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# Business Opportunities for Water Supply Projects in the Western Highlands of Papua New Guinea

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## **ABSTRACT**

This paper has identified the opportunity for a water supply project in a rural village in the heart of the Western Highlands in Papua New Guinea. It begins with a brief review of the issue of access to safe, clean and portable water for citizens and the inability of Third World governments to meet water requirements and the changing emphasis of donor agencies, more specifically the World Bank to fund water supply and related services through a demand response approach [DRA]. It then examines the national social and economic development status of the country and focuses on the issue of lack of access to safe portable water as a key problem for rural inhabitants who comprise the majority of the population. Against this background the opportunity for this project is presented with a critical analysis of the community's capacity to undertake and maintain the water supply facility using previous experience in two similar projects. It also outlines progress of work on this water project to date in relation to the formation of the water supply committee, completion of a feasibility study, design information, required materials and cost estimates, community financial contributions and the preparedness of the community to be responsible for the entire process. Potential risks to the project have also been identified and risk mitigation strategies are in place to address emerging issues. The value of undertaking this project is rooted in meeting the requirement for access to safe portable water as a basic need and for the long-term improvement in health and well-being of the people which indirectly contributes to economic benefits.

Keywords: Business Opportunities, Projects

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## 1.0 INTRODUCTION

Papua New Guinea is a nation of rural inhabitants with 86 per cent of its 5.5 million people dwelling in rural villages dependent on subsistence forms of survival [NSO, 2003]. Access to safe water and sanitation is crucial for the improvement of living conditions and health and its associated benefits of increased social and economic opportunities [WSP, 2003]. But, about 70 % of Papua New Guinea's rural population do not have access to safe water and sanitation services that are taken for granted by citizens of the UK and other developed countries. The opportunity for this project stems from the concern to meet a basic human need for access to safe and clean portable water for people in a rural village [Kelta] in the Western Highlands of the world's second largest island, New Guinea.

Internationally, the focus on water supply issues have shifted from a concern with water as a basic service to be provided for by the state to an integrated view to include water supply, sanitation and hygiene education [Nicol,2000]. Among the main problems of the supply orientated approach were difficulties of governments to finance the huge capital required to provide water supply systems and sustain the maintenance cost of technology to operate community based supply systems as well as issues of sustainability and ownership among the consumers. The change in the focus from supply based water provision was anchored on the premise that water is a social and an economic good. Governments of Developing Countries were increasingly unable to provide safe water for their populations. By 1992 the International Conference on Water in Dublin which preceded the Earth Summit in Rio and subsequently the international financial institutions came up with the idea that the state should play an enabling role by setting the appropriate institutional framework and work in partnership with communities, NGOs and the private sector to ensure that water is provided on the basis of demand. However, this raises issues of who should pay for what proportion of the costs.

The concerns with sustainability of water supply systems have been taken up by the World Bank to advocate for demand responsive approaches [DRA] to rural water supply and sanitation systems. Under DRA consumers are expected to pay for some of the costs whether it is capital or recurrent costs.

Key features of the DRA that:

- the community takes the initiative and makes the choice about the service option and how it is to be delivered;
- the community contributes to the cost of investment, relative to the service to be provided and has control of how the funds are managed;
- the state facilitates, sets policies and strategies, creates an enabling environment for all parties to operate;
- the community owns and sustains the facilities;
- this strengthens community capacity and awareness stimulates further demand for the service [World Bank, 2004, 2002, Nicol, 2000].

With regard to Papua New Guinea much of the urban water supply and sanitation service improvement systems around the country are attributed to project funding by the donor community, especially the World Bank under the DRA reviewed above, Asian Development Bank [ADB], Australian Aid, New Zealand Aid, the European Union and Japanese JICA. Currently ADB loan to the Water Board [National Water Authority] is undertaking a major water supply and sanitation provision and improvement to six Provincial towns [ADB, 2000] as part of the wider international commitment under UNDP's Millennium Development Goals to reduce world poverty by 2020. It is highly unlikely that the state would have made any significant investment on improving access to safe water, not even for the rural sector with recurring economic problems and the pressure from International Financial Organisations on the government to 'address economic management and political crises' [Baxter, 2001].

## 2.0 NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT STATUS

Since 1990 the economy took a down hill turn and the country went through an economic crisis. These economic problems have led the country to request aid from the International Monetary Fund [IMF] and the World Bank and underwent consecutive Structural Adjustment Programs [Lamour, 2002, Duncan, 2002]. The World Bank and IMF economic recovery packages set stringent conditions for the government to meet in order to qualify for funding and these included reducing the size of its public service, currency devaluation, privatisation of publicly provided services and introducing user pay systems for health and education. The country has a negligible manufacturing base and is highly dependent on the import of basic consumption goods, so the floating value of the currency has led to increasing costs for imported goods and prices have quadrupled between 1990 and 2000 [Duncan, 2002].

There are vast differences in social and economic development between regions and provinces. In the provinces the rural sector fares badly in both social and economic terms. Some infrastructure [national roads and bridges], health and education services are provided from the public purse, but official policy does not cover many other areas like employment opportunities, housing, water and sanitation services.

Up to date social and economic statistics on the country are not readily available due lack of research. The UNDP Human Development Report 2006 for PNG would have provided some recent guide, but it was not possible to get a copy for this paper. The table below provides some social indicators where data is available from different base years just to give the reader some idea of the situation.

Table 1.0, Selected Social Indicators of PNG

Indicator	National	Western Highlands Province	Year for which statistics are available
Employment [a]	10%	10%	2000
Access to safe water [b]	24	19	1996
	39	Not available	2002
Adult literacy rate [15 years +] [a]	56%	38%	2000
Average life expectancy [b]	55	55	
GDP per capita [ppp] [b]	\$US 2543	Not available	2006

Source: a) NSO, 2003

b) UNDP, 2006

### 3.0 ACCESS TO SAFE PORTABLE WATER

In PNG the function of water provision used to be the responsibility of the Water Board, the government arm established with the mandate for providing and regulating water and sanitation services. While water responsibility continues to be a state responsibility in some of the provinces the beginning of privatisation of water services in the nation's capital, Port Moresby commenced in 1998 when a Malaysian company was contracted to [on BOT terms] build and operate the city's water supply system to be transferred to the city council in 30 years. This has effectively turned water into a commodity and is no longer a basic service with sky high water rates that ordinary people can not afford to pay. This contributes to other problems, but that is beyond the scope of this paper.

Rural areas suffer from chronic lack of economic activity, opportunity, inadequate infrastructure and access to basic services [Baxter, 2001]. An ODI study by Nicol [2000] from a sustainable livelihood perspective suggests that in 1994 an estimated 74 % of the population in the Asia Pacific region had access to safe water and 34 % sanitation, but this is misleading and does not reflect actual country differences. In PNG the 1998 UNDP Human Development estimated that 24 per cent of the national population had access to safe portable water [UNDP and GovPNG, 1999:180] while its 2006 estimates show that this been increased to 39 per cent [UNDP, 2006]. However, these national average figures also disguise the huge urban and rural disparities in that 88 per cent of the urban population have access to safe water compared to 32 per cent of the rural population [UNDP, 2006]. In contrast, only 19 per cent of the Western Highlands Provincial population have access to portable safe water. In terms of health both national and provincial health statistics indicate that common water borne diseases continue to be the common causes of hospital admission and death with pneumonia as the leading cause of all hospital admissions and death followed by typhoid and diarrhoea [Temu, 1995]. This is partly due to the low levels of access to safe clean water and sanitation.

#### **4.0 BACKGROUND TO THE COMMUNITY**

Komapi is a sub-clan of one of the biggest tribes known as the Jiga of the Western Highlands Province. The Komapi people number up to about 2000 and they dwell in four villages [Kalam, Tipuka, Willimby and Kelta]. Each village is separated by rivers flowing from West to East. The villagers live in widely scattered hamlets of family groups. The identified project is intended to serve Kelta Village. Rates of education and literacy are low among the people and there are less than 15 members of the Komapi population in fulltime paid employment. Two major advantages are that: the people have a very good track record of co-operation and work together for any common purpose and their land is productive as it is located on the upper end of the Whagi Valley, one of the most fertile flood plains in the country.

The community has proven experience of initiating and undertaking projects from two previous examples: the construction of the only access road into Kelta and an electricity supply project for the entire Komapi people. The road project was undertaken when I was too young to be involved, but I had a major input for the electricity supply project. The projects are briefly described below to provide an indication of the community's experience in undertaking projects and the capacity to commit itself to the current project.

##### **Kelta road project 1980**

In the early 1970s the Kompai people constructed only one dirt road which connects Kalam village to the main road leading into Mount Hagen, the Provincial capital. Kelta, Willimby and Tippuka were not connected by road, until 1980 when the people of Kelta village constructed a 6 kilometre access road into the village with bare hands using spades and digging sticks. The only resource they had was the leadership of one of their own sons, who then was studying at the University of Papua New Guinea. The people contributed funds and purchased materials to build the bridge over the Rongen River and they compensated the people from the neighbouring clan whose coffee, trees and gardens the road was built through.

### Electricity supply project 2002/2003

Several young uneducated men from Kelta and Willimby have taken the initiative to organise the people to contribute money towards connecting electricity supply into the four villages. They requested the Provincial Electricity Commission to help out and as part of the government's rural electrification programme and the commission carried out a survey of the feasibility of providing electricity for the Komapi population. This provided the cost estimates for the overhead electricity lines, timber poles, cement and other connection equipment. With the estimated costs the volunteers collected about £5.00 per month from each family over a period of 18 months. Their contributions were topped up with help from the only ten graduate members of the clan who are in paid employment around the country and a self employed coffee buyer who operates at the village. Each village had to pay for the poles, lines, cement bags and connection equipment for their community and each household had to purchase lines for connecting electricity to their houses as well as electricity meter boxes. Labour and timber resources were provided by the men from the villages and women provided food. Each village had to contribute to pay the Electricity Commission workmen as they came out on weekends outside of normal duties to do the construction work. The community celebrated the opening of the electricity facility in 2003.

Empowered from experiences with the above two projects and the confidence that the people can help themselves we have now identified the need for access to safe water to be a pressing issue and propose a water supply project for Kelta Village. Kelta has a population of 526 which is approximately a quarter of the population of the clan. Distribution of the population is as follows.

Table 2: Population of Kelta in 2003

Hamlet	Population Composition				Total
	Men	Women	Children		
			Boys	Girls	
Willi	11	11	13	10	45
Kent	10	12	12	11	45
Kom	18	18	17	18	71
Meng	17	31	18	17	83
Kelta	5	11	4	5	25
Bitu	28	37	25	20	110
Koto	12	10	7	9	38
Rern	15	17	7	6	45
Rong	22	17	13	12	64
<b>Total</b>	<i>138</i>	<i>164</i>	<i>116</i>	<i>108</i>	<b>526</b>

Source: Kopel, 2003

## **5.0 THE CURRENT PROJECT 5.1 Project**

### **Objectives**

The proposed project complies with and shares the characteristics of the World Bank's criteria for assessing Demand Response Approach [DRA] to rural water supply projects. The community has commendable capacity and experience in undertaking and sustaining self help projects as indicated by the road and electricity supply projects. The underlying objective of the current project is to promote and improve the health of the people. The specific objectives include:

Access to sustainable source of safe water for all 526 members of Kelta Reduction and prevention of waterborne diseases in the village

### **5.2 Project Identification and Justification**

In Kelta the Rongen River which flows from West to East at the North end of the village used to be the source of washing, cooking and drinking. The clearance of vast parts of the highly dense forest and vegetation for cultivating coffee and commercial potatoes as well as subsistence crops has contributed to the drying up and pollution of streams which were valuable drinking water sources. In the wet season rain water is collected using drums, buckets and pots for consumption. In the dry season people switch to using the Rongen River for cooking, washing and drinking but with population increase both in this village and the neighbouring clan further upstream, the river is now contaminated. Levels of sanitation and health education and hygiene are low due to low levels of education so as a result water ways and river systems are polluted by animal and human faeces, open disposal of waste and washing. The existing source of water for cooking and drinking has adverse effects on people. The poor health of children affects their growth, school attendance, levels of concentration and over all level of learning. Adults are affected to the extent that both subsistence and economic activities are reduced or neglected and general levels of health deteriorate. As also demonstrated else where [WSP, 2003, ADB, 2000] poor health takes up extra household income and time on hospital visits and purchase of medicines. In recent years many children as well as adults have frequently suffered from water borne diseases especially typhoid and diarrhoea and recently two adults died from typhoid. The village people are now desperate for clean safe water.

Investment in this water supply project will be valuable in both social and economic terms. Access to safe water would significantly reduce the incidence of water borne diseases and improve the health and wellbeing of the people. It will also have economic benefits in that healthy people will reduce the need to make hospital visits and spend more time on increased economic activities, save more of their income instead of spending on medicine purchases. The water could also be used for their crops in extreme dry weather to improve crop yields. The need for investment in this project is immense for the people in a community that works extremely hard to improve their existence without any form of external service of assistance, not even from the government.

### **5.3 Feasibility study**

A water supply committee comprised of six members has been formed. The leader of the committee, Mr. Joseph Ulunga made a 200 mile bus journey down to the University of Technology on the coast to see if the Appropriate Technology Division at the University would be able to help with conducting a feasibility study of the possibility of the village getting a water supply. The Appropriate Technology Division sent two British volunteer engineers and they conducted the feasibility study on the means of a suitable water supply system. The feasibility study took two days and identified the Koma Puka, a spring with its source high in the mountains to be the most feasible and clean source of water for the village. The outcome of the feasibility study determined that the water source is at a higher altitude so the force of gravity will enable the water to flow downwards into the valley and along the ridge where the storage tank will be constructed, thereby avoiding any need for pumps [Refer to appendix A]. Therefore the project has been

designed as a gravity flow water supply system. The recommendations from the feasibility study are not the most technical or the cheapest options, but these were considered to be the most appropriate means through which water could be supplied to the village. The information on the design and distribution system is based on the feasibility study report.

#### *5.3.1 Construction of water intake works supply pipe line*

Water flow was measured to be 0.187 litres per second. A spring box is to be constructed of concrete for intake works to protect the water coming in from the Koma Puka source. This will collect the water to feed the supply pipe. The pipe from the intake works will be of galvanised iron because it will run above ground near the source where the ground is hard and rocky until it can be buried under ground. The use of underground PVC pipes will protect it from damage by gardening, flooding, animals and falling trees.

#### *5.3.2 Storage tank*

A ferrocement tank with a 10,000 litre capacity has been recommended to be installed for the storage system because it will be easy to construct on site. This will reduce the chances of damage during transportation and can easily be maintained if damaged. It is cheaper than tanks made of other materials and is longer lasting than other types of tanks. The ferrocement tank is to be constructed by fabricating a steel bar cage and wrapping it in wire mesh.

#### *5.3.3 Distribution system*

The engineers used a World Bank developed computer water distribution network design program to design the pipes from the tank to the tap stands [See Appendix B]. Again PVC pipes will be used where these can be buried underground and galvanised iron where the ground is hard. The design has provided eight communal stand taps for the system.

### **5.4 Resource implications and cost estimates**

Details of cost estimates and financing plan for the project are provided as follows. *5.4.1 Financing Plan*

The estimated total cost of the project is **£5,704.24**. The community contributions towards the project have amounted to [£947.96] K4,308.89 in the local currency [Refer to appendix C]. Hence the required funding yet to be secured is £4,756.28. The community will be providing the food and labour contributions towards the project. They have also selected two young unemployed school leavers to be observers of the pipe and tap stand works so that they could be responsible for maintenance work. Upon completion, water consumption will be free, but at the end of each year the water supply committee will collect £5.00 [K23.00] from each family to contribute towards the maintenance account. That money will be kept in an interest bearing water supply account until it is needed for repairs.

#### *5.4.2 Cost estimates*

A detailed breakdown of material requirements and costs can be found in appendix D and E respectively.

Table 2: Resources required and cost estimates

Exchange rate: K1= 0.22 pence  
 £1= K4.55

Resources	Quantity	Total Local Currency [Kina]	Total £UK [Pound Sterling]
Material costs	Refer to appendix E	20,662.15	4,545.67
Materials VAT @3%		2,066.21	454.57
Freight cost of materials from Mt. Hagen town		200.00	44.00
Contingency costs		1,000.00	220.00
Water board technical and supervisory assistance costs		2,000.00	440.00
<b>Project Total</b>		<b>25,928.36</b>	<b>£5,704.24</b>
<b>Resources to be provided by the community</b>			
Funding contribution		4,308.89	947.96
Water supply maintenance fund	Ongoing		
Water supply committee to oversee work			
Food for workmen			
Labour for:			
Construct intake works			
Clear pipe route			
Dig trench			
Construct storage tank			
Laying pipes			
Two trainees to be responsible for maintenance			
<b>Total Community contributions</b>		<b>K4,308.89</b>	<b>£947.96</b>
<b>Total Required Project Funds</b>		<b>K21,619.47</b>	<b>£4,756.28</b>
K25,928.36 minus K4,308.89 = K21,619.47			
£5,704.24 minus £947.96 = £4,756.28			

## 6.0 IMPLEMENTATION ARRANGEMENTS

In relation to project implementation Blacker [1995:52–53] warns that a major drawback of bringing in an outside team to implement a change initiative is that ‘any subsequent difficulties can be blamed on the outside team whereas a local team would almost certainly buckle down to get the problems fixed’ and this would improve successful project delivery and implementation. Taking this advice and given financial resource constraints it has been decided that the local people will contribute as much as possible as they are passionate about the project and are keen to do the work. The provincial water board has agreed to help with technical and supervisory assistance in the construction process. Two water board employees will come out to supervise and help as part of the rural service scheme of their work. The entire village community will provide labour for the construction work. The men will clear the area where the pipes will be laid and dig the trench for the pipes while the women will prepare the food and drinks to feed the workmen. Two young male school leavers from the village have been identified and selected to work with the plumber who would show them how to replace broken pipes and taps.

### 6.1 Timescale

The estimated timescale of the project and the duration of the various activities involved in the process are indicated in the following schedule of activities.

Table 3: Schedule of activities

Activity	Time in days											
	1	2	3	4	5	6	7	8	9	10	11	12
Organise & delegate tasks	■											
Clearing land		■	■	■	■							
Digging trench			■	■	■	■	■					
Constructing tank						■	■	■	■			
Laying pipes							■	■	■	■		
Construction of intake works									■	■		
Finishing touches and testing											■	■
Monitoring	■	■	■	■	■	■	■	■	■	■	■	■
Evaluation	Evaluation of operation, consumption and maintenance will be made after 12 months of use of the water supply facility											

## **6.2 Project performance and evaluation**

Once the project is completed water consumption and its impact will be monitored for 12 months. The incidence of adults and children with waterborne diseases will also be monitored to identify any association between access to safe water consumption water borne diseases among consumers. An evaluation study will be conducted after 12 months of operation to document the community's project experience, its benefits, project management and performance. There will also be a need for hygiene and sanitation education and awareness to further improve the health of the people, but that will remain to be the basis for another project.

## **6.3 Potential risks and assurances**

Potential risks to the project have been identified and considered. Refer to appendix F for potential risks to the project and risk mitigation strategies.

## **7.0 PROJECT MANAGEMENT THOUGHTS**

Unlike the role of project managers in other projects, in this situation as a member of this particular community I have a stake in the successful outcome of the project. My role as project manager is to work with the water supply committee and facilitate the process rather than playing the role of a conventional project manager as someone who leads the rest of the team as defined in western terms. This is for two fundamental reasons. First the water supply committee and members of the community have previous project experience which will be useful and secondly for cultural reasons to observe appropriate cultural codes of conduct in a male dominated rural society. Conducting meetings, making decisions and allocating responsibilities including division of labour for community resource input into the entire project process will comply with local cultural norms and practices to achieve maximum output.

As Newton states:

'Good project managers do not only use their sense of ownership to drive themselves to deliver. They project this passion onto the teams they are managing, and onto the customers they are delivering for' [Newton, 2005:79].

## **8.0 FINAL THOUGHTS ON VALUE OF OPPORTUNITY**

The value of this project to the people of Kelta must be reiterated. Currently people do not have access to safe portable water and have demonstrated their commitment to improve their lives through two previous projects as outlined earlier. The feasibility study for the water supply project was already done and community contributions have amounted to about a fifth of the project costs. The community is prepared to make contributions in kind with food and labour for construction. This is a crucial investment which future generations could benefit from. This project has both short and long term returns economically and socially. The high incidence of typhoid and diarrhoea will be reduced and health of the people will improve with the use of safe water for generations to come. The water could also be used to water their crops in the dry season and that will give improved yields. There is no doubt that this project will be sustainable because it is community based and demand driven by the potential beneficiaries who are partly financing it and they will also maintain the facility. This case demonstrates a genuine effort by people to improve their lives without a helping hand from the state. Manifestation of the World Bank's Demand Response Approach to rural water supply services is evident in this opportunity. Is there anyone out there who can help?

## 9.0 REFERENCES

- ADB, [2000] 'Water Supply and Sanitation Projects in Papua New Guinea'. Asian Development Bank <http://www.adb.org/PapuaNewGuinea/projects-water.asp> Accessed 21st April, 2007
- Baxter, M. [2001] *Enclaves or Equity: The rural crisis and development choice in Papua New Guinea*. Canberra: AusAid
- Blacker, K.[1995] *The Basics of Business Process Re-Engineering*. Birmingham: Edi Stone Books
- Duncan, R. [2002] 'Structural Adjustment Programs: The roles of the IMF and the World Bank'. Paper Presented at the Kumul Scholars International Conference on Structural Adjustment. Canberra 2002 [http://www.apseg.anu.edu/publish/pub\\_online.php](http://www.apseg.anu.edu/publish/pub_online.php) Accessed 11th April 2007
- GovPNG and UNDP,[1999] *Papua New Guinea Human Development Report*. Port Moresby: Gov PNG and UNDP
- Kopel, E.[2003] 'Kelta Community Development Survey'. Waigani: Social Development Strand, School of Social Science and Humanities, University of Papua New Guinea
- Lamour, P. [2002] 'Conditionality, Coercion and Other Forms of 'Power': International Financial Institutions in the Pacific'. Paper Presented at the Kumul Scholars International Conference on Structural Adjustment, Canberra 2002. [http://www.apseg.anu.edu/publish/pub\\_online.php](http://www.apseg.anu.edu/publish/pub_online.php) Accessed 11th April 2007
- Newton, R. [2005] *The Project Manager: Mastering the Art of Delivery*. Harlow, England: Prentice Hall
- Nicol, A. [2000] 'Adopting a Sustainable Livelihoods Approach to Water Projects: Implications for Policy and Practice'. London: ODI Working Paper 133 [http://www.odi.org.uk/wpp/publications\\_pdfs/BP\\_4.pdf](http://www.odi.org.uk/wpp/publications_pdfs/BP_4.pdf) Accessed 21st April, 2007
- NSO, [2003] *Report on the 2000 National Population and Housing Census in Papua New Guinea*. Port Moresby: National Statistics Office.
- Sweeney, S. and Rychnovsky, M. [1996]. Feasibility Study Report of the Proposed Water Supply for Kelta Village'. Lae: Community Development Committee, Appropriate Technology Division, University of Technology
- Temu, I. [1995]. *District and Provincial Health Profiles*. Waigani: Monitoring and Research Section Department of Health
- UNDP, [2006] 'Papua New Guinea Millennium Development Goals'. Available online, <http://www.adb.org/PapuaNewGuinea/png-mdgs.asp> Accessed 11th April, 2007
- World Bank, [2004] 'Rural Water Supply and Sanitation Tool Kit for Multisector Projects'. World Bank. [http://www.worldbank.org/html/fpd/water/rural\\_toolkit.html](http://www.worldbank.org/html/fpd/water/rural_toolkit.html) Accessed 21st April, 2007
- World Bank, [2002] Key Characteristics of Demand Responsive Approach: Water Supply and Sanitation'. World Bank. [http://www.worldbank.org/html/fpd/water/rural\\_dra.html](http://www.worldbank.org/html/fpd/water/rural_dra.html) Accessed 21st April, 2007
- WSP, [2003] 'Water Supply and Sanitation in Poverty Reduction Strategy Papers in the Sub-Saharan Africa: Developing a Bench Marking Review and Exploring the Way Forward'. Water and Sanitation program. [http://siteresources.worldbank.org/INTPRS1/Resources/PDFs/wss\\_in\\_prsp.pdf](http://siteresources.worldbank.org/INTPRS1/Resources/PDFs/wss_in_prsp.pdf) Accessed 21st April, 2007

Appendix C: Risk Management Table

	Consequence	Probability	Risk rating	Risk Management strategy
	4 <i>Extreme</i> 3 <i>High</i> 2 <i>Medium</i> 1 <i>Low</i>	4 <i>Almost certain</i> 3 <i>Likely</i> 2 <i>Possible</i> 1 <i>Unlikely</i>	<i>Multiply by columns 2 &amp; 3</i>	
Lack of community cooperation with construction work	1	1	1	Low risk Entire community is behind the project and willing to fully contribute time and labour for the project.
Intentional damage by people	1	1	1	Low risk! There is no way in which any one in the community will damage something they worked so hard for.
Damage by animals and the environment	1	2	2	Underground pipes will be buried deep in the ground Regular checks and cleaning by water committee, plumbers and community
Lack of funds for maintenance of water supply	2	2	4	The water supply committee will collect £5 from each family for the maintenance fund at the end of each year. That money will be used to pay for maintenance work.
Storage tank may burst	1	1	1	Low risk Tank is durable
Lack of skill for maintenance of water supply	3	3	9	Community identified and selected two young school leavers to work along side the water board plumber and engineer and learn how to do basic maintenance work on pipes and tap stands  In serious cases, the water supply committee will seek help from the Mt. Hagen town water board. Any payment will come from the maintenance account.