" of temporary casing permanently	2	M	150,00	300,00
	(d) Setting time.	-	Ls	180,00	Rate Only
	(e) Bentonite seal.	0	Ls	2 000,00	Rate Only
11	Pump testing completed well. Time taken to install and remove pump, will be charged at same hourly rate	24	Hr	50,00	1 200,00
12	Provide all materials and construct concrete top slab with well cap	1	Sum	65,00	65,00

	and engraving serial number				
13	Standby charges for reasons beyond the Contractor's control excluding force majeure conditions	0	Hr	65,00	Rate Only
14	Borehole Completion Data and Water Chemical Analysis Report	1	Sum	200,00	200,00
15	Hydrogeological Survey Report	1	Sum	1 250,00	1 250,00
	Contract Sum Per Site Before VAT				**13 810,00**
	18% Vat				**2 485,80**
	Total Contract Sum Per Site				**16 295,80**

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SVENSK INSAMLINGS KONTROLL

Appendix 20

D&S DAVIS & SHIRTLIFF
know HOw through experience

Water Pumps
Borehole Service
Swimming Pools
Water Treatment
Generators
Solar Equipment

DAVIS & SHIRTLIFF (TZ) LTD • PO Box 2877, Mwanza, TANZANIA • Tel: (255 28) 2541971/2 • Fax: (255 28) 2541871 • Dmwanza@dayliff.com

PROFORMA INVOICE

Ref.P/MM/063/15
April 8, 2015

OUR VAT REG. No.:10-005498-I
OUR TIN No.:100-147-785

Kolandoto Hospital
P.O BOX 1
Shinyanga
ATT; Mr. Andreas Berg
Email:berg.andreaas@gmail.com

RE: QUOTATION FOR SUPPLY ONLY OF IN-LINE CHEMICAL FEEDERS

Reference is made to your enquiry in regard to the above and now we have a pleasure to forward our quotation, terms and conditions as follows

ITEM	DESCRIPTION	QTY	UNIT PRICE	DISC.	NETT (Tshs)
1	Dosatron D20S	1	16,059,800	10%	14,453,820

Note: Nett Price is VAT inclusive
Availability: 3-4 working weeks from the date of confirmation of order (subject to date of confirmation of order)
Payment: 70% with order, 30% on collection
Validity: Subject to confirmation on the date of payment.

We trust you find our proposals of interest and look forward to your further instructions in due course.

Yours faithfully,
for Davis & Shirtliff (T) LTD,

Mringi Msangi
0757 997842
Mringi.Msangi@dayliff.com

Appendix 21

DAVIS & SHIRTLIFF

Water Pumps
Borehole Service
Swimming Pools
Water Treatment
Generators
Solar Equipment

know HOw through experience

DAVIS & SHIRTLIFF (TZ) LTD • PO Box 2377, Mwanza, TANZANIA • Tel. (+255 28) 2541971/2 • Fax. (+255 28) 2541871 • Dmwanza@dayliff.com

PROFORMA INVOICE

Ref.P/MM/065/15
April 20, 2015

OUR VAT REG. No.:10-005498-I
OUR TIN No.:100-147-785

Kolandoto Hospital
P.O BOX 1
Shinyanga
ATT; Mr. Andreas Berg
Email:berg.andreaas@gmail.com

RE: QUOTATION FOR SUPPLY ONLY OF WATER TREATMENT CHEMICALS

Reference is made to your enquiry in regard to the above and now we have a pleasure to forward our quotation, terr and conditions as follows

ITEM	DESCRIPTION	QTY	UNIT PRICE	NETT (Tshs)
1	Dayliff Chlorine 65% HTH 5kgs	1	59,000	59,000
2	Dayliff Chlorine 65% HTH 20kgs	4	281,312	1,125,248

Note: Prices are VAT inclusive
Availability: 3-4 working weeks from the date of confirmation of order (subject to date of confirmation of order)
Payment: 70% with order, 30% on collection
Validity: Subject to confirmation on the date of payment.

We trust you find our proposals of interest and look forward to your further instructions in due course.

Yours faithfully,
for Davis & Shirtliff (T) LTD,

Mringi Msangi
0757 997842
Mringi.Msangi@dayliff.com

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Appendix 22

Offer sheet from Resco Ltd (Dar es-Salaam) regarding solar power system

Design sheet 17.7 kW

Load (KW)	17,7	17,7	17,7	17,7
Time (hrs)	0,25	1	8	24
Daily Load Energy Requirment (KWhr)	4,4250	17,7000	141,6000	424,8000
Overall System Efficiency	0,6	0,6	0,6	0,6
Daily System Energy Requirement (Kwhr)	7,3750	29,5000	236,0000	708,0000
Peak Sun Hours in Shinyanga (hr)	5,96	5,96	5,96	5,96
Solar Array Size (KWp)	1,2374	4,9497	39,5973	118,7919
Minimum Inverter Size (KW)	22,1250	22,1250	22,1250	22,1250
Minimum Battery Capacity (KWh)	11,3462	45,3846	363,0769	1089,2308
Depth of Discharge (DoD) - (%)	0,65	0,65	0,65	0,65
Number of Autonomy Days	1	1	1	1

Design sheet 43.7 kW

Load (KW)	43,7	43,7	43,7	43,7
Time (hrs)	0,25	1	8	24
Daily Load Energy Requirment (KWhr)	10,9250	43,7000	349,6000	1048,8
Overall System Efficiency	0,6	0,6	0,6	0,6
Daily System Energy Requirement (Kwhr)	18,2083	72,8333	582,6667	1748
Peak Sun Hours in Shinyanga (hr)	5,96	5,96	5,96	5,96
Solar Array Size (KWp)	3,0551	12,2204	97,7629	293,2886

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Minimum Inverter Size (KW)	54,6250	54,6250	54,6250	54,6250
Minimum Battery Capacity (KWh)	28,0128	112,0513	896,4103	2689,2308
Depth of Discharge (DoD) - (%)	0,65	0,65	0,65	0,65
Number of Autonomy Days	1	1	1	1

No.	Item Description	Offer	Unit
1	Solar Module Price	1065	$/KWp
2	Solar Module Mounting structure	195	$/KWp
3	Charge Controller	215	$/KWp
4	Inverter	840	$/KW
5	Battery	250	$/Kwhr
6	Battery racks/room	50	
7	Wiring and Connecting accessories	2000	Lumpsum
8	Transport & Labour	461,5	% of materials
		5 076,50	

	Peak Load 17.7KW for 0.25 hrs	Size	Unit	Offer (USD)
1	Solar array	1,5	KWp	1 598
2	Solar Module Mounting Structure	1,5	Kwp	293
3	charge Controller	3	Kwp	645
4	Inverter	24	KW	20 160
5	Battery	11,346	Kwh	2 837
6	Battery Racks	1	Unit	50
7	Wiring and Connecting accessories	1	Lumpsum	2 000
8	Transport, installation & Commissioning			2 758
	TOTAL			**30 340**

	Peak Load 17.7KW for 1 hrs	Size	Unit	Offer (USD)
1	Solar array	5,4	KWp	5 751
2	Solar Module Mounting Structure	5,4	Kwp	1 053
3	charge Controller	8	Kwp	1 720
4	Inverter	24	KW	20 160
5	Battery	45,385	KWh	11 346
6	Battery Racks	1	Unit	100
7	Wiring and Connecting accessories	1	Lumpsum	2 000
8	Transport, installation & Commissioning			4 213

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	TOTAL			**46 343**

	Peak Load 17.7KW for 8 hrs	Size	Unit	Offer (USD)
1	Solar array	39,6	KWp	42 174
2	Solar Module Mounting Structure	39,6	Kwp	7 722
3	charge Controller	40	Kwp	8 600
4	Inverter	24	KW	20 160
5	Battery	363,077	KWh	90 769
6	Battery Racks	1	Unit	250
7	Wiring and Connecting accessories	1	Lumpsum	5 000
8	Transport, installation & Commissioning			17 468
	TOTAL			**192 143**

	Peak Load 17.7KW for 24 hrs	Size	Unit	Offer (USD)
1	Solar array	118,8	KWp	126 522
2	Solar Module Mounting Structure	118,8	Kwp	23 166
3	charge Controller	120	Kwp	25 800
4	Inverter	24	KW	20 160
5	Battery	1089,231	KWh	272 308
6	Battery Racks	1	Unit	500
7	Wiring and Connecting accessories	1	Lumpsum	10 000
8	Transport, installation & Commissioning			47 846
	TOTAL			**526 301**

	Peak Load 43.7KW for 0.25 hrs	Size	Unit	Offer (USD)
1	Solar array	3	KWp	3 195
2	Solar Module Mounting Structure	3	Kwp	585
3	charge Controller	3	Kwp	645
4	Inverter	60	KW	50 400
5	Battery	28,013	KWh	7 003
6	Battery Racks	1	Unit	500
7	Wiring and Connecting accessories	1	Lumpsum	4 000
8	Transport, installation & Commissioning			6 633
	TOTAL			**72 961**

	Peak Load 43.7KW for 1 hrs	Size	Unit	Offer (USD)
1	Solar array	13,2	KWp	14 058

lx

2	Solar Module Mounting Structure	13,2	Kwp	2 574
3	charge Controller	16	Kwp	3 440
4	Inverter	60	KW	50 400
5	Battery	112,051	KWh	28 013
6	Battery Racks	1	Unit	500
7	Wiring and Connecting accessories	1	Lumpsum	4 000
8	Transport, installation & Commissioning			10 298
	TOTAL			**113 283**

	Peak Load 43.7KW for 8 hrs	Size	Unit	Offer (USD)
1	Solar array	97,8	KWp	104 157
2	Solar Module Mounting Structure	97,8	Kwp	19 071
3	charge Controller	100	Kwp	21 500
4	Inverter	60	KW	50 400
5	Battery	896,410	KWh	224 103
6	Battery Racks	1	Unit	2 000
7	Wiring and Connecting accessories	1	Lumpsum	6 000
8	Transport, installation & Commissioning			42 723
	TOTAL			**469 954**

	Peak Load 43.7KW for 24 hrs	Size	Unit	Offer (USD)
1	Solar array	300	KWp	319 500
2	Solar Module Mounting Structure	300	Kwp	58 500
3	charge Controller	300	Kwp	64 500
4	Inverter	60	KW	50 400
5	Battery	2689,231	KWh	672 308
6	Battery Racks	1	Unit	2 000
7	Wiring and Connecting accessories	1	Lumpsum	8 000
8	Transport, installation & Commissioning			117 521
	TOTAL			**1 292 728**

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Offer sheet from Power Providers (Tanzania) regarding solar power system

	24hrs	8hrs	1hr	15min
KWH PER DAY	**131,726**	**62,689.70**	**17,564**	**4,391**
Solar Modules	$40,050.0	$29,370.0	$10,680.0	$2,670.0
Charge Controller	$18,000.0	$890.0	$2,670.0	$1,400.0
Battery bank	$76,680.0	$25,560.0	$8,720.0	$2,180.0
Inverters/Chargers	$12,000.0	$12,000.0	$12,000.0	$12,000.0
Balance of System Estimate	$13,699.7	$12,412.8	$5,903.0	$4,398.0
Installation	$6,938.4	$5,947.2	$3,964.8	$1,888.0
Transport	$0.0	$0.0	$0.0	$0.0
TOTAL CLIENT ESTIMATE	**$167,368.1**	**$86,180.0**	**$43,937.8**	**$24,536.0**

Load Analysis

Electrical System Load Analysis:

Project:	24HRS SOLAR POWER SYSTEM
Client Name:	KOLANDOTO HOSPTAL
Site Location:	SHINYANGA

Electrical Loads	Qty	Volts	AC=1 DC=0	Priority=1 Not=0	Run Watts	Total Watts	Hours /Day	Days /Wk	Ave. WH /Day	Percent of Total
Sterilization Unit	0	230	1	1	1600	0	4,00	7	0,0	0,0%
Sterilization for caps	0	230	1	1	500	0	4,00	7	0,0	0,0%
Light (tube)	21	230	1	1	36	756	4,00	7	3024,0	2,3%
Operation lights (small)	1	230	1	1	150	150	2,00	7	300,0	0,2%
Operation lights (large)	1	230	1	1	250	250	2,00	7	500,0	0,4%
Operation bed	1	230	1	1	240	240	2,00	7	480,0	0,4%
Air condition	1	230	1	1	2000	2000	12,00	7	24000,0	18,2%
Electro surg. Generator	1	230	1	0	1000	1000	2,00	7	2000,0	1,5%
Suction pump	1	230	1	1	220	220	1,00	7	220,0	0,2%
Anasthesia machine	1	230	1	0	1500	1500	1,00	7	1500,0	1,1%

						0		7	0,0	0,0%
Water boiler	0	230	1	1	2000	0	0,00	7	0,0	0,0%
		230	1	1		0			0,0	0,0%
Eye Theatre		230	1	1		0			0,0	0,0%
Operation light	1	230	1	1	150	150	2,00	7	300,0	0,2%
Anasthesia machine	1	230	1	0	280	280	1,00	7	280,0	0,2%
Light (tube)	10	230	1	1	36	360	4,00	7	1440,0	1,1%
Light (bulb)	3	230	1	1	11	33	4,00	7	132,0	0,1%
Microscope	1	230	1	1	20	20	1,00	7	20,0	0,0%
Air condition	1	230	1	1	1320	1320	12,00	7	15840,0	12,0%
Sterilization unit	0	230	1	1	1600	0	4,00	7	0,0	0,0%
Water boiler	0	230	1	1	2400	0	4,00	7	0,0	0,0%
Flat screen TV	0	230	1	1	190	0	4,00	7	0,0	0,0%
		230	1	1		0			0,0	0,0%
Laboratory		230	1	1		0			0,0	0,0%
Hot oven	0	230	1	1	550	0	3,00	7	0,0	0,0%
Centrifugue	0	230	1	1	660	0	3,00	7	0,0	0,0%
Analyzer	1	230	1	1	100	100	4,00	7	400,0	0,3%
Air condition	0	230	1	1	980	0	12,00	7	0,0	0,0%
Battery	0	230	1	1	670	0	2,00	7	0,0	0,0%
UPS Battery	0	230	1	1	1495	0	2,00	7	0,0	0,0%
Fridge	1	230	1	1	57	57	8,00	7	456,0	0,3%
Sterilization Unit	0	230	1	1	1250	0	4,00	7	0,0	0,0%
Centrifugue	0	230	1	1	308	0	3,00	7	0,0	0,0%
Biochemical analyzer	1	230	1	1	90	90	4,00	7	360,0	0,3%
Microscope	4	230	1	1	60	240	1,00	7	240,0	0,2%
Incubator	0	230	1	1	500	0	6,00	7	0,0	0,0%
Water boiler	0	230	1	1	2200	0	1,00	7	0,0	0,0%
Fridge	2	230	1	1	180	360	8,00	7	2880,0	2,2%
Freezer	1	230	1	1	114	114	14,00	7	1596,0	1,2%
Lights (tube)	6	230	1	1	36	216	4,00	7	864,0	0,7%
						0			0,0	0,0%
						0			0,0	0,0%
Pharmacy						0			0,0	0,0%
Fridge	1	230	1	1	118	118	8,00	7	944,0	0,7%
Light (tube)	5	230	1	1	36	180	4,00	7	720,0	0,5%
						0			0,0	0,0%
						0			0,0	0,0%
						0			0,0	0,0%
Maternity						0			0,0	0,0%
Light (tube)	19	230	1	1	36	684	4,00	7	2736,0	2,1%
Light (bulb)	7	230	1	1	11	77	4,00	7	308,0	0,2%

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Incubator babies	2	230	1	1	800	1600	4,00	7	6400,0	4,9%
Oxygen machine	1	230	1	1	320	320	2,00	7	640,0	0,5%
Suction pump	1	230	1	1	90	90	2,00	7	180,0	0,1%
Washing machine	0	230	1	1	470	0	2,00	7	0,0	0,0%
Water boiler	0	230	1	1	2000	0	2,00	7	0,0	0,0%
Fridge	1	230	1	1	75	75	2,00	7	150,0	0,1%
Oxygen machine	1	230	1	1	320	320	4,00	7	1280,0	1,0%
						0			0,0	0,0%
Private Ward						0			0,0	0,0%
Light (tube)	22	230	1	1	36	792	4,00	7	3168,0	2,4%
Oxygen machine	1	230	1	0	320	320	6,00	7	1920,0	1,5%
						0			0,0	0,0%
Pediatrics						0			0,0	0,0%
Light (tube)	15	230	1	1	36	540	4,00	7	2160,0	1,6%
Oxygen machine	1	230	1	1	320	320	6,00	7	1920,0	1,5%
						0			0,0	0,0%
General Ward						0			0,0	0,0%
Lights (tube)	41	230	1	1	36	1476	4,00	7	5904,0	4,5%
Oxygen machine	1	230	1	0	320	320	6,00	7	1920,0	1,5%
						0			0,0	0,0%
Reproductive and Child Health						0			0,0	0,0%
Lights (tube)	16	230	1	1	36	576	4,00	7	2304,0	1,7%
Fridge for vaccines	1	230	1	1	300	300	8,00	7	2400,0	1,8%

Total Daily Average Watt-hrs	131726,0
Largest AC Appliance Wattage	2400
Inverter Priority Wattage	14144
Total AC Wattage (Inverter Power Demand)	17564,0
Total Daily Average AC Watt-hrs	131726,0
Total Average Amp/Hours per day (System Voltage48V)	3049,2

Appendix 23

(85)

RECEIVED
DATE 21 APR 1997
O. I/c OFFICE.

Medical Doctor in charge
Kolandoto Hospital

ref. extension water supply Kolandoto Hospital

Dear Sir,

Reference to our DWSP letter with ref. 90.3.3/TvM/97.102 of 10 March 1997 and discussions with the Medical Doctor in charge on 12/04/97, I like to inform you on the technical and financial requirements for the Extension of the Hospital Water Supply.

1. The Domestic Water Supply Programme (DWSP) executed an extensive ground water survey to locate an additional borehole location to supply more water to the proposed rehabilitated part of the hospital building.
The hospital rehabilitation plans have been prepared by ICCO from the Netherlands but the plans did not foresee for an additional water source and supply. The plans only foresee for a new water distribution system within the building.

2. Under the DWSP, a 35 metre deep borehole was drilled, permanent casings installed and the borehole test pumped with a <u>safe yield</u> of 1500 litres per hour. Presently the borehole has been sealed. Financing was obtained from DWSP.

3. On request of the DWSP, the Regional Water Engineer's office prepared a design for the supply of water from the new borehole to a proposed new storage tank, opposite the church. The new supply consists of the following elements:

   * construction of a pump house at the new borehole; estimated cost 1,500,000/= Tsh.
   * purchase and installation of a sub mersible pump and related electrical fittings; estimated cost 1,500,000/= Tsh.
   * Tanesco power supply to the pump house; estimated cost 3,000,000/= Tsh.
   * an estimated 1000 metre rising main of 1,5 inch HDPE pipe from the new borehole to the new storage tank; estimated cost 2,000,000/= Tsh.
   * erection of a new storage tank with capacity of 20.000 litres on a 6 meters riser with an estimated cost of 3,000,000/= Tsh.

For the estimated 11.000.000/= TSH. investment cost and an additional estimated 2.500.000/= TSH cost for the detailed surveys, procurement of equipment and supervision of contractor, only 5.000.000/= TSH (dfl. 15.000,=) is presently available from the Donor from the Netherlands, known as Het Bosje and Emilia.

Therefor additional funding has to be found before the technical plans can be detailed and contracted out for implementation.

Hoping to have informed you sufficiently.

Tom van Miert/DWSP

Appendix 24

PROGRAMMING AND PLANNING WORKSHOP
2015-02-19

The following table includes all the building suggestions and justifications by the head of departments participating at the workshop.

room/function/building needed 2015-2025	why? (problem today or trend in development)
room for ICU	because we don't have such a room now
a theatre for maternity to be expanded	the present room is too small
minor theatre at OPD	we don't have now
enough rooms for doctors OPD	there are only two nowadays
resting room for doctors and clinicians on call	
new wards for female and male	now they are very congested
renovation of OPD building	the roof is leaking the trenches are blocked and there is no smooth water flow
to build or to renovate the water and septic tanks (to the whole hospital)	- sewage and septic tanks are broken - many mosquitoes due to poor sewage and septic tanks drainage
in the OPD we don't have causality and ICU building	the emergency case needs to be attended in the ward directly
to build wards for patients, male and female ward	wards for male and female patients are overcrowded
to build administration office	the administration office is not made in good layout
RCH	its too far from other outpatient department
2 big operation theatre	- hence the hospital will be CDH more patients will come for operation purpose - also, road traffic accident is increasing so is necessary for emergency care
a need for modern central supplies room CSR	which will reduce the chance of dust and infection

room/function/building needed 2015-2025	why? (problem today or trend in development)
also there is a need of having big labour room and 4-6 delivery beds for the mothers	- as now we have two delivery beds which is not enough - as I know also the cost will become low so I expect the mothers will come as much as possible
ICU	also is important for serious ill patients as we donut have nowadays
at OPD: room for ICU	no ICU room
at OPD: causality room	no causality room
at OPD: registration room to be increased or expanded	
minor theatre to be separated with major theatre	
wards: extend all wards	
wards: build a new private ward	because the present one was maternity house
extend the maternity house with a theatre in it	
paediatric ward needs a malnutrition room	
new building with different rooms for radiology	- room for x-ray machine - room for staff protection - room for toilet for patients after special examination, eg. (uts. blenemy?)
emergency room	for receiving patients when arriving
reception at the entrance of the hospital	if you enter the hospital main gate you face the theatre which is not appropriate
recovery room at the theatre	no room at the moment
the plan of eye OPD should be built at the current car park	I think is ideal for the entrance of patients
ICU	we need one as we expand our services
24 hours water flow in wards	only available for some hours
resource centre	people to get information
social hall	for meeting, sessions and lectures

room/function/building needed 2015-2025	why? (problem today or trend in development)
ICU	for care of critical patients
causality department	to receive (xxxx?) patients off hours
waiting room	care takers, patients at OPD
main store	to replace the present
playground	socialization
FP (family planning?) by (DKT or OKT?)	
Leprosy ward	
eye outpatient building	because the one we have is mixed with ward for inpatient which makes too much crowdedness
at eye ward: rooms for the children	because we mix the children with adults which makes the children not happy and free
extension of sluice room on main theatre	the room at present is too small to accommodate the daily activities in sluice
building of sluice room in minor theatre	Currently there is no sluice room for minor theatre, hence every sluice activities are to be done to major room sluice. This will reduce/remove the possibilities of transmitting infections from one theatre to another one.
water supply to the minor theatre	At the moment there is no water supply to minor theatre. This will reduce the unnecessary movements from one theatre to another.
Connecting the OT (operating theatre) & CSR (central sterilization room) buildings to be one building	control of sterile supplies protocols
Laboratory department waiting space	no areas for the patient waiting
resting room for laboratory workers at night	
Laboratory department waiting space	patients area for waiting lab results
lab: rest room (a place to sleep)	To allow lab staff to sleep in the laboratory during the night shifts as for now there is no room to sleep during the night shift.

room/function/building needed 2015-2025	why? (problem today or trend in development)
lab: waiting area for the clients/patients	Patients to have a place where they can sit & wait for the service in the laboratory either to wait for the test or results.
Obstetrics: new theatre room - emergency c-sections & elective ones - improve maternal and neonatal services - reduce maternal and perinatal death	- Currently it takes too long to accomplish the procedure. - high (?) maternal death - high perinatal death
Expansion of maternal wards - surgical room - intensive care room - offices for consultation, nurses and ultrasound room	patients are mixed which goes against - infection prevention - privacy
Proper water supply for daily, (tively?) water needs	Currently insufficient (erf?).
We need new modern main store which is big enough to accommodate all drugs and medical supplies.	The store we have now it is not big enough to accommodate a big stock of drugs and medical supplies.
A main store which has air conditioning, strong shelves, supply of water available, and enough pass way which you can pass with a trolley.	It has no air conditioning and no supply of water.
Main store need ladder for pick items which is stored at the high shelves.	
(We are CDH? (Central designated hospital?)) now my opinion is to build a big ward in male/female	Because that ward is too small.
To build ICU room in the open area near physiotherapy area	So that every patient from theatre will get good resuscitation and intensive care before sent to the ward.
To have an emergency room also in that open space by the physiotherapy	So that when emergency cases comes we can give quality care in their area.
Maternity - we need to expand the rooms in the open space there in maternity (dt - delivery theatre? or rt - right?) side	So that to get space for enough maternity theatre and ant-natal, post-natal mothers, also (because?) are too small.
OPD should be expanded	to meet the number of patients we receive per day

room/function/building needed 2015-2025	**why? (problem today or trend in development)**
Also special building for causality + ICU rooms should be constructed	since we don't have currently
Theatre room is now large enough to meet the criteria of modern one.	
Paediatric ward should be extended	Due to fact that it doesn't have special room for contagious diseases like ADD, meningitis, and other air borne diseases including PTB, so we need isolation room.
Private ward does not meet the demand of being called so because it has very small rooms, and inadequate ventilation.	
Maternity ward should also be expanded	Because of the numbers of pregnant mothers we receive, to be many compared to the rooms we have so as to avoid nosocomial infections in wards.
Emergency unit where the car can enter directly, so the doctors and nurses are there	
Place to sit and eat outside general ward	So the patients don't have to eat inside by the bed
A better pharmacy	Now it is confined, poor Ventilation, smell problem, health issue.
Place for patients at the ward waiting to be discharger or having recovered a little bit. want a recreational area or dayroom	Now the patients sit along the outside corridor
ICU, next to operation theatre	
Causality department	
Family planning close to CTC	
Social hall for hospital, with space for meetings with 50-100 people.	Nowadays the hospital uses the church for larger meetings and presentations
Kitchen for hospital	Leprosy patients should be provided food, and when the hospital is a district designated hospital other patients should be able to get food as well.
Leprosy ward behind private ward	

room/function/building needed 2015-2025	why? (problem today or trend in development)
Big mortuary with place for 12 bodies	
Social welfare office	When it becomes district designated hospital. This is since the social welfare pays for patients who can't afford treatment, or for burial of a patient lacking relatives who can pay.
Waiting bay for patients	
Resource centre - library, search for information	
ICU	
Social hall	
Building for pharmacy	
Building for outpatient department	
Causality building	
Building for physiotherapy	
Every ward should have an office for the doctor	
A building for emergency	For for example injured patients
A building for a pharmacy	For pharmaceutical activities
In paediatric: increase the amount of rooms	So that we can accommodate to admit children according (basing) on their disease (ie room specific) eg. room for admitting children with malaria or room for anaemia or room for malnutrition or room for infectious diseases
In paediatric: to add a room for counselling and identification of health status of the children (ie HIV testing)	
In paediatric: to add another room for (1/c ?) is a room for storing its documents (records) and other office activities (ie room as an office for paediatric care)	
Male and female ward: addition of rooms and renovation of the isolation room	Because the rooms are not enough

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Appendix 25

MATERNITY BUDGET AT 2015-04-10

OVERVIEW

Category	**Budget**	**Expenses**	**Difference**
Masonry	1774000	2616100	−842100
Roofing	2427800	2341000	86800
Plumbing	477000	528000	−51000
Electricity	276000	268500	7500
Windows	1136000	0	1136000
Doors	2570000	1080000	1490000
Painting	875600	0	875600
AC	1200000		1200000
Demolition staff cost	30000		30000
Other administration	0	30000	−30000
Total	10766400	6863600	3902800
Donation	6863600		
AICT budget KNH	3902800		

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MASONRY

Date	Description	Qty	Unit price	Expense	Receipt number
16/3	Bags of cement	7	17000	119000	8
16/3	Rebar (Nondo)	8	16500	132000	8
16/3	Binding wire	1	3000	3000	8
16/3	Ring wire	3	6500	19500	8
16/3	Bricks including transport	500	1200	600000	11
16/3	Transport	1	20000	20000	12
21/3	Staff Salary	1	150000	150000	15
25/3	Wood 1x8 inch	99	1400	138600	18
25/3	Bags of cement	7	17000	119000	16
25/3	Haek saw blades	2	2000	4000	16
25/3	Nails 2 inch	2	3000	6000	16
25/3	Naisl 3 inch	1	3000	3000	16
25/3	Bricks	200	900	180000	17
24/3	Sand (Mchanga)	2	35000	70000	22
24/3	Gravel (Kokoto)	1	110000	110000	22
24/3	Finer gravel (Molam)	2	40000	80000	22
28/3	Staff Salary	1	100000	100000	25
30/3	Vents	16	1000	16000	26
3/4	Cement	5	17000	85000	29
6/4	Cement	13	17000	221000	32
9/4	Staff Salary plastering	1	290000	290000	36
paid by KNH	staff salary floor		70000	0	
9/4	Finer gravel (Molam)	2	40000	80000	34
paid by KNH	vents		1000	0	
9/4	Sand (Mchanga)	2	35000	70000	34
Total				2616100	

ROOFING

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Date	Description	Qty	Unit price	Expense	Receipt number
25/3	Wood 2x3 inch	694	700	485800	18
25/3	Wood 2x4 inch	300	900	270000	18
25/3	Wood 1x8	80	1400	112000	18
25/3	Iron sheet 28G	23	25000	575000	16
25/3	Randa	1	4100	4100	16
25/3	Mould	1	4100	4100	16
25/3	Wood treatment (Dawa)	20	1000	20000	16
25/3	Roofing nail	6	4000	24000	16
25/3	Nail 5 inch	4	3000	12000	16
25/3	Nail 4 inch	8	3000	24000	16
25/3	Nail 3 inch	4	3000	12000	16
25/3	Nail 2 inch	3	3000	9000	16
25/3	Ceiling board	12	16000	192000	
25/3	Metal wire	5	2000	10000	
25/3	Transport	1	75000	75000	19
25/3	Loading, unloading	1	55000	55000	19,21
3/4	Staff Salary	1	200000	200000	30
6/4	Ceiling board nails	3	4000	12000	32
9/4	Staff salary	1	200000	200000	37
30/3	Nail 6 inch	5	3000	15000	27
30/3	Nail 5 inch	2	3000	6000	27
30/3	Nail 4 inch	6	3000	18000	27
30/3	Nail 3 inch	2	3000	6000	27
paid by KNH	iron sheet bati		25000	0	
	staff salary for the walkway roof, to be negotiated with Nicco			0	
Total				2341000	

PLUMBING

Date	Description	Qty	Unit price	Expense	Receipt number
16/3	PVC pipe 4 inch	4	16000	64000	8
16/3	Rebar (Nondo)	2	16500	33000	8
16/3	Cement	3	17000	51000	8
16/3	Wire mesh	1	18000	18000	8
16/3	Binding wire	1	3000	3000	8
16/3	Seal tape	5	1000	5000	9
16/3	Coppling 3/4 inch	8	2500	20000	9
16/3	Coppling 1 inch	4	4000	16000	9
16/3	Poly pipe 3/4 inch	10	1500	15000	9
16/3	Poly pipe 1 inch	10	2000	20000	10
16/3	T connector	1	6000	6000	10
16/3	Wash basin	1	40000	40000	9
16/3	Socket 1/2 inch	4	1000	4000	9
16/3	L Bow	10	1000	10000	9
16/3	Nipple 1/2 inch	4	1000	4000	9
16/3	Union 1/2 inch	2	1500	3000	9
16/3	PVC 1 1/2 inch	2	14000	28000	9
16/3	Vogathin pipe 1/2 Inch	3	16000	48000	9
16/3	PVC L Bow 1 1/2 inch	4	3000	12000	9
16/3	Bottle trap 1 1/2 Inch	1	5000	5000	9
16/3	Bib tap 3/4 inch	1	12000	12000	9
16/3	Male connector 3/4 inch	8	2000	16000	9
18/3	Staff Salary	2	5000	10000	13
9/4	Tee coppling	2	5000	10000	35
9/4	gate valve	1	10000	10000	35
9/4	Bush 3/4 inch * 1/2 inch	2	2000	4000	35
9/4	Elbow 3/4 inch	1	1000	1000	35

Date	Description	Qty	Unit price	Expense	Receipt number
9/4	return the wash basin, and change to a kitchen sink	1	60000	60000	35
Total				528000	

ELECTRICITY

Date	Description	Qty	Unit price	Expense	Receipt number
25/3	Konduti	7	1000	7000	23
25/3	Small Skwea box	7	500	3500	23
25/3	Big Skwea box	2	1000	2000	23
25/3	Jantion	4	1500	6000	23
25/3	Clipps box	4	500	2000	23
25/3	Fluorescent tube	7	12000	84000	23
25/3	Insulation tape	2	1000	2000	23
30/3	Switch Socket	2	10000	20000	28
6/4	Flash switch	3	3000	9000	33
6/4	2 genge switch	1	4000	4000	33
30/3	Misumari 0,5 special	2	2500	5000	28
25/3	Wire 2,5	20	1700	34000	23
25/3	Wire 1,5	60	1500	90000	23
Total				268500	

WINDOWS

Qty needed	Date	Description	Qty bought	Unit price	Expense	Receipt number
4		Windows		284000	0	
	Total				0	

DOORS

Qty needed	Date	Description	Qty bought	Unit price	Expense	Receipt number
6	3/4	frame	6	80000	480000	31
4		top		250000	0	
2	10/4	top	2	250000	500000	38
6		fitting		15000	0	
4		locks		28000	0	
2	10/4	hinge spring	2	50000	100000	39
12		bawaba gångjärn		1500	0	
	KNH bought	vent in frame		35000	0	
	Total				1080000	

PAINTING

Qty needed	Date	Description	Qty bought	Unit price	Expense	Receipt number
1		Rangi nyepe ya manji ya kawaida ndoo		35000	0	
1		Primer ndoo		80000	0	
2		Silk ndoo		150000	0	
2		Rangi nyepe ya manji ya kawaida ndoo		35000	0	
2		Msasa		2000	0	
2		Rangi ya mafuta ya msingi wan je kopo		20000	0	
3		Mafuta ya taa		2200	0	
1		Fisher board kopo		20000	0	
10		unga wa kuzibia		2000	0	
1		Staff salary		300000	0	
	Total				**0**	

OTHER ADMINISTRATION COSTS

Date	Description	Qty	Unit price	Expense	Receipt number
19/3	ATM costs Daniel	4	7500	30000	
TOTAL				**30000**	

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Appendix 26

A brochure from Makiga engineering that explains the ISSB machine and technique

Advantage of Stabilised Soil Blocks Technology

- The production of high quality blocks, uniform in size and shape with defined edges and smooth surfaces, makes construction easier.
- It mobilizes and empowers communities to create local infrastructure and amenities.
- Ownership of a press provides long-term income generation for entrepreneurs.
- It is particularly suitable in areas where cement is costly and difficult to obtain.

Financial Savings

- On-site manufacture of SSBs dramatically reduces transportation costs and damage during transit.
- The Cost of building materials especially cement is significantly lower.
- The amount of mortar required is minimal.
- Unskilled people can be quickly trained to use the press and acquire the skill.
- Cost analysis reveals savings of around 50% can be achieved in the construction of water tanks, septic tanks and in the lining of wells and pit latrines.
- Savings of around 50% is possible in the construction of houses, classrooms, clinics etc.

Environmentally Friendly

- SSBs are 'cured' NOT fired. This dramatically reduces the environmental damage of construction when compared to clay-fired bricks.

Appropriate Technology

- Makiga Soil Block Press provides an answer to affordable housing, water storage and sanitation needs of community level in Africa

It is an ideal tool for building contractors, entrepreneurs, developers, co-operatives and community based organizations

NAIROBI Head Office:- K.I.E shed No. 27 off Likoni Rd.

ELDORET Office:- Park Tyre Building along Kisumu Rd.

MAKIGA

ENGINEERING SERVICES LTD

AFFORDABLE DURABLE ECO-FRIENDLY

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Makiga manufactures the Stabilised Soil Block Press. The Press is heavy-duty, requires low maintenance and manually operated. It compacts a mixture of soil and cement into Stabilised Soil Blocks for the construction of affordable housing, water and sanitation systems. The Press is locally manufactured under patent and is a proven, appropriate technology suitable for both rural and urban areas.

There are four types of Makiga Soil Block Presses:-

- **Standard Straight Interlocking Soil Block Press**
- **Wide Straight Interlocking Soil Block Press**
- **Curved Interlocking Soil Block Press**
- **Standard Non-Interlocking Soil Block Press**

All four Makiga Soil Block Presses have the following unique features:-

- Double action ejection stroke to ease operation.
- Adjustable volume mould box to suit different soil types.
- High compression which produces blocks as strong as concrete blocks.

Stabilised Soil Blocks (SSBs) are strong, economical blocks made from a mixture of sub-soil and a small quantity of cement. Almost any soil that contains clay and sand, for example murram, can be used to make between 100 and 150 SSBs per 50kg bag of cement.

Cement to Soil Ratio

The cement to soil ratio varies according to soil type and can be determined by testing the soil for shrinkage. This can be done quickly and easily using a special shrinkage box supplied with the Soil Block Press.

Shrinkage	Cement to Soil	No. of Blocks
Up to 12mm	1:18	150
12–23mm	1:16	120
24–39mm	1:14	100

NB. Where shrinkage exceeds 40mm the soil may require further stabilization with sand

TECHNICAL SPECIFICATIONS

Makiga Soil Block Press

- Typical Compression force: 80-100 kN
- Weight: 140 Kg
- Typical daily production by 4 workers working on 8 hour day: 400-500 blocks

Stabilised Soil Blocks

- Size: 266mm x 140mm x 95mm
- Weight: 5Kg
- No. of blocks per 50kg bag of cement: 100-150
- Average curing period: 14 days
- Minimum dry compressive strength: 2.5N/mm²
- Maximum wet compressive strength: 1.5N/mm²
- Maximum water absorption (after 28 days): 15%

Stabilised Soil Blocks are tested and approved by the Kenya Bureau of Standards (KS012070) as permanent walling materials. These blocks have been used to construct buildings, water tanks, pit latrines, wells and septic tanks in Kenya and other African countries.

Water Storage and Sanitation

Curved Interlocking SSBs make excellent Water tanks, wells, septic tanks and pit latrines.

- Tanks up to 12,000 litres can be built above ground and up to 50,000 litres below ground for water storage or sanitation systems.
- Curved Interlocking SSBs reinforce and line wells and pit latrines giving strengths and long life.
- The diameter of the water tank, well or pit latrine ranges from 1 to 4 metres by simply adjusting the angle of the Interlocking Blocks.

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Appendix 27

A PRICELIST FROM MAKIGA ENGINEERING IN NAIROBI

MAKIGA

AFFORDABLE•DURABLE•ECO-FRIENDLY

MAKIGA KENYA PRODUCTS PRICE LIST – KES 2014

Soil Block Presses	VAT excl KES	VAT incl KES
Standard	KES 79,000	91,640
Double Straight Interlocking	KES 86,185	99,975
Single Straight Interlocking	KES 83,500	96,860
Wide Straight Interlocking	KES 95,836	111,170
Curved Interlocking	KES 101,724	118,000
Hydraulic Wide Straight Interlocking	KES 1,350,000	1,566,000
Concrete Making Products		
Concrete Block Making Machine – 16" block master	KES 54,813	63,583
Concrete Block Making Machine – 18" block master	KES 60,078	69,691
Vibrators		
MCR tile vibrator with two D.C. 12V motors	KES 33,598	38,974
Medium Multipurpose vibrator 4x3ft	KES 154,310	179,000
Large Multipurpose vibrator 5x4ft	KES 191,810	222,500
Moulds		
Fibreglass Mother mould set (4pcs)	KES 19,687	22,837
Wooden Vee-Ridge mould	KES 10,122	11,742
Ventilation mould	KES 5,820	6,752
Zig Zag Paving mould	KES 6,875	7,976
Demoulding Plate	KES 850	986
Hollow/Solid Concrete Block mould	KES 11,501	13,342
Special 4 set Concrete mould	KES 22,750	26,390
Block Press wooden base	KES 5,812	6,742
Master mills (Posho mill)		
Engine Driven	KES 215,962	250,516
Electric Driven	KES 173,617	201,396
Stone Crusher (manually operated)	KES 230,935	267,887

Please note that all prices are subject to change without notice

Nairobi Tel: +254 722 669 730 Eldoret Tel: +254 721 318 717 Mombasa Tel: +254 718 852 699
Email: makiga@wananchi.com Web: www.makiga-engineering.com

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Appendix 28

Social areas outside the general ward cost estimation:

MABENCHI 4, NONDO 8 WAYA MESH 4

MBAO 1X8 – FT 40 @ 1300	=	52,000/=
WAYA MESHI 4 @ 18,000/=	=	72,000/=
MATOFALI 100 @ 1200/=	=	120,000/=
BOMBA 3 @70,000/=	=	210,000/=
MBAO 2X3= FT 100 @ 700	=	70,000/=
MABATI 10 FT 10 @15,000/=	=	150,000/=
GHARAMA YA KAZI		
KUPIGA PAA	=	80,000/=
KUJENGA	=	160,000/=
		1,046,000/=

Provided by Musa

Appendix 29

PUBLIC PATH COST ESTIMATION

KUTENGENEZA VERANDER

1. MABATI 34 @ 15,000/=	=	450,000/=
2. CEMENT 30@ 17,000/=	=	510,000/=
3. MAWE TRIP 6 @ 70,000/	=	420,000/=
4. KOKOTO TRIP 2 @ 120,000/	=	240,000/=
5. MCHANGA TRIP 4@ 35,000/=	=	140,000/=
6. MBAO 2X3 FT 580@700/	=	406,000/=
7. BOMBA 9@ 70,000/	=	630,000/=
		2,796,000/=

1. MABATI 20 @ 15,000/	=	300,000/=
2. CEMENT 20 @ 17,000/	=	340,000/=
3. MAWE TRIP 3 @70,000/	=	210,000/=
4. KOKOTO TRIP 1 @ 120,000/	=	120,000/=
5. MCHANGA TRIP 2 @ 35,000/	=	70,000/=
6. MBAO 360 FT @ 700	=	252,000/=
7. MAKOWA	=	20,000/=
MISUMARI KG 5 4"	=	4,000/=
MISUMARI KG 2 2" @ 4000	=	8,000/=
MISUMARI YA BATI KG 8 @ 4,000	=	32,000/=
		1,372,000/=

GHARAMA YA KAZI ZOTE

KUPIGA BATI	=	350,000/=
KUJENGA	=	500,000/=
		850,000/=

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Appendix 30

X-RAY REORGANIZATION COST ESTIMATION:

X-RAY

KUBOMOA UKUTA

KUWEKA MLANGO

CEMENT MIFUKO 5 @ 17,000/=		85,000/=
MABATI 10 @ 15,000/=	=	150,000/=
MBAO 2X3= 60 FT @ 700=	=	42,000/=
MISUMARI 1 KG 4" @ 4000	=	4,000/=
MISUMARI KOFIA KG 1 @ 4000	=	4,000/=
BOMBA 2 @ 70,000/=	=	140,000/=
GHARAMA YAKE	=	200,000/=
		625,000/=

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SVENSK INSAMLINGS KONTROLL 90 KONTO

Building materials of x-ray dep

1. mninga wood for frem 3pcs @ 26000x3 → 78,000/-
2. 1pcs ordinary Door @ 350,000/ → 350,000/-
3. 3pcs hinges "4" @ 3000x3 → 9000/-
4. Mould . → 35,000/-
5 Smothing machine → 35,000/-
6. 2pcs of metal @ 70,000x2 → 140,000/-
7 18 pcs of Bolt @ 200x18 → 3600/-
8 Driling holes for metal → 10,000/
9. Transports 50,000/-
10 ~~Mortice lock, 1pc~~ ~~25,000/~~
2pcs Slaper latch @ 5000x2 10,000/.

~~738,600/-~~

Provided by Abedinego, carpenter at KNH

Total 720,600/-

Appendix 31

DRAWING FOR THE MATERNITY THEATRE EXTENSION!

Note that it is out of scale in this document.