

A Sustainable Business Proposition for Selling Irrigation Pumps in Ndola, Zambia

A Senior Project

presented to

the Faculty of the General Engineering Department  
California Polytechnic State University, San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

by

Robert Hosbach

May, 2010

© 2010 Robert Hosbach

## Table of Contents

Abstract .....	1
Introduction.....	1
Background.....	3
Literature Review.....	5
Reason and Rationale .....	8
Business Model Considerations and Selection.....	9
Financial Considerations .....	11
Stakeholder Analysis .....	15
Risks.....	18
Metrics for Success .....	20
Conclusion .....	22
Appendix A: Map of Ndola, Zambia .....	23
Appendix B: Technical Drawings of Irrigation Pump .....	25
Appendix C: Financial Analysis Tables and Graphs.....	29
Appendix D: Stakeholder Analysis Tables .....	34
Annotated Bibliography .....	37

## **Abstract**

Robert Hosbach is proposing a sustainable business plan to bring a small-scale irrigation pump to rural Ndola, Zambia. With hundreds of thousands of citizens living in poverty and semi-annual starvation, Ndola is in need of a means to grow crops effectively in the rainy season. Their current agricultural practices rely solely on the inconsistent rainfall during this time. My pump will be constructed from locally-available aluminum cans, epoxy, glue, and fasteners (refer to Appendix B for technical drawings of the pump). The business will employ only a small number of Zambians, but will bring a means of food and income to an impoverished populace. Once the business is running steadfast in Ndola, I hope to bring this service to the whole country of Zambia and even the entire continent of Africa.

## **Introduction**

Coming into California Polytechnic State University, San Luis Obispo as a freshman in 2006, I had no idea what type of engineering career I wanted to pursue. After working through my major courses from the various engineering departments, I found my passion in engineering design.

In my third year I decided to take UNIV-X492: Design for Impoverished Communities. This course, taught by Dr. Peter Schwartz, provided a means to take my passion for engineering design and apply it toward helping developing countries. For the course, I worked as part of a three-person team to design a bicycle-powered irrigation pump for rural Malawi, Africa. Never have I felt so fulfilled from working on a project before. As the quarter came to an end, my team had created a working prototype, though we missed one particularly essential design

aspect: sustainability. Dr. Schwartz stressed three main points in his course: technologies for developing countries need to 1) be made of locally available materials, 2) be easily repairable, and 3) provide a source of income. The pump we used for our project was a molded plastic pump made in India, so it was not made of readily available materials from Malawi and the Malawian people would not be able to easily repair it.

As the summer of 2009 approached, I was presented with the opportunity to travel to Ndola, Zambia on a two-week mission trip with my local church to work with the faith-based organization Seeds of Hope. The trip was to take place in August and our ministry there would entail visiting orphanages, delivering water filters to rural communities, and working on various projects for Seeds of Hope. By then I had a longing to travel to Africa, and I was excited to experience the culture and difficulties faced by the impoverished community members. From this trip an idea was born, and for that I owe many thanks to the Coca-Cola Company.

The people of Ndola, Zambia are in desperate need of drinking water and a means to grow crops during the dry season – this was plain to see. However, during the two-week mission trip I noticed something quite peculiar: everywhere I went, even in the most rural community, there were Coca-Cola stands selling cans of the popular beverage.

This paper details the means by which a small operation could be born in Ndola, Zambia to sell sustainable, affordably-priced irrigation pumps made from locally-available aluminum cans. The pumps can be easily made and, with education from Seeds of Hope on proper agriculture techniques, will prove effective to providing a viable means of growing crops in the dry season. In summary, the following business plan could help curb starvation and poverty in Ndola, Zambia.

## Background

Ndola sits in the heart of the Copperbelt Province of the Republic of Zambia, just south of the Democratic Republic of Congo's southeastern border. As with most African countries, Zambia is the current cultivation of a history of European colonization and political turmoil.

In 1855 David Livingstone, a Scottish missionary and African explorer, came across the great falls on the Zambezi River, which he named Victoria Falls. To this day, the town of Livingstone, named after him, sits on the Zambian border overlooking the falls. After Livingstone, Cecil Rhodes came to the area in 1888. Mr. Rhodes came with the political intentions of Great Britain and declared British influence over Northern and Southern Rhodesia, currently known as Zambia and Zimbabwe, respectively. The British influence over Northern Rhodesia lasted until 1964, during which time the demands from native Africans for more equality in government representation increased steadily. The election of 1962 resulted in an African majority over the legislative council that aimed for a more democratic government, independent from Great Britain. They succeeded in gaining total independence from Britain in 1964, and Northern Rhodesia was named the Republic of Zambia.

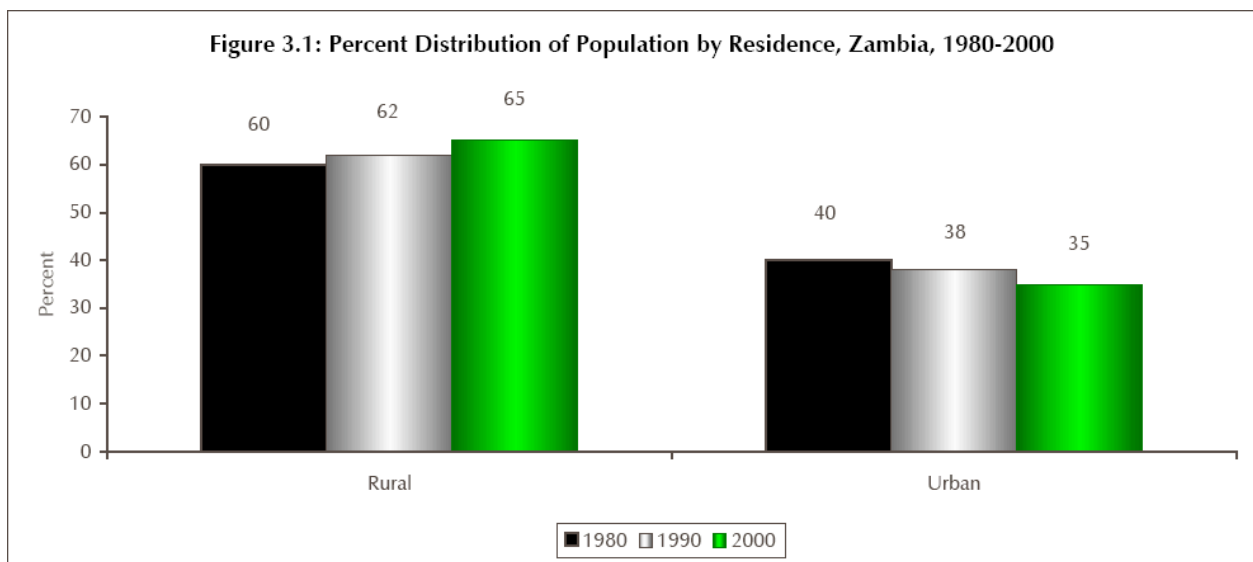
Despite gaining independence from Britain, Zambia suffered through many hardships in the following years. With neighboring countries still under the colonial influence of Portugal and Britain, trade negotiations became strained and Zambia was forced to close its borders. In addition, civil wars in neighboring countries between former Portuguese colonies resulted in refugees for Zambia and further strain on international relations. Beyond political turmoil, Zambia also suffered a sharp decrease in the price of copper, its principle export, in the 1970s. With nowhere to replace the lost income from the copper decline, Zambia was forced into

debt. Today, poverty remains an issue in Zambia but the country has received debt relief and is beginning to see consistent, albeit minimal, economic growth. In addition to colonial history of Zambia as a whole, the population characteristics of Ndola will prove an important consideration for the development of a sustainable business venture there.

Although the last Zambian census took place in 2000, the Central Statistical Office (CSO) of Zambia projected the 2009 midyear population of the Copperbelt Province to reach just over two million people. In addition, the CSO of Zambia presented data on the proportion of the Zambian population living in rural and urban areas from 1980-2000 (refer to Figure 1 on page 5). Figure 1 clearly shows that the majority of Zambia's population lived in rural areas in 2000, and from my experience in Ndola I make the claim that most of Ndola's population follows this trend and lives in rural compounds outside of the downtown area.

Severe poverty has led to a large portion of Ndola's population living in rural areas, creating a positive feedback mechanism that keeps this populace in poverty. Looking beyond the chronic problem of AIDS that affects Zambia as a whole, the people living in rural areas of Ndola experience a lack of clean drinking water and the inability to properly irrigate crops during the dry season. Without steady and sufficient income to pay for food and water filters, and without transportation to get into the downtown area, the lack of drinking water and irrigation techniques drives these people further into poverty. The 2007 Zambia Demographic and Health Survey reported that 17% of the total population of the Copperbelt Province was infected with HIV, the precursor to AIDS. Furthermore, the Living Conditions Monitoring Survey conducted in Zambia in 2006 stated that only 42% of rural households in Zambia have access to safe drinking water and showed a poverty incidence of 42% in the Copperbelt Province.

With access to an affordable, locally-constructed irrigation pump, the citizens of Ndola living in rural areas will be better able to minimize starvation and produce income. In Zambia, many people starve during the rainy season because no crops were grown in the dry season. An irrigation pump would allow impoverished families to grow various crops for themselves as well as sell off the surplus crops for an income. In addition, developing small distribution hubs in the rural areas would provide a job source.



**Figure 1. Graphical representation of the geographical distribution of the Zambian population from 1980-2000. This graph sources data from 1980, 1990, and 2000 Censuses of Population by Housing conducted by the CSO of Zambia.**

### Literature Review

Currently, there are various non-profit and non-governmental aid organizations working toward ending the water crisis in developing countries. With this in mind, a variety of pumps have been designed by these organizations and implemented in these countries. The pumps are mainly borehole pumps intended to draw water from deep underground that can be

filtered and safely consumed. This technique is effective in providing drinking water in the dry season, but it is expensive and ultimately ill suited for irrigation applications.

Some of the key organizations working in Zambia presently are LifeWater International, Seeds of Hope International Partnerships (SOHIP), and Blood:Water Mission. These organizations are working diligently to provide safe drinking water to the impoverished, rural communities of Zambia using numerous water pumps, filtration methods, and community outreach programs. The main pumps currently being installed and maintained by these organizations are the India Mark IV and India Mark V hand pumps manufactured by Meera & Ceiko. These pumps boast a volumetric discharge of 900 liters per hour and 1050 liters per hour, respectively (Product Range). Although these pumps work well, they are not manufactured in Ndola, they require a deep hole to operate from, and they are expensive. The SOHIP Giving webpage asks for a donation of \$5500 to drill the borehole, install the pump, and educate the community members on sanitation and hygiene and how to repair the pump. Therefore, rural communities in Ndola cannot afford, on their own, to purchase and install these pumps. In addition, because villagers without any training often operate these pumps, the pumps are prone to breaking and needing repair. Data produced by the Rural Water Supply Network in 2007 indicated that Zambia had 15,000 total installed hand pumps, but 4,800 of them were not working.

In addition to deep borehole hand pumps, the treadle pump has had a major impact in Africa and India. The treadle pump is used mainly for irrigation purposes. It costs much less than the Mark IV or Mark V pumps and can be manufactured in country from steel pipe, lumber, or various other locally-available materials. According to a report produced in 2000 by



the International Programme for Technology and Research in Irrigation and Drainage, treadle pumps in Zambia cost between \$60 and \$120 dollars. It is safe to assume (due to the spread of these pumps globally) that the costs have dropped slightly in the past decade, but even \$40 for a pump often presents too much financial strain for a rural family in Ndola.

Although providing clean drinking water is a necessary step to ensuring the health and safety of the Zambian rural population, the population also suffers from starvation during the rainy season and an overall lack of income-generating business. In short, while the issue of lack of clean water is currently being undertaken by numerous organizations, the starvation issue is still falling under the radar in a big way. My proposition to utilize small-scale rotary pumps to provide an affordable means of irrigation will cut into the starvation experienced during the rainy season and provide a means to create income.

To be more specific, the pump I am proposing is a sliding vane, rotary-type positive-displacement pump. To further classify, this pump is considered a fixed-displacement pump (as opposed to a variable displacement pump). Although the name implies complication, this type of pump can be geometrically simple and easy to build. A Positive-displacement pump “emits a given volume of fluid for each revolution” based on pressure created from recurring volume reductions inside the pump (“Cole-Parmer”). For industrial use, these pumps are run at thousands of revolutions per minute (rpm) at very high pressures. For the irrigation purposes of Ndola, the pump would be run by hand (and therefore at low rpm’s) and at considerably lower pressures than that used in industrial practice.

## Reason and Rationale

To bring a cheap, easily constructed, irrigation pump to Ndola, Zambia would provide a means to escape poverty and avoid starvation during the rainy seasons. According to the Central Statistical Office of Zambia, the incidence of poverty was 64% in 2006, with a 42% incidence rate in the Copperbelt province. Furthermore, the Copperbelt province recorded a 31% unemployment rate in 2006. An estimated 65% of Zambian households do not make enough income (about 300,000 Kwacha per month) to live above the basic needs basket. With a low income and no means to consistently produce crops from small farming operations during the rainy season, families face the imminent danger of starvation and malnutrition annually.

According to a crop production data sheet produced by the Central Statistical Office of Zambia, maize, groundnuts, and cotton are the most prominent crops in terms of total hectares planted. Emerson Nafziger, professor of crop production and Extension agronomist at the University of Illinois at Urbana-Champaign, was quoted in a Southeast Farm Press article as saying, “A 200-bushel corn crop uses about 600,000 gallons of water — nearly 3,000 gallons per bushel” (Bennett). A bushel of shelled maize is equivalent to 56 pounds, meaning it takes nearly 54 gallons of water to produce a pound of maize (Murphy). Cotton and groundnuts don’t require nearly as much water as maize, but with a lack of education in agricultural methods in the rural sections of Ndola, growing any crops with a lack of consistent rainfall is difficult.

By providing an affordable water pump that can help irrigate small crop areas (vegetable gardens, for example) the people of Ndola will not only have a means to curb starvation-related deaths and illnesses, but they will also be empowered to sell surplus crops at market for a

profit. In addition, the local crop market will not be undermined by simply giving the people of Ndola vegetables to sell for profit. When a commodity is given to a community in large quantities, the supply of that commodity increases and the demand for the commodity stays equal or even decreases. Basic macroeconomic principles show that the heightened supply without an increase in demand will drive the price of the commodity down. Therefore, the market for this commodity is destroyed. When the people earn the commodity, though, the market is not bombarded with a sudden increase in supply and so the people find themselves in a position to sell their commodity and make a profit. The pumps will be available for purchase at a small cost and any surplus crops can then be sold to pay off the pump and provide an income for the family. The pumps will be constructed from locally available materials, repairable locally, and therefore manufactured and sold in a sustainable fashion.

### **Business Model Considerations and Selection**

Due to the fact that my business will not only be manufacturing, but selling the water pumps as well, I will be following a retail business model. My business does not yet exist, and therefore will need to be constructed from the ground up. Everything from deciding the type of management for our business, selecting a location, and setting an affordable, yet profitable, price for our product needs to be decided. All of these factors, along with numerous other considerations, will have a dramatic effect on the success of my water pump business.

My retail business will not be making sales on the Internet. The pumps, at least at the outset, will be manufactured for and sold specifically to the rural citizens of Ndola, Zambia. To this end, selecting a location for our business is a crucial landmark. Ndola has a number of rural

compounds situated around the city, so placing my business in any one of these compounds would be largely counterproductive. For instance, if the business were placed in Twapia, citizens of Kansenji would find it difficult to travel to the location to purchase a pump (refer to Appendix A for a map of Ndola, Zambia). With this in mind, positioning the business in the downtown area of Ndola should prove to be the best area to distribute my pumps from, thereby making the most profit. After researching real estate in Ndola, it seems that renting a suitable office and construction space will cost about one thousand dollars per month.

Next, the management hierarchy needs to be established. At the outset, this business will be lead explicitly by the owner, Robert Hosbach. If, and when, the business proves profitable and successful, implementing a board of directors will be considered. Under the owner will be a number of workers: manufacturers, pump testers, drivers, etc. With the company starting as a sole proprietorship, Mr. Hosbach will be responsible for all of the business's assets and liabilities. This represents a high-risk situation that can be mitigated by donor funding and various types of fundraising efforts.

Finally, a general overview of how the business will run is in order. Before a location is determined, the pumps will be tested in Ndola for their durability and effectiveness. Then, once the location is established, the first priority will be to advertise the pumps and to continue engaging in fundraising ventures. During this time, pumps will be manufactured and sold to the rural citizens of Ndola. After a number of weeks, my company will give follow-up surveys to each of the families who purchased the pumps. These surveys will give me an idea of how the pumps are working and what the company could do better as a retailer, manufacturer, or pump repairer.

## Financial Considerations

With any startup business there are a number of financial considerations to take into account. For my business there will be legal fees, rental unit costs, vehicle costs, travel costs, petrol costs, advertising costs, office supply and stationary costs, pump material costs, manufacturing tools and machinery costs, and the cost of hiring a staff. On the revenue side, there will be donations, fundraising, and the income generated from selling and repairing the water pumps.

It is important to consider ties my business could potentially have with non-profit organizations working in Zambia. There are many non-profits working to bring clean water to the Zambian people and, therefore, a number of hand pumps have been installed in and around Ndola. Seeds of Hope International Partnerships works exclusively in Zambia and, to date, has drilled nearly 150 wells (upon which hand pumps were installed) and repaired more than 350 broken hand pumps. Currently, they estimate that clean water has been brought to approximately 370,000 people in Zambia due to their efforts, most of which are in Ndola (Stat Sheet). With the work of Seeds of Hope and other non-profits working toward the same goal, a large number of hand pumps are already installed in Ndola, which provide the source of water to which the pumps can be applied. Also, working alongside Seeds of Hope or other non-profits could allow my company access to their consumer base, hopefully resulting in quick recognition of my company and pump sales.

Building a company from the ground up is never an easy task. It is expected that in the first few years the company will be working out of accumulated debt resulting from the onerous onset of start-up costs. At the most basic level, the company will have a sum of money

due for settling the legal matters. Once the legal aspect is taken care of, a rental unit in Ndola will need to be obtained which will incur either a monthly or annual payment. After the office is leased, phones, computers, printers, copiers, and fax machines will need to be purchased. Without these basic technologies the company will never get started. In addition to this, the aluminum cans, epoxy, and rubber seal material will need to be obtained so the manufacturing process can take place. Thankfully, manufacturing the pumps will not require any specialized equipment beyond tin cutters and other basic hand tools. Once the pumps are ready to be sold, at least one vehicle will need to be purchased to disseminate them to the rural residents of Ndola. This vehicle will not only incur a one-time capital cost, but a recurring fuel cost as well. Finally, a small staff will need to be hired at the outset. The company could run, at the beginning, with a staff of six people: three pump manufacturers and repairers, one pump deliverer, an office assistant, and myself. As the company grows, more workers will need to be hired, especially if the company has the opportunity to expand into other cities of Zambia or even across the continent.

A break-even financial analysis with the necessary assumptions has been provided for the first 5 years of company operation (refer to Appendix C). This analysis was conducted to determine the required sale price of each pump for the company to break even after 5 years. The analysis, although not highly precise, indicates that the pumps can be sold for about \$4.54 apiece.

In addition, I have included a sensitivity analysis, which determines the effect of changing the assumptions on the required pump price. From the sensitivity analysis, it is plain to see that the most influential assumption is the amount of pumps sold in the first year of

operation. This affects the break-even pump price dramatically because it is compounded by the assumed 15% annual growth rate of sales. As it turns out, this annual growth rate is the next most influential assumption. Considering the large rural population of Ndola and the marketing assistance from the various non-profits working there, it is conceivable that these assumptions are on the conservative side anyhow. The potential to sell more than 10,000 pumps in the first year is there, and a growth rate greater than 15% is likely, at least in the first five years. Nevertheless, this conservative analysis has shown that pumps can likely be sold for \$4.54 each, and even if 5000 pumps are sold in the first year, they could still be sold for about \$9.08 each.

This price of \$4.54 is largely affordable, even to the impoverished, rural population of Ndola. If my assumption proves wrong and only 5000 pumps are sold in the first year, paying \$10.00 per pump will be more difficult for the rural families. However, this price is still well under that of purchasing a treadle pump or any other advertised pump in Zambia. It should also be noted that this economic analysis does not include the effect of any potential grants my business is awarded over the years. Grant funding will help lower the sale cost of the pumps and will allow the business to thrive through unexpected (and unaccounted for) economic turmoil. Whether the pumps are sold for \$4.54 or \$9.08, the company will be making a profit after only 5 years of operation that can be used to hire more workers, develop more pumps, or expand the company into other cities or countries.

At this point, an explanation of the required pump construction materials is necessary. Financially, this aspect of my business is crucial to its long-term success. When I traveled to Ndola in the summer of 2009, one thing stood out to me: The Coca-Cola Company was

everywhere. Not only did the downtown grocery stores sell Coca-Cola products, but also street-side shanties in the rural outskirts of Ndola sold Coca-Cola beverages. In general, the beverages sold were in aluminum cans, not glass bottles. Furthermore, there is not an operating recycling center in Ndola. After witnessing this first hand the idea was born to make irrigation pumps from the abundance of aluminum that is discarded every day in Ndola. To accomplish this task I will contact the local stores, restaurants, and street-side shanties to ask them to collect any used beverage cans. These retailers have no reason not to let my company have the cans because there is no way for them to make a profit from the cans. With no recycling facilities, these used cans get thrown in with the daily garbage. The company will be helping to keep the environment cleaner by reusing these aluminum cans for the greater purpose of providing an irrigation means to a starving people. To this end, the Coca-Cola Company plays a huge role in the success of my company.

Beyond the aluminum cans that the pumps will be made from, a glue or epoxy will be needed to act as a binder for the aluminum. The construction of the pumps will not require the cans to be melted down, which would be detrimental to the environment, so the aluminum will be layered and cut to produce the necessary parts for the pumps. Therefore, this binder is required for the construction process. With a number of local hardware stores in Ndola, the supply chain is already in place to obtain epoxy, glue, or any other types of hardware fasteners the company will need. However, it will most likely prove cost-effective in the future to obtain these binders and fasteners from a wholesaler. With all of this taken into consideration, the construction of the pumps should not be cost prohibitive, which enables us to sell the pumps at an affordable price.



Keep in mind that the purpose of this business venture is not to make a fortune. My goal is to supply a need to an impoverished populace for an affordable price without going deep into debt. Yes, these pumps could be sold for \$20.00 each and they would still be the cheapest pumps in Ndola. The company will enjoy large profits and it will be debt free in less than 5 years if the above economic analysis is correct. The problem is, while my company would be thriving, the needy people in Ndola would have considerably more debt to pay off, thereby feeding their ongoing struggle to survive.

### **Stakeholder Analysis**

A stakeholder analysis looks into the affect of important parties, or stakeholders, on your project and the project's affect on those stakeholders. For instance, Coca-Cola is a stakeholder for this business venture because without the sales of Coca-Cola cans in Ndola, an essential supply line would be cut. For the project I have identified six major stakeholders: myself, the rural citizens of Ndola, Ndola hardware stores, non-profit organizations working in Ndola, the Zambian government, and the Coca-Cola Company.

As the founder and manager of the business, I will be a key stakeholder for this venture. The work I have put into planning and starting this business, as well as running it, makes me an important stakeholder in terms of my importance for the project's success. However, because the success of this venture is based solely on sales to the rural villagers of Ndola, my level of influence is slightly less than my importance.

The rural villagers of Ndola are the key stakeholders for this venture. Of course, they are the primary recipients of the irrigation pumps, making their level of influence and

importance for the project high. If they do not like the pumps, for whatever reason, the company could be out of business quickly. However, if the villagers do like the pumps and find that more income is generated for their families by owning one of the pumps, the company's sales volume could swiftly increase.

Ndola hardware stores represent another stakeholder for the project. On one hand, these stores provide the glues, epoxies, and fasteners for the construction of the irrigation pumps. In this respect, they would be eager for my business to start in Ndola because they would be suppliers for the company. On the other hand, some (if not most) of these hardware stores sell various types of water pumps for much higher prices than my company would charge. Therefore, they would not be happy to lose the sales from the pumps they were advertising. With all of this in mind, this stakeholder is important for the success of the company but does not hold much influence on this venture.

The next stakeholder group covers the non-profit organizations currently working in Ndola. While there are a number of organizations in Ndola, Seeds of Hope International Partnerships is the primary organization my business would be coordinating with. This is because of the ties I have with Seeds of Hope from traveling with them to Ndola. Seeds of Hope already has a client they provide hygiene and sanitation training to, donate water filters to, and employ. By working alongside Seeds of Hope my company could start advertising to this large client base. In addition, my business and Seeds of Hope could provide any necessary support (financially, materially, etc.) the other may need. This stakeholder holds some influence on the success of my business.

In doing any work, or starting any business, in a foreign country the government of the country needs to be taken into consideration. Thankfully, the Zambian government is a peaceful government that has allowed numerous non-profit and volunteer organizations to work in Zambia. This may reflect on the Zambian governments goal to help its people out of poverty. I do not foresee any problems with the Zambian government's interference of my business, and so this stakeholder is not important for the success of the project, but could potentially hold some influence in the future.

The Coca-Cola Company represents the final stakeholder. This stakeholder bears heavily on the success of my business. If, for instance, the Coca-Cola Company pulls out of Zambia and ceases to sell its products there, my business will have no source of cheap aluminum to construct the pumps out of. In contrast, if Coca-Cola increases its sales in Ndola there should be a greater supply of used aluminum cans, which will benefit my business. Although the Coca-Cola Company is important for the success of my business, it does not hold much influence on my business or its operations.

Appendix D has a visual breakdown of the stakeholder analysis. The first table gives a numerical ranking for each stakeholder for influence and importance for the project's success. In addition, it shows the effect of the project on the interests of each stakeholder. The second table provided compares each stakeholder, side by side, in terms of their importance and influence. From this table it's easy to see that the rural citizens of Ndola have the greatest impact on the success of my business, whereas the Zambian government has the least impact of the stakeholders analyzed.

## Risks

Pursuing any international business venture will inevitably result in risks that need to be taken into consideration. Of course, the major risks for my company are financial risks, risks associated the pump materials supply chain, and the risk of the pump not being accepted by the villagers of Ndola. If the business is suffering economically, or the supply chain is ended, the future of the venture could be quite short.

There are a number of financial risks associated with starting a business in Zambia. First, it is difficult to obtain an accurate estimate of how many rural villagers will be willing to purchase an irrigation pump. This could be correlated with the number of available, working hand pumps in a location at any given time. Next, prices for materials in Zambia can fluctuate greatly over time due to the hassle of transporting anything by road in country. There is uncertainty in various assumptions made in the economic analysis, but the most influential was the number of pumps sold in the first year. If the company does not sell enough pumps in the first year, it will be in a deep financial hole from the outset which may never be fully recovered from.

Following from the economic risks, and actually contributing to them, are supply chain risks. As stated in the shareholder analysis, the Coca-Cola Company and the local Ndola hardware stores are essential components for the successful operation of my business. If, for some reason, Coca-Cola pulls their operations in Zambia my company would suffer huge losses. This would force my company to look into other means of getting mass volumes of aluminum to Ndola cheaply and quickly. Now, an even greater threat is the part of the supply chain that the local hardware stores control. My business will need to purchase epoxies, glues, tools, and

fasteners from local hardware stores in order to construct the pumps. In general, the local hardware stores are regularly stocked and receive consistent shipments. However, if their suppliers were lost, my company would need to search for other supply outlets. In addition, the possibility of local hardware stores not selling these products to my company poses a threat. This should not be the case for hardware stores that do not sell pumps, but for the stores that do, they may feel that my company has taken that share of their business. Nevertheless, I do not foresee this as a likely problem my business will encounter, as the Zambian people are exceedingly helpful and kind.

The last major risk is the possibility of the pump not being accepted, for cultural or functional reasons, by the people in Ndola. Once again, I do not foresee this being an issue that is likely to affect my business, but it has the potential to devastate my company. If the people in Ndola do not like the pump I will have to go back and develop new prototypes before my business even gets off the ground. This could economically debilitate my business venture in addition to the supply chain risks.

Ultimately, the risks above are unlikely to influence the success of my business. However, they need to be taken into consideration and the business needs to be operated in a fashion that negates these risks as much as possible. Financially, I do not believe my business will have any issues selling a large number of pumps in the first year with the help of other non-profit organizations in the area. The supply chain risks are mitigated by the fact that the Coca-Cola Company has given no reason to believe it will cease its operations in Zambia. Lastly, I do not see any cultural or historic barriers forbidding the acceptance of my pump in Ndola. With adequate field-testing and market research I will have a good idea of what needs to be altered

on the pumps before the business starts selling them. All of the major risks presented here can be mitigated effectively and should therefore pose no immediate threat to the success of my company.

### **Metrics for Success**

For my business venture I have created nine metrics for success. The seven quantitative metrics are *pump sales per month, pump repairs per month, percentage of rural households in Ndola with a pump, average volume of water pumped before repairs are necessary, sale price per pump, monthly income generated from pump, and percentage increase in crop yields from using the pump*. The two qualitative metrics are *localization of pump materials* and *consumer happiness*.

For the quantitative metrics, I want some of them to be high and some of them low. For instance, I want the *pump sales per month* to be high. The higher this metric is, the more irrigation pumps are getting into the rural areas of Ndola and helping to bring the rural villagers food and income. On the other hand, I want the *sale price per pump* to be low so that the pumps are affordable. The *average volume of water pumped before repairs are necessary* should be high along with the *monthly income generated per month* and *percentage increase in crop yields from using the pump*. *Pump repairs per month* is a tricky metric. On one hand, the more repairs I complete the more money my company makes. However, because I am not starting this business to make a fortune, I want this metric to be low which will indicate the pumps are robust. The *percentage of rural households with a pump* I want to increase each year my company is in business, which will show growth in my company and in the livelihood of

my customers. In addition, I hope the *monthly income generated from owning a pump* will be substantial enough to help the rural families of Ndola out of poverty.

In contrast to the quantitative metrics, I want both of my qualitative methods to be high. The first, *localization of pump materials*, needs to be high in order to ensure the pumps can be sold at an affordable price and to keep my business as sustainable as possible. While “sustainable” is a loaded word, in this case I am speaking to the heart of appropriate technologies. Appropriate technologies should be constructed of locally available materials so they can be repaired locally. In addition, my company will help keep the hardware stores in Ndola in business by purchasing materials from them. The second qualitative metric, *happiness*, obviously needs to be high. If my pump customers are not happy with their pumps, my sales will drop, my company may go out of business, and my goal of bringing these families out of poverty will not be completed.

For a number of these metrics, a first-year goal should be set. For *pump sales per month* in the first year I hope to average about 800. I will shoot for 5% of rural Ndola households owning a pump in the first year, with that number increasing each subsequent year. I hope the sale price can be set, and remain, at around \$4.54 per pump. In addition to all of this, both qualitative metrics need to be rated as “High” in the first year and every year thereafter for my business to succeed. The other metrics are difficult to set a value on just yet, but as the first year unfolds ambitious goals will be set for them as well.

## Conclusion

After considering cultural influences, business models, finances, stakeholders, metrics for success, and risks I believe my company has a good chance of thriving. With the business being a non-profit organization, obtaining grant funding and help from other business and non-profits will be possible and necessary. The risks presented can be mitigated and the financial outlook of my business is promising.

So many organizations and businesses, including the World Bank and International Monetary Fund, have tried to bring poverty to its end in Africa to little avail. Their approach, in many cases, was not sustainable. Many of their efforts did not take into consideration cultural aspects or the preservation of local markets in the area. For instance, when money is poured into an area to alleviate poverty, the local market is devastated from this monetary onset. Once the donation is spent, the locals are again left without any means from which to generate income. Practices like this happen far too often and devastate the countries of Africa, despite their good intentions. My business of selling locally-constructed, affordable, and sustainable water pumps in Ndola, Zambia takes into consideration the overlooked details that caused many other projects to fail. My company will start the process of weeding out the starvation and poverty so often experienced in Ndola, Zambia and set the bar for other organizations and projects to follow. I believe that my approach to this business will have a lasting impact on the lives of the people not only of Ndola, but Zambia as a whole and eventually the whole continent of Africa.



**Appendix A:  
Map of Ndola, Zambia**



Images courtesy of <http://www.maps.google.com/> and <http://www.ilo.org/>.

**Appendix B:**  
**Technical Drawings of Irrigation Pump**



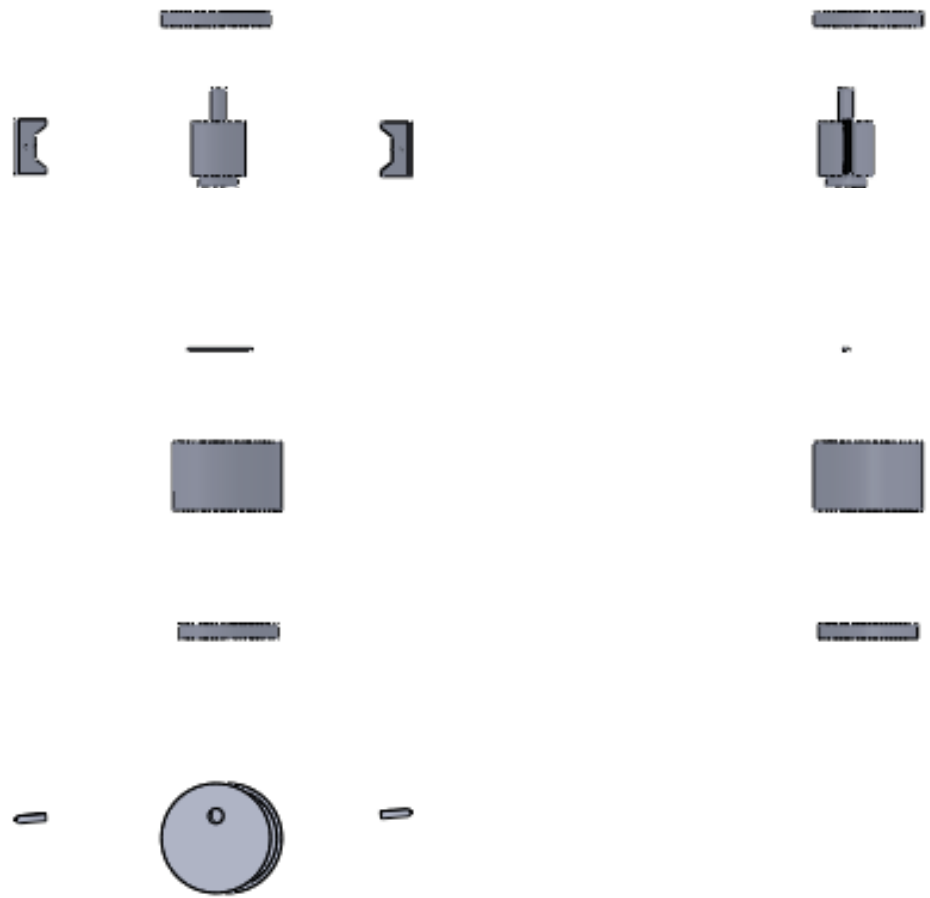
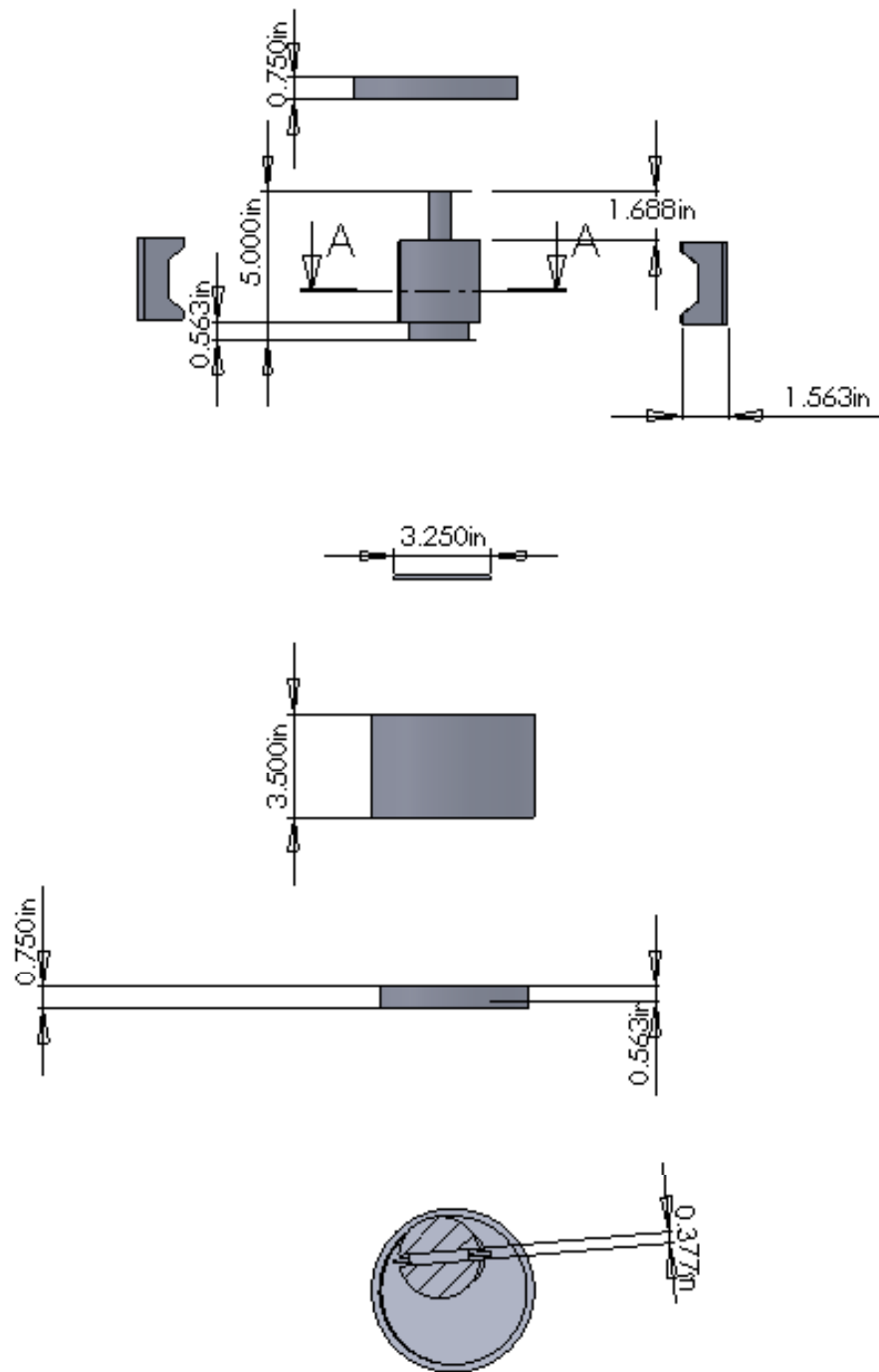


Figure B2. Exploded view of the irrigation pump assembly.



SECTION A-A  
SCALE 1 : 5

Figure B3. Further measurements and assembly view of the irrigation pump.

**Appendix C:  
Financial Analysis Tables and Graphs**

### Financial Break-Even Analysis: First 5 Years

Question: To break even after 5 years of company operation, how much should each pump cost?

- Assumptions:
- 1) 10,000 pumps sold in first year with a 15% sales increase annually for the first 5 years.
  - 2) Materials cost \$1.00 per pump produced.
  - 3) Pump repairs bring in \$5.00 per pump. 500 pumps repaired in first year increasing 15% annually.
  - 4) Donation funds of \$2000 at start-up and \$1,000 annually each year thereafter.
  - 5) Monthly rent costs of \$1,500 for the office, resulting in \$18,000 annually.
  - 6) At start-up: legal fees costing \$1000, office supplies costing \$2000, vehicle cost of \$1500, and hand tools costing \$100.
  - 7) 1500 miles driven annually by company vehicle resulting in \$500 of petrol costs.
  - 8) Annually maintenance cost for vehicles and equipment of \$300
  - 9) Labor wages: \$500 per month for each of the 6 workers with no new hires during the first 5 years.
  - 10) Internal rate of return (IRR) of 7%.

Table C1. Financial break-even analysis showing a pump cost of \$4.54. This table works from the assumptions detailed in the Financial Analysis section.

Year	Start-Up	Materials and Rent	Petrol and Maintenance	Wages	Repairs	Donations	Pump Sales	Balance
0	\$ (4,600.00)	\$ (28,000.00)	\$ (800.00)	\$ (36,000.00)	\$ -	\$ 2,000.00	\$ 45,414.81	\$ (21,985.19)
1	\$ -	\$ (29,000.00)	\$ (800.00)	\$ (36,000.00)	\$ 2,500.00	\$ 1,000.00	\$ 52,227.04	\$ (10,072.96)
2	\$ -	\$ (30,100.00)	\$ (800.00)	\$ (36,000.00)	\$ 2,875.00	\$ 1,000.00	\$ 60,061.09	\$ (2,963.91)
3	\$ -	\$ (31,310.00)	\$ (800.00)	\$ (36,000.00)	\$ 3,306.25	\$ 1,000.00	\$ 69,070.26	\$ 5,266.51
4	\$ -	\$ (32,641.00)	\$ (800.00)	\$ (36,000.00)	\$ 3,802.19	\$ 1,000.00	\$ 79,430.79	\$ 14,791.98
5	\$ -	\$ (34,105.10)	\$ (800.00)	\$ (36,000.00)	\$ 4,372.52	\$ 1,000.00	\$ 91,345.41	\$ 25,812.83
							<b>Present Value=</b>	\$ 0.00

**PUMP COST: \$ 4.541**



## Financial Break-Even Analysis: Sensitivity Tables and Chart

Table C2. The values in the table below show the values of assumptions once they are changed by a given percentage (a range of -50% to 50%). From here, we will plug in these values to determine how much each assumption affects the break-even price of a pump.

Change	Start-Up	Materials	Rent	Sale/Repair Increase	1st Year Pumps Sold	1st Year Pumps Rep.	1st Year Don. Funds	2nd-5th Year Don. Funds
-50%	\$ (2,300.00)	\$ (0.50)	\$ (750.00)	7.50%	5000	250	\$ 1,000.00	\$ 500.00
-40%	\$ (2,760.00)	\$ (0.60)	\$ (900.00)	9.00%	6000	300	\$ 1,200.00	\$ 600.00
-30%	\$ (3,220.00)	\$ (0.70)	\$ (1,050.00)	10.50%	7000	350	\$ 1,400.00	\$ 700.00
-20%	\$ (3,680.00)	\$ (0.80)	\$ (1,200.00)	12.00%	8000	400	\$ 1,600.00	\$ 800.00
-10%	\$ (4,140.00)	\$ (0.90)	\$ (1,350.00)	13.50%	9000	450	\$ 1,800.00	\$ 900.00
0%	\$ (4,600.00)	\$ (1.00)	\$ (1,500.00)	15.00%	10000	500	\$ 2,000.00	\$ 1,000.00
10%	\$ (5,060.00)	\$ (1.10)	\$ (1,650.00)	16.50%	11000	550	\$ 2,200.00	\$ 1,100.00
20%	\$ (5,520.00)	\$ (1.20)	\$ (1,800.00)	18.00%	12000	600	\$ 2,400.00	\$ 1,200.00
30%	\$ (5,980.00)	\$ (1.30)	\$ (1,950.00)	19.50%	13000	650	\$ 2,600.00	\$ 1,300.00
40%	\$ (6,440.00)	\$ (1.40)	\$ (2,100.00)	21.00%	14000	700	\$ 2,800.00	\$ 1,400.00
50%	\$ (6,900.00)	\$ (1.50)	\$ (2,250.00)	22.50%	15000	750	\$ 3,000.00	\$ 1,500.00

Change	Petrol	Maintenance	Wages	IRR
-50%	\$ (250.00)	\$ (150.00)	\$ (18,000.00)	3.50%
-40%	\$ (300.00)	\$ (180.00)	\$ (21,600.00)	4.20%
-30%	\$ (350.00)	\$ (210.00)	\$ (25,200.00)	4.90%
-20%	\$ (400.00)	\$ (240.00)	\$ (28,800.00)	5.60%
-10%	\$ (450.00)	\$ (270.00)	\$ (32,400.00)	6.30%
0%	\$ (500.00)	\$ (300.00)	\$ (36,000.00)	7.00%
10%	\$ (550.00)	\$ (330.00)	\$ (39,600.00)	7.70%
20%	\$ (600.00)	\$ (360.00)	\$ (43,200.00)	8.40%
30%	\$ (650.00)	\$ (390.00)	\$ (46,800.00)	9.10%
40%	\$ (700.00)	\$ (420.00)	\$ (50,400.00)	9.80%
50%	\$ (750.00)	\$ (450.00)	\$ (54,000.00)	10.50%

Table C3. The values in the table below shows the break-even price of a pump once the assumptions are changed by the given percentage. This analysis only deals with one variable changing at a time while all others stay at their assumed or "0%" value.

Change	Start-Up	Materials	Rent	Sale/Repair Increase	1st Year Pumps Sold	1st Year Pumps Rep.	1st Year Don. Funds	2nd-5th Year Don. Funds
-50%	\$ 4.510	\$ 4.097	\$ 3.907	\$ 5.445	\$ 9.083	\$ 4.635	\$ 4.555	\$ 4.570
-40%	\$ 4.516	\$ 4.186	\$ 4.034	\$ 5.252	\$ 7.569	\$ 4.616	\$ 4.553	\$ 4.564
-30%	\$ 4.522	\$ 4.275	\$ 4.161	\$ 5.065	\$ 6.488	\$ 4.598	\$ 4.550	\$ 4.558
-20%	\$ 4.529	\$ 4.364	\$ 4.288	\$ 4.885	\$ 5.677	\$ 4.579	\$ 4.547	\$ 4.553
-10%	\$ 4.535	\$ 4.453	\$ 4.415	\$ 4.710	\$ 5.046	\$ 4.560	\$ 4.544	\$ 4.547
0%	\$ 4.541	\$ 4.541	\$ 4.541	\$ 4.541	\$ 4.541	\$ 4.541	\$ 4.541	\$ 4.541
10%	\$ 4.548	\$ 4.630	\$ 4.668	\$ 4.379	\$ 4.129	\$ 4.523	\$ 4.539	\$ 4.536
20%	\$ 4.554	\$ 4.719	\$ 4.795	\$ 4.221	\$ 3.785	\$ 4.504	\$ 4.536	\$ 4.530
30%	\$ 4.561	\$ 4.808	\$ 4.922	\$ 4.069	\$ 3.493	\$ 4.485	\$ 4.533	\$ 4.524
40%	\$ 4.567	\$ 4.897	\$ 5.049	\$ 3.923	\$ 3.244	\$ 4.467	\$ 4.530	\$ 4.519
50%	\$ 4.573	\$ 4.986	\$ 5.176	\$ 3.782	\$ 3.028	\$ 4.448	\$ 4.528	\$ 4.513

Change	Petrol	Maintenance	Wages	IRR
-50%	\$ 4.524	\$ 4.531	\$ 3.273	\$ 4.480
-40%	\$ 4.527	\$ 4.533	\$ 3.527	\$ 4.492
-30%	\$ 4.531	\$ 4.535	\$ 3.781	\$ 4.505
-20%	\$ 4.534	\$ 4.537	\$ 4.034	\$ 4.517
-10%	\$ 4.538	\$ 4.539	\$ 4.288	\$ 4.529
0%	\$ 4.541	\$ 4.541	\$ 4.541	\$ 4.541
10%	\$ 4.545	\$ 4.544	\$ 4.795	\$ 4.554
20%	\$ 4.549	\$ 4.546	\$ 5.049	\$ 4.566
30%	\$ 4.552	\$ 4.548	\$ 5.302	\$ 4.578
40%	\$ 4.556	\$ 4.550	\$ 5.556	\$ 4.590
50%	\$ 4.559	\$ 4.552	\$ 5.810	\$ 4.602

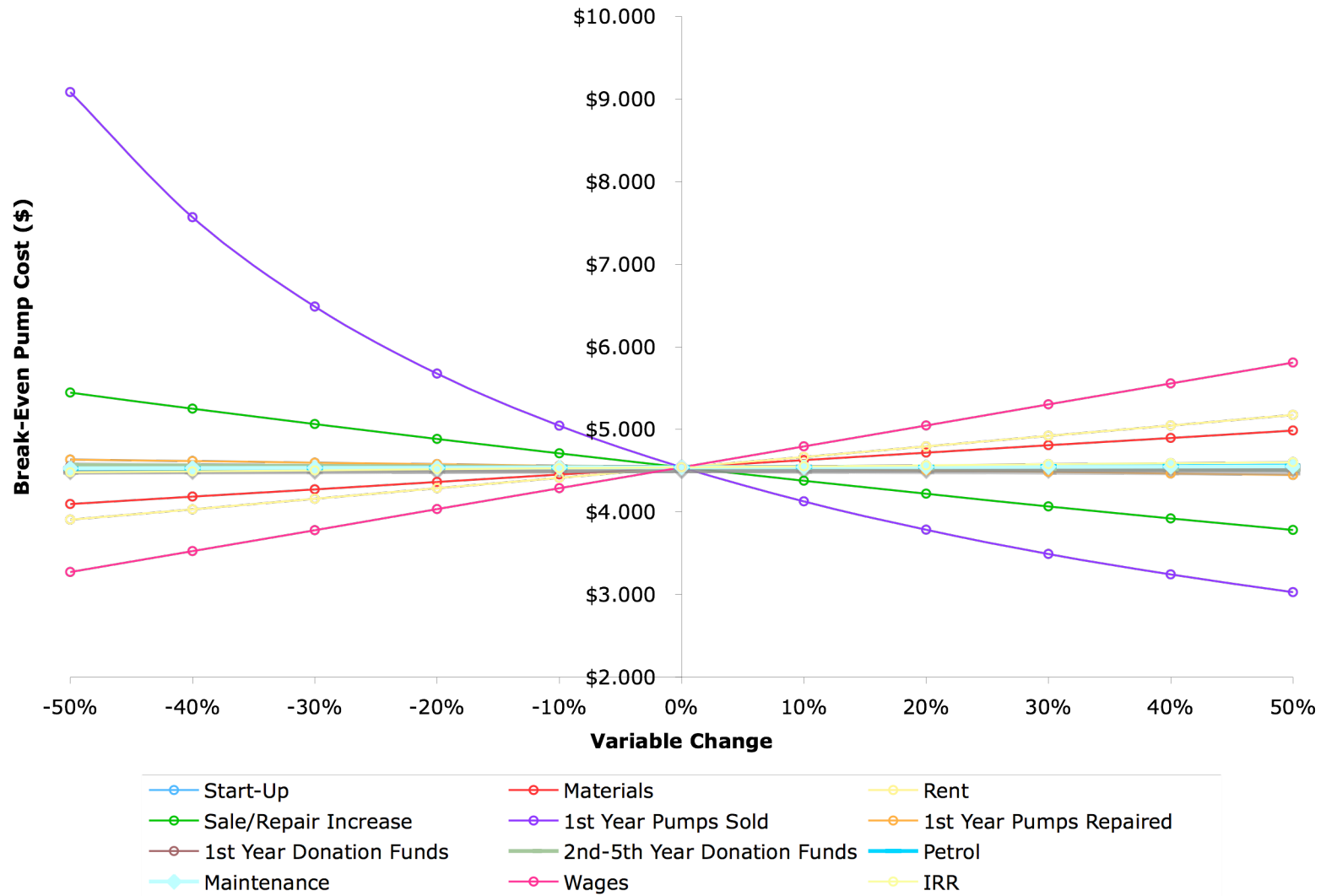


Figure C1. Chart showing the effect of changing different assumptions on the break-even pump price.

**Appendix D:  
Stakeholder Analysis Tables**

**Table D1. Stakeholder analysis table showing stakeholder interests in relation to project, effect of project on interests, importance for project success, and influence.**

<b>Stakeholder Groups</b>	<b>Interests at Stake in Relation to Business</b>	<b>Effect of Project on Interests (+,-,0)</b>	<b>Stakeholder Importance for Project Success (U,1,2,3,4,5)</b>	<b>Degree of Influence of Stakeholder (U,1,2,3,4,5)</b>
Robert Hosbach	Bring an affordable pump to rural Ndola citizens. Provide a source of income for those citizens.	+	5	3
Ndola Rural Citizens	Need a means to grow crops for food and to sell. Need an affordable pump to irrigate properly.	+	5	5
Ndola Hardware Stores	Want to be main seller of pumps and hardware.	0	4	2
Non-Profit Organizations	Want to serve a need of Ndola citizens.	0	2	2
Zambian Government	Want to see Zambian citizens get out of poverty.	0	1	2
Coca-Cola Company	Want to sell as many beverage cans as possible.	0	5	1

Table D2. Stakeholder influence and importance visual comparison table.

Stakeholder Influence	Importance of Stakeholder for Success of Project					
	Unknown	None 1	2	3	4	Great 5
Unknown						
None 1						Coca-Cola Company
2		Zambian Government	Non-Profit Organizations		Ndola Hardware Stores	
3						Robert Hosbach
4						
Great 5						Ndola Rural Citizens

## Annotated Bibliography

"Background Note: Zambia." *United States Department of State* Feb. 2010. Web. 10 Feb. 2010.

<<http://www.state.gov/r/pa/ei/bgn/2359.htm>>.

*This source provided historical background from colonization to present.*

Bennett, David. "It takes a lot of water to grow a corn crop." *Southeast Farm Press* 28 Dec.

2007. Web. 8 Apr. 2010.

<<http://southeastfarmpress.com/grains/122807-corn-water/>>

*This source provided information from a known agronomist about the water requirement for a bushel of corn.*

"Cole-Parmer Technical Library." *Cole-Parmer*. Web. 21 May 2010.

<<http://www.coleparmer.com/>>

This source provided a simple overview of the main characteristic of a positive-displacement pump.

"Giving." *Seeds of Hope International Partnerships*. Web. 2 Mar. 2010.

<<http://www.sohip.org/giving.html>>

*This source provided a cost estimate to install a hand pump.*

"Handpump Data, Selected Countries in Sub-Saharan Africa." *Rural Water Supply Network*

1 May 2007. Web. 2 Mar. 2010.

<<http://www.watsan.org/docs/number-of-broken-down-handpumps-in-Africa.pdf>>

*This source provided data on hand pumps in Zambia.*

“HIV Prevalence Decline.” *Central Statistical Office of Zambia*. Web. 10 Feb. 2010.

<[http://www.zamstats.gov.zm/media/hiv\\_prevalence\\_rates\\_decline.pdf](http://www.zamstats.gov.zm/media/hiv_prevalence_rates_decline.pdf)>.

*This source provided HIV prevalence statistics from a 2007 health survey of Zambia.*

Kay, Melvyn, and Tom Brabben. “Treadle Pumps for Irrigation in Africa.” *Food and Agriculture*

*Organization of the United Nations* Oct. 2000. Web. 2 Mar. 2010.

<<ftp://ftp.fao.org/docrep/fao/005/x8293e/x8293e00.pdf>>

*This source provided information of treadle pumps.*

“Living Conditions.” *Central Statistical Office of Zambia*. Web. 10 Feb. 2010.

<<http://www.zamstats.gov.zm/lcm.php>>

*This source provided data about poverty incidence and access to safe drinking water in Zambia.*

Murphy, William J. “Tables for Weights and Measurement: Crops.” *University of Missouri*

*Extension* Oct. 1993. Web. 8 Apr. 2010.

*This source provided information on the definition of a bushel of shelled corn.*

“Product Range.” *Meera & Ceiko*. Web. 2 Mar. 2010.

<<http://www.meera-ceiko.com/product.htm>>

*This source provided information about Meera & Ceiko hand pumps.*

“Projected Mid-Year Population 2000-2009.” *Central Statistical Office of Zambia*. Web. 10 Feb.

2010.

<[http://www.zamstats.gov.zm/media/projected\\_mid\\_year\\_population.pdf](http://www.zamstats.gov.zm/media/projected_mid_year_population.pdf)>.

*This source provided population estimations for the Copperbelt Province of Zambia.*



*"Stat Sheet: February 16, 2010." Seeds of Hope International Partnerships. 16 Feb. 2010. Web.*

8 Apr. 2010.

<http://sohip.org/Stat%20sheet%2002-16-10.pdf>

*This source provided current information about the impact Seeds of Hope International Partnerships has had in Zambia.*