

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

VALUING WATER SUPPLY SERVICE
IMPROVEMENTS IN ADDIS ABABA

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**VALUING WATER SUPPLY SERVICE
IMPROVEMENTS IN ADDIS ABABA**

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“Valuing Water Supply Service Improvements in Addis Ababa”

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List of Acronyms

AACG	Addis Ababa City Government
AAWSS III-A	Addis Ababa Water Supply Stage Three Project
AAWSA	Addis Ababa Water and Sewerage Authority
AWDR	Africa Water development Report
CSA	Central Statistical Authority
CVM	Contingent Valuation Method
CV	Contingent Valuation
DTN	Distribution, Transfer and Networking
EEPC	Ethiopian Electric Power Corporation
ETC	Ethiopian Telecommunication Corporation
BoFED	Bureau of Finance and Economic Development, Addis Ababa City Administration
ESRDF	Ethiopian Social Rehabilitation and Development Fund
FDRE	Federal Democratic Republic of Ethiopia
lpcd	Liter Per Capita Per Day
MLE	Maximum Likelihood Estimates
MoWR	Ministry of Water Resources
PF	Public Fountain
PRPC	Policy Research and Planning Commission
PRSP	Poverty Reduction Strategy Paper
UNCED	United Nations Conference on Environment and Development
WEDC	Water Engineering and Development Center
WSP	Water and Sanitation Program
WTP	Willingness to Pay
WTA	Willingness to Accept
UNDP	United Nations Development Program

Abstract

Using the contingent valuation method (CVM), the study sets out to analyze determinants of households' WTP, estimate total WTP, and derive aggregate demand and aggregate benefit for improved water supply service. The study used cross-sectional data collected from 240 households in Addis Ababa, the capital city of Ethiopia through closed-ended value elicitation format with open-ended follow up questions. The empirical models adopted by this study are probit and tobit models. The tobit model is used to identify socio-economic factors that affects the WTP of households and to estimate aggregate demand and aggregate benefits for the proposed improvement in water supply service. The probit model is used to calculate the mean WTP for the closed-ended format.

Results of the study reveal that about 38.72% of the respondent reported that they do not have private tap connection to the existing system. The majority of the households (83.82%) also indicate that they are not satisfied with the existing water supply service. The mean per capita consumption of water is found to be 37.6 liters per day which is far lower than the absolute minimum UN standards (50 lpcd). The mean WTP values are 15.34 and 20.20 cents per Baldi (a 20 liter bucket) for the improved water supply service as calculated from the tobit and probit model, respectively. The households WTP for improved water service is greater than the existing water tariff rate of the authority. The total WTP amount from the sample of 126,108 households in Addis Ababa sub-cities was found to be Birr 154, 198.26 per day.

The area under the demand curve represents the gross value of consumers' surplus which is Birr 181,935.36 per day if water is considered as a free good. But water is an economic good and if a new tariff rate of the authority proposes to be 8 cents per Baldi the consumers' surplus will be reduced to Birr 94,397.85 per a day. The rest of the benefit is distributed to the water authority Birr 80,364.96 in the form of revenue and Birr 7,172.55 as a dead weight loss per day.

The tobit model shows that there are several explanatory variables that affect the WTP value. Income of the household, sex of the respondent dummy (female = 1), education (both secondary and tertiary level), households' year of stay, households not using tank as a storage, wealth of a household, occupation of the respondent dummy (employed = 1), households satisfaction with the existing service, and location of the study site (Addis Ketema) have positive and significant effects on willingness to pay. Family size has negative and significant effect on willingness to pay.

The policy implication of the study is that the inhabitants of Addis Ababa city are willing to pay for improved water supply service if it is provided for an affordable price. In addition, policymakers need to be aware that socio-economic characteristics and water use practices of households influence the willingness to pay for better water services.

Key words: *water, supply, reliability, CVM, WTP, Addis Ababa*

CHAPTER ONE

INTRODUCTION

1.1 Background

The world faces severe and growing challenges to sustain water quality and meet the rapidly growing demand for water resources. New sources of water are increasingly expensive to exploit, limiting the potential for expansion of new water supplies. Moreover, poor women and other disadvantaged groups have unequal access to water in many regions. The number of countries facing problems of water scarcity is rising. In 2006, 1.1 billion people lack access to water and 2.6 billion are without adequate sanitation. The lives of these people are blighted by disease, poverty and indignity. Worldwide, a child dies every fifteen seconds from water-related diseases (Water Aid, 2006).

In relation to this, many urban water supplies provided by public utilities are facing an acute crisis in many low-income countries. Capacity has fallen far lower than the exponentially rising demand; 450 million urban dwellers, particularly in marginal settlements, are excluded from piped water network which compromises their health and productivity. Thus, private sector participation in water utilities and full-cost recovery pricing measures has been widely advocated. However, given the scale of the problem and the limited funds available, neither public nor private utilities alone may necessarily provide the ideal delivery vehicle (WEDC, 1999).

As in other developing countries, the urban centers of Ethiopia are also characterized by poor water supply services. At the moment, Addis Ababa city which accounts for over a quarter of the nations urban population is facing unreliable and inadequate supply of water and sanitation services (AAWSA, 2005).

However, different studies indicate that customers are willing to pay to avoid water shortages, and many customers value water supply reliability quite high. According to Carson and Mitchell (1987) a contingent valuation study was conducted in southern and northern California residential customers. The result showed that customers were willing to pay \$142 per year to avoid 30% to 35% shortage twice out of 5 years.

According to Abdella (2003) reliability means availability of water at a point of consumption (household or public stand pipe) for 24 hours a day, 7 days a week, 365 days a year. In our case this definition has been adopted with regard to reliability.

Hence, in order to assess the household willingness to pay for improved water supply service the study employs a contingent valuation method. This method involves obtaining direct information from individual household about their willingness to pay for changes in water service. Thus, this study tries to evaluate the demand for improved water service by inhabitants of the city based on their WTP.

1.2 Statement of the Problem

Rapid growth of the Ethiopian population which is estimated about 2.9% per year reached 77 million in 2007 (CSA, 1994), together with the different socio-economic needs of the country, will put pressure on the needs to optimize the utilization of the water resources. In return to this, it leads to the deterioration in quality and quantity of the resources.

Moreover, water has been regarded by the Ethiopian society as a free gift of nature. But actually it is not so. This attitude has to change by creating public awareness. Now we have learnt that it is a scarce economic good. Its under use, over use or misuse can lead to

environmental, social, economic and health disasters. The supply of water to the intended need costs public funds which will have to be recovered in part or in whole as the case demands (MoWR, 1996).

In connection to this, AWDR [ca.2004] indicated that effective water resource management requires that water be treated as an economic good. AWDR also mentioned 1992 UNCED which states that “water has an economic value in all its competing uses and should be recognized as an economic good”. To argue for water to be treated as an economic good does not necessarily imply that a market price must be paid for it. What it means is that water is scarce and valuable resource that should not be wasted, and the proper pricing (valuation) will ensure efficient utilization.

Thus, water supply service in Ethiopia is found far below the required level. According to CSA (2000) cited by MoWR (2003) states that for all the water development activities achieved so far, the average access to safe water supply is 28% of the total population of Ethiopia. The average per-capita consumption in urban areas is close to 15 *lpcd*. This can be taken as an example of a very low supply and coverage level. It must be noted here that the coverage figures will even reflect much worse situations considering the unreliability and unsustainable of the supply of safe water. This is a clear indication of the vulnerability of the wellbeing and productivity of the peoples of Ethiopia.

Lack of adequate and safe water supply and sanitation remain two of the main transmitters of disease in Ethiopia such as diarrhea, cholera and dysentery, which are potential causes of loss of life especially in the case of children. Moreover, water and sanitation inadequacies hinder economic and social development that constitutes a major impediment to poverty alleviation. Thus, information regarding the existing water supply service would be of great importance



for policy considerations in the context of providing adequate water supply service so as to mitigate the spread of water borne diseases in particular and poverty in general.

Recently, Addis Ababa has been undergoing rapid changes in terms of its size and importance. In relation to this, it was forecasted that its water demand would substantially increase in the subsequent decades. However, AAWSA (2005) states that since 1994 no substantial water supply was added to the existing one and so demand for water has by far exceeded supply which resulted in shortages and low pressure in many areas of the city.

In general, the root causes of the problems of the existing water supply system in this city includes: rapid growing of population, fast expansion of metropolitan area, financial constraints, high rate of water wastage, and administrative constraints. Thus, these causes are the major factors for the incompatibility between the water demand of Addis Ababa and supplying capacity of AAWSA.

In relation to this, to improve water supply service in Ethiopia, the government has implemented integrated short and long-term plans. The Poverty reduction strategy paper (PRSP), for instance, stresses the need for a greater focus on rural water supply and on the poor urban. ESRDF (2005) further states that Ethiopia has adopted the Millennium Development Goals (MDGs). The MDGs have been constituted as the integral part of the government's Sustainable Development and Poverty Reduction Program (SDPRP). One development target of the MDGs is to increase access to clean water at national level from 30% in 2005 to 70 % by 2010.

The above phenomena call for immediate efforts to improve the existing water supply and promote the construction of new supplies so as to cope up with the increasing demand for

water. To find solution to the existing water supply problems, the water utility needs to link it self with its customers and stakeholders for the communal advantage of the whole residents of the City.

Nevertheless, most previous studies made on the city water supply system focus on the development of supply-oriented approach to deal with the water supply service problems. But along this, to attain an improved water service to residents of the city, an assessment on effective demands of the majority of the households need to be made. According to Whittington et al. (1990) a new vision based on the demand-oriented approach has emerged. This new approach asserts that water utility bodies need to understand actual household water use behavior and the observed ability and willingness to pay for improved water services.

Hence, this information gap on the household water demand behavior needs to be investigated and reconsidered to be used for policy purposes. This study, therefore, assesses the factors that affect the households' WTP for water supply service in terms of availability and access. Thus, the result of the study is believed to help policy makers to design appropriate water pricing for cost recovery systems under the proposed improvements.

1.3 Objectives of the Study

The major objective of this study is to estimate the value of improved water supply services to the water consumers of Addis Ababa by measuring their willingness to pay, which provides basis for appropriate financing policy. The specific objectives of the study include:

1. Examine the status of water supply services in Addis Ababa.
2. Estimate household's willingness to pay for improved water supply service.
3. Identify factors determining willingness to pay.
4. Use the willingness to pay responses to calculate aggregate benefits.
5. Draw appropriate policy implications and recommendations based on the findings.

1.4 Significance of the Study

Addis Ababa, with its ever increasing population, has reached a state of critical water shortage. To satisfy the rapidly increasing water demands of the city, Addis Ababa Water and Sewerage Authority (AAWSA) has been doing some expansions of the water treatment plant, transmissions and distribution facilities, and successive works are undergoing. However, major water sources must urgently be developed in order to overcome the current shortage and to cope the future requirements of the growing population.

In relation to this, the study will help to assess the value of water supply service with the help of the consumer's demand approach for a given supply system. It shows how much the consumer is willing to pay for improved water supply service with the intension of cost recovery systems. Generally, this study will contribute to the country's implementation of its water sector development strategies in general and its water supply service in particular.

Furthermore, the result of the investigation is expected to help the city authority, AAWSA, NGOs, and other interested donor agencies that work or want to work on this sector. In this regard, the findings of the study have vital contributions to the country in general and to the city, in particular.

1.5 Organization of the Study

The remaining part of the paper is structured as follows: Chapter two deals with water supply situation of Addis Ababa. The third chapter deals with review of literature. In the fourth chapter, scope and methodology is discussed. Chapter five covers the empirical results and discussions. The last chapter deals with the summary, conclusions and policy implications of the study.

1.6 Limitations of the Study

The study is limited to generating demand side information about improved water services from households in Addis Ababa. Secondly, time and finance limit us in both size and coverage of the sample survey to a specific area in the city. The sample size was limited to 240 households.

CHAPTER TWO

WATER SUPPLY SITUATION OF ADDIS ABABA

2.1 Description of the Study Area

Addis Ababa is the capital and largest city of Ethiopia, and also the country's commercial, manufacturing, and cultural center. It is situated in central Ethiopia at an elevation of about 2440m above sea level on a plateau which is crossed by numerous streams and surrounded by hills. It is suited between 9 degrees north latitude and 39 degrees east longitude. It is the seat of the African Union and a center of a variety of other international organization with a large number of expatriate personnel.

BoFED (2004) cited by AAWSA (2004) indicate that the Federal Democratic Republic of Ethiopia (FDRE) has set up a new city's government structure by the Proclamation No. 31/2003. According to the proclamation, Addis Ababa city government is divided in to 10 Sub-Cities and 203 Kebeles. This restructuring of the previous 28 woredas (districts) that were divided into 306 Kebeles and 29 Peasants' Associations is in line with the current civil service reform programs and administrative decentralization. The 10 sub cities are the administrative divisions of AACG, whereas, the 203 Kebeles under the sub cites are the lowest local government's administrative structures. Out of the 203 kebeles of the 10 sub cities of Addis Ababa, 181 are urban and 22 are rural. The rural kebeles are situated in 4 different sub cities, namely, Nifas Silk-Lafito, Yeka, Bole and Akaki-Kaliti.

The population of Addis Ababa is about 3million in 2007 with 2.89 % annual growth rate and is projected to reach about 4.7 million by 2025 (CSA, 1994). In 1984 the administrative area of Addis Ababa had been 220 km² and by 1994 it had extended 530 km² and at present it is

over 540 km². Such this expansion aggravates the demand of the ever increasing problem of water scarcity in the city. AAWSA (2004) states that only 300 km², out of a total area of the city of over 540 km², are served with water supply. Consequently a considerable percentage of the population has been forced to collect water from creeks and dug wells that have vulnerability to high pollution and related health risks. The proportion of people with out sustainable access to safe drinking water is almost half of the total number of inhabitants and is over one million.

Mostly these un-served people are people of low-income living in socially disadvantaged periphery-urban areas which have been lately incorporated in to the city administrative area, namely the south east part of the city. The north east part of the city is also with a critical water shortage due to its higher elevation. Similarly, most of the west part of the city with serious water shortage depends on small pumping stations of inefficient subsystems.

2.2 Water Production and Household Use

For the first time, the potable¹ water supply for Addis Ababa city was initiated during the reign of Emperor Menelik in the year 1895 particularly for the palace, patriarch and parliament service by conveying the water through 2 pipes. The water supply was realized by constructing minidam along Kebena at the slope of Enteto mountain in the south. Later on,

¹ Access to potable water is broadly defined as the availability of at least 20 liters per capita per day from a sources located with in 1km of users dwelling (UN, no date , cited in Alebel, 2004).

the first Gefersa dam construction with a height of 9 meters was completed in 1944 to impound 1.5 million cubic meters of water at 18 kilometers west of the city. However, due to lack of treatment facilities and pipe lines to convey water to the city, the source remained unused until 1952. Currently, the dam is 15 meters high having a storage capacity of 6.5 million cubic meters of water and the treatment plant produces 30,000 cubic meters of water per a day. The existing transmission line include two 400 mm steel pipes from the dam to the treatment plant and another two 400mm steel pipe that convey from the treatment to the reservoir of the city (WEDC, 1999).

The next major phase of expansion of the water supply facilities commenced in 1970 with the commissioning of the Legedadi dam / treatment plant which is located at 33 kilometers on the big Akaki river, east of Addis Ababa city. Further development of the water supply facilities was pursued in 1986 under Water Supply Stage II project and treatment plant of the Legedadi plant was upgraded from 50,000 to 150,000 cubic meters of water per a day. Along these, the Dire Dam project was completed to avail additional 42,000 cubic meters of water per day for the Legedadi plant. The transmission line is now 900mm steel pipe from the Legedadi dam to the treatment plant and then two parallel 900mm and 1200mm steel pipe to convey water from the treatment plant to the terminal reservoir of the city. In addition to this, AAWSA (2005) indicate that Akaki ground well field as well as a few other springs and wells have been developed with a total capacity of 38,000 cubic meters of water per a day.

In the future, AAWSA is planning to have more water sources in the coming 20 years under Water III-A project to produce a total of about 813,500 cubic meters of water per day. Out of this, the ground water in the Akaki well field is expected to produce 125,000 cubic meters of

water per a day while the surface water from Sibilu and Gerbi Dams would have a supply of 611,500 and 77,000 cubic meters of water per a day respectively (WEDC, 1999). TAHIL² Engineering Consultants estimated that this proposed supply system is about 4 times greater than the existing one.

Table 2.1 gives a summary of the major indicative production parameters relating to water supply in Addis Ababa over the past five years. It shows that AAWSA had registered water production about 207,000m³/day. The average figure for the observed period implies a production of about 67 *lpcd*. Considering the UFW³ (unaccounted for water), at average was around 32 % over the period 2000-2004, the actual consumption rates average only around 45 *lpcd*.

It has been indicated that UFW in Harar town was 34 % as a result of leaks and illegal connections (Genanew, 1999). UFW in Addis Ababa still remains high compared to the international standards (between 10 and 20 percent) as indicated by Menard and Clarke [ca. 2001]. The main reasons for UFW are: leakage, illegal connection, poor maintenance and ancient infrastructure, malfunctioning meters and erroneous readings. Out of the billed volume that is, on average, around 45 million m³ per year in 2000-2004, the domestic consumption accounts for approximately half and that of the industry about 7.5 %. The rest 41.9 % is attributed to mainly institutional and commercial consumption (see table 2.1). Similarly, on average, the water supply system for the year 2000-2004 had 186,304 connections per a year.

²TAHIL -Consulting Engineers Ltd on Addis Ababa Water Supply Project – STAGE III -A (AAWSA, 2004).

³ UFW is the volume of water calculated as the difference between the water produced at the treatment plants and the amount of water legally consumed from the system for which corresponding billing has been performed through meters (WEDC, 1999).

Table 2.1: Water production and consumption of Addis Ababa

Year	2000	2001	2002	2003	2004	Average
Population	2,495,000	2,570,000	2,646,000	2,725,000	2,805,000	2,648,200
No. of connection	165,959	173,067	186,066	197,095	209,332	
Volume (in 000 m ³)						
Produced	65,793.9	63,082.2	68,775.0	67,537.6	75,820.2	68,201.81
Consumed (billed)	41,501.6	40,435.4	45,203.8	49,120.6	55,336.2	45,203.8
Domestic (%)						50.7 %
Industry (%)						7.4 %
Others (%)						41.9 %
UFW	36.9 %	35.8 %	34.3 %	27.3 %	27.0 %	32.3 %
Water production (lpcd)	69.2	64.0	67.4	63.9	69.3	66.7

Source: AAWSA, 2005

2.3 Water Tariff Structure in Addis Ababa

It can be observed from documents that piped water supply for Addis Ababa city started in 1901 during the reign of Menlik II. Initially, piped water was supplied to the public free of charge. It was noted that between 1927 and 1928 a flat rate was fixed and people started to pay for water services. However, the amount of the then fixed rate is not known (AAWSA, 2001).

The history of known water rates and fees of Addis Ababa started from 1945. Water tariff rates and fees were levied in the Water Rules Legal Notice No.91 of 1945. The schedule showed two types of rates for volumetric charges. A fixed rate related to the size of the household was laid for water supplied without meter and a flat rate of birr 0.50 /m³ was set for water supplied through a meter. The flat tariff rate of birr 0.50 per meter cube had been functional for 50 years and the first change was introduced in July 1995 (AAWSA, 2001).

Currently AAWSA is implementing a tariff policy that should lead to financial sustainability. The policy was based on the findings of the tariff study carried out in 1999 by Earnest⁴ and Young. Gradual implementation of the policy began in 2002/03 and full implementation was expected in 2006/07. The tariff rates are based on consumption blocks, with rates for the 5 year implementation period is shown in table 2.2.

Table 2.2: The tariff rates of AAWSA

	Total (Birr/m ³)				
Consumption Block (m ³ /month)	2002/03	2003/04	2004/05	2005/06	2006/07
Any amount from PF	1.15	1.30	1.45	1.60	1.75
<7	1.15	1.30	1.45	1.60	1.75
7-20	1.95	2.25	2.55	2.85	3.15
>20	2.65	3.04	3.40	3.75	3.80
Other than residence	2.65	3.04	3.40	3.75	3.80
Weighted average		2.81	3.15	3.48	3.57

Source: AAWSA, 2005

The tariff rate of AAWSA has been increased slightly since 2002/03 on different uses such as: domestic consumption, industrial consumption, institutional and commercial consumption. For a domestic use, a progressive tariff rate has been implemented in which the lower consumption block consumer pays lower tariff rate and the higher consumption block consumer pays higher tariff rate. However, for all non domestic consumption there is a flat tariff rate which is relatively higher than the domestic consumption. Similarly, any amount from public fountain (PF) and more than 20 m³/month of the domestic consumption have been paid a flat tariff rate.

⁴Earnest and Young- a consulting Engineers on Addis Ababa water supply project (AAWSA, 2005)

For the year 2006/07, the domestic consumption of household up to 7 m³ per month is paid 1.75 Birr/m³. Similarly, the domestic consumption of households between 7-20 m³/month also pays 3.15 Birr/ m³. Furthermore, the monthly consumption for domestic use exceeding 20 m³/month and any amount for non domestic use have been paid 3.80 Birr/m³. Finally, any amount of water from the PF is also a flat tariff rate of 1.75 Birr/m³. For all types of water consumptions, the weighed average rate of tariff is 3.57 Birr/m³ (see table 2.2).

2.4 Mode of Water Service Provision in Addis Ababa

As indicated on table 2.3, with the betterment of the standard of living of the population, more inhabitants upgrade their mode of supply from lower to a higher standard, say from Public Fountain (PF) to Yard Connection Shared (YCS), or from YCS to Yard Connection Private (YCP) or from YCP to House Connection (HC). The shift from a lower mode of service (PF) to a higher level (YCP or HC) is often associated with increased demand either for personal use or for improved hygiene in public outfits.

By the year 1994, around 4%, 22%, 26%, and 45% of the total tap connections were composed of in house, YCP, YCS, and PF, respectively. For the year 2025, 50%, 35%, 10% and 5% of the tap connections of the inhabitants are expected to be in house, YCP, YCS, and PF, respectively (see table 2.3).

Table 2.3 Mode of water service provision in the city

Year	Mode of services			
	HC (%)	YCP (%)	YCS (%)	PF (%)
1994*	4.43	22.43	25.57	45.33
2011	30	30	20	20
2020	40	35	15	10
2025	50	35	10	5

Source: AAWSA, 2005

2.5 Income and Expenses of AAWSA

AAWSA is a self-financing authority, the sources of revenue being sale of water, sewerage service, connection fee, other miscellaneous income, aids, grants, loans, and capital subsidy from Addis Ababa city Administration (AAWSA, 2001). However, the water supply provision system in Addis Ababa can not cover its costs. Thus, AAWSA has suffered huge losses and is subsidized by the city government. For the year 2000-2003, from the total income of the authority, subsidies of the city government on average accounts for about 26.9 % every year. For the sample period AAWSA had incurred a cumulative loss of 139 million birr, with average annual deficit of 35 million (BoFED, 2004). Since 2006 AAWSA has been covering its operation and maintenance costs and the rest is still subsidized for capital investments.

* The balance populations obtain their supplies from rivers, creeks, springs and private boreholes (CSA, 1999)

CHAPTR THREE

REVIEW OF LITERATURE

3.1 Theoretical Literature Review

This section deals with ways in which how economists attach values to the resources provided by the natural environment. In relation to this, we deal with the theoretical foundations for the techniques that economists have developed for environmental valuation in connection with the resources. The economic approach to the valuation of resources is based on the contribution of the resources to human welfare. Whether the good or services is marketed or non-marketed, its unit economic value is determined by the welfare contributions that it makes to humans. Consequently, the need to demonstrate the importance of environmental policy is the ultimate objective of the valuation.

3.1.1 Measures of Welfare Changes

The change in utility due to change in prices, quantities or both leads to a change in welfare of the society. Changes in welfare are measured in terms of each individual's personal assessment of changes in well-being. For traded commodities, the demand curve depicts the marginal willingness to pay (WTP) for the good or service. The household will consume all units of the commodity where the marginal WTP exceeds the market price. The consumer enjoys a consumer surplus for all points where the marginal WTP is higher than the market price. The welfare change associated with a change in the price of a marketed commodity is often measured using the change in consumer's surplus, derived from the Marshallian demand curve with a constant level of income.

For non market ecosystem service, the maximum WTP for an improvement in quantity or quality is the area between the initial and new levels of the resource under the demand (marginal benefit) curve. Value estimation then involves determining directly or indirectly the shapes of these marginal WTP curves for the ecosystem services (Shiferaw et.al., 2005).

According to Shiferaw et al. (2005) a given household maximizes its welfare (U) from consumption of a vector of marketed goods (c), ecosystem goods and services (q) and has a fixed budget y, such that :

$$\text{Max } U = U(c, q) + \mu(\mu - p'c) \text{-----}(3.1)$$

The standard utility-maximizing solution to this problem will give the Marshallian demand function for the tradable commodity:

$$c^* = c(p, q, y) \text{-----}(3.2)$$

which is a function of a vector of market prices (p), the disposable income (y) and the ecosystem services (q) considered to be a public good. If this is substituted in to the utility function it could be derived:

$$v(p, q, y) = U(c(p, q, y), q) \text{-----}(3.3)$$

The marginal effect of the change in the level of the public good q_i on household welfare can be derived as:

$$\frac{\partial v(p, q, y)}{\partial q} = \frac{\partial U(c(p, q, y), q)}{\partial q} \text{-----}(3.4)$$

This is equal to the marginal valuation of the environmental good. For a given change in q from q^0 to q^1 , the welfare effect on household **h** can be estimated as

$$\Delta U^h = v^h(p, q^1, y) - v^h(p, q^0, y) = \int_{q^0}^{q^1} \left[\frac{\partial v^h(p, q, y)}{\partial q} \right] \text{-----}(3.5)$$

The total welfare effect (WTP) summed over all the affected households (h) can be calculated as:

$$\sum_h \Delta U^h = \sum_h \int_{q^0}^{q^1} \left[\frac{\partial v^h(p, q, y)}{\partial q} \right] dq \text{-----} (3.6)$$

The compensating surplus (CS) and equivalent surplus (ES) measures (analogous to the compensated variation (CV) and equivalent variation (EV) for price changes) can also be directly derived from the indirect utility function. For an improvements in q from q^0 to q^1 the CS and ES measures can be computed as:

$$v(p, q^1, y - CS) = v(p, q^0, y) \text{-----} (3.7)$$

$$v(p, q^1, y) = v(p, q^0, y + ES) \text{-----} (3.8)$$

The expenditure function for household h is given by $e^h(p, q)$. The aggregate welfare change measures for a change in q from q^0 to q^1 for CS can be

$$CS = \sum_h (e^h(p, q^0, u^0) - e^h(p, q^1, u^0)) = \sum_h \int_{q^0}^{q^1} \left[\frac{\partial v^h(p, q, u^0)}{\partial q} \right] dq \text{-----} (3.9)$$

The aggregate ES measure for a change in q from q^0 to q^1 can be given as:

$$ES = \sum_h (e^h(p, q^0, u^1) - e^h(p, q^1, u^1)) = \sum_h \int_{q^0}^{q^1} \left[\frac{\partial v^h(p, q, u^1)}{\partial q} \right] dq \text{-----} (3.10)$$

The CS is the maximum amount of money that the individual is willing to pay (WTP) to secure an increased provision of the public good q. The ES measures the minimum sum of money that must be given to individuals (WTA) before the change to make them as well-off as they would have been following an increase in q. This forms the basis for valuation of non-marketed ecosystem services.

The measure of welfare change can be either positive (a welfare gain) or negative (a welfare loss). For a proposed welfare gain the compensated variation measures tell us how much money income the individual would be willing to pay (WTP) to ensure that the change occurs; while the equivalent variation measure tell us how much extra money income would have to be given to an individual (WTA) for the person to attain the final improved utility level in the absence of provision change occurring.

3.1.2 Methods for Valuing Environmental Resources

Economists have made great strides over the past decade in developing better methods to estimate the benefit of environmental quality improvements. For the most part, these methods are aimed at estimating primary benefits, implicitly assuming that secondary benefits are insignificant – likely offset by secondary costs. A review of the extensive literature on the subject shows that there are several methods used in practice. Some are better than others at quantifying the more abstract or intangible benefits of improved environmental quality.

Economics literature indicates that the total economic value of an environmental good is composed of two types: Use value and non-use value. The total economic value of water can be broadly defined as the maximum amount the user would be willing to pay for the use of water.

A study by Borgoyary (2002) cited by AWDR [ca.2004] states that people obtain many types of value and benefits from water that can generally be classified in to two categories: use value and non use value. Use value involves commodity benefits (for drinking, cooking, sanitation and leading to productive activities on farm and industries) and waste assimilation benefits (to carry away and dilute waste). The non use value is difficult to measure, but can

be divided in to existence value (value from knowledge of continued existence), bequest value (the willingness to pay in order to ensure the next generation will be able to use the resource in the future), social value (value that an individual derives from knowing that person other than himself will be able to use the good in question once it has been provided) and option value (WTP for a non-marketed good may stem from a desire to preserve to option to enjoy the good in the future).

In relation to this, various valuation methods are available to attach economic values to non-marketed environmental resources. According to Callan and Thomas (1996), these methods can be discussed in to two: indirect (revealed) method and direct (expressed preference) methods.

3.1.2.1. The Indirect method

Economists use indirect methods to make inferences about markets that are linked to the environmental good under investigation. While there are many indirect estimation methods, the researcher consider two common on benefit valuation: the travel cost method (TCM) and the hedonic price method (HPM).

One approach to valuing environmental benefits is the travel cost method, which uses the complementary relationship between the quality of a natural resource and its recreational use value. The TCM depends on information about the amount of money and time people spent getting in to a site to infer a value for that site. According to Callan and Thomas (1996) TCM has a primary advantage of measuring environmental benefits based on actual behavior, but it ignores non-use value. Furthermore, this method focuses on recreational use, making it

ineffective for estimating any incremental benefits that might be accrue to commercial users of a resource.

The HPM is based on the theory that a good or service is valued for the attributes or characteristics it possesses. This perception of value suggests that implicit or hedonic price exist for individual product attributes, and these can be determined from the explicit price of the product. Housing markets have been a classic context for hedonic environmental pricing studies. Such analysis assume that the market price of a home is determined by the implicit value of its many characteristics, such as location, number of baths, lot size, public services, and the environmental quality of the commodity. According to Carson (2000), however, this method does not capture non-use values that are very important when we deal with environment and hence underestimate the total economic value.

3.1.2.2 The Direct Method

The direct methods estimate environmental benefits according to responses or observed behaviors directly tied to the environmental quality. The common method in this approach is contingent valuation method (CVM).

Contingent Valuation Method

When market data are unavailable or unreliable, economists can use alternative estimation methods that rely on hypothetical market conditions. Such methods typically use surveys to inquire about individuals' willingness to pay (WTP) for some environmental policy initiative. This survey approaches to benefit estimation is known as the contingent valuation method (CVM) because the results are dependent up on the hypothetical market devised. CVM is based on classical economic theory using Hicksian technique, that is, either compensation

variation (WTP) for improved in environmental services or equivalent variation (WTA) compensation for environmental deterioration.

The CVM first came into use in the early 1960s by Economist Robert K. Davis (1963) when he used questionnaire to estimate the benefits of outdoor recreation in a Marine backwoods USA. Since then, the CV technique has been utilized by various economists to measure the benefits of a variety of goods including recreation, hunting, water quality and toxic waste dumps (Mitchell and Carson, 1989).

In general, CVM helps researchers to capture the total value of the good: both use and non-use values and its flexibility facilitate valuation of a wide range of non-marketed goods. As a result, this method is becoming the most preferred valuation at present. Thus, based on the reasons mentioned above CVM is employed for this study.

Methodology of CVM

CVM can be conducted in various ways such as: mail, telephone or in person interview. If resources are available to properly train interviewers and supervise the enumeration then face to face interview is better than other survey methods for developing countries like Ethiopia. Because of this reason, this study uses a face-to-face interview survey method to get accurate and reliable information to address the objectives of the study.

The major steps involved in using CVM include:

1. Designing and administering a CV survey that elicits individuals' values for a good or service. According to Mitchell and Carson (1989) in this step of CVM, a questionnaire consisting of three parts used to administer the survey. The first part of

the questionnaire includes a hypothetical description of the terms under which the good or service is to be offered to the respondent. The second part tries to determine how much the respondent values a good or service (elicitation of WTP or WTA). The third part includes questions about the socio-economic and demographic characteristics of the respondent including his/her family.

2. Analyzing WTP responses- this involves the calculation of frequency distribution, cross-tabulations of WTP responses with socio-economic characteristics and other variables and the estimation of bid function.
3. Estimating aggregate benefits and the total revenue - calculating the total economic benefit (total WTP) by multiplying the population by the mean WTP is the third step.
4. Evaluating the CVM exercise (validation tests) - undertaking validity test to determine whether the CVM results are acceptable or not is the last step. There are two common procedures of testing the validity of the CVM study.

The first is test-retest procedure which involves conducting a CVM survey for a particular change in environmental quality on a certain sample and then repeating the same CVM survey on a different sample from the same population some time later. Results from these two samples will then be compared for statistically significant differences, where insignificant differences are the manifestation that the CVM provides reliable estimates of WTP (Loomis, 1989). The second procedure is convergent validity checks. This procedure compares CVM estimates for a particular environmental good with estimates gained from other valuation methods such as TCM or HPM. If CVM survey provides similar results to TCM or HPM, then it can be said that the study is reliable (Hanley et al., 1997). Thus, to test the validity of CVM, the researcher used test-retest procedure by which the result of this study was compared with other similar studies.



Approaches of Contingent Valuation (CV) Elicitation Techniques

The basic approaches to asking questions that lead directly to willingness to pay are: open-ended, closed-ended format, bidding game, payment card, closed-ended with a follow up format. Each method has its advantage and disadvantages.

Open ended- is a CV question in which the respondent is asked to provide the interviewer with a point estimate of his or her willingness to pay. This method was the first measure used in CV surveys. It has the advantage of its relative computational ease and counter starting point bias. But, this method is associated with a large number of respondent non responses and protests zero bids. Mitchell and Carson (1989) further argue that this method is difficult since respondents face to pick a value out of the air with out some form of assistance.

Closed-ended- (dichotomous choice question) involves question format in which respondents are asked simple yes or no questions of the stylized form: would you be willing to pay \$t?. This method has the advantage of being familiar with respondents like in real markets where buyers face fixed price and it will be on the decision of the buyer to accept or reject that price. While this format is familiar, it suffers from starting point bias, shortage of information reducing efficiency and requirement of large sample to estimate benefits as maximum WTP not directly obtained from this format.

Bidding game- is a CV question format in which individuals are iteratively asked whether they would be willing to pay a certain amount. The amounts are raised (lowered) depending on whether the respondent was (was not) willing to pay the previously offered amount. Some have argued that this method has the potential to elicit the respondent's maximum willingness to pay (Cummings et al., 1986) and that the iterative process aids respondents in fully

considering the value of the good in question (Hoehn and Randall, 1987). It has a better efficiency than closed ended format. However; recently iterative bidding has fallen out of favour because many feel that the bidding process is unduly influenced by the starting bid (Cummings et al., 1986). This method exhibits very strong starting point bias and may be boring to respondents. Moreover, respondents may give answers only to avoid additional questions.

Payment cards- is a CV question format in which individuals are asked to choose a willingness to pay point estimate from a list of values predetermined by the surveyors, and shown to the respondent on a card. The payment card format provides respondents with a large number of WTP amounts out of which they pick one.

This method is better than open-ended format in which it could be simpler for the respondents and then large proportion of response could be obtained. However, this method requires the respondent to be literate, and this makes it of little use in developing countries where considerable part of the population is illiterate.

Closed-Ended with a Follow Up- this method starts with a closed-ended question but to increase efficiency an open-ended follow up question is added in which the respondent provide his/her maximum willingness to pay. This method may suffer from a starting point bias which can be minimized by conducting a pilot survey. Compared to bidding game, this method is easier to handle for both the interviewer and respondent. In addition to this, it is more familiar to the inhabitants of Addis Ababa where the seller encourages buyers to name a price if they are not willing to pay the initial bid. Thus, the study has employed this method due to its convenience and applicability uses.

Critiques on CVM

Although a number of researchers have employed the CVM, using such survey method has some basic problems in the sense that survey respondents could give biased information. Five major potential types of bias have been identified as follows (Callan and Thomas, 1996).

Strategic bias-an individual may have an incentive not to reveal his/her true preferences about an environmental good when responding to questions about willingness to pay (WTP). This bias may arise from free-rider ship problem typically associated with public good. Individuals may be tempted to understate their true WTP for public goods in the hope of a “free ride” while others pay for the provision of the good or service. Alternatively, if the price to be charged for the public good is not tied to an individual’s WTP response, the respondent may over-report WTP in order to ensure the provision of the good. To reduce this bias, the questionnaire for this study is designed to the respondents with some how detail description of the proposed improvement of the scenario.

Hypothetical bias- because the market is a hypothetical one, the respondent may view the questions as not believable or unrealistic, and respond with an equally unrealistic estimate of WTP. If respondents are not familiar with the scenario presented, their response can not be taken as their real WTP. However, this type of bias is not likely significant for water supply service in the study area. Because, in Addis Ababa different water systems have already been built; our respondents are all familiar with public fountains, shared tap connection and private water connections and already understood the possibility that the community will receive improved water supply services. In general, this bias has been tried to minimize in this study by a careful description of the good under consideration for the respondents.

Interviewer bias- the respondent's answer may be influenced by the enumerator who is employed to administer the interview. To minimize this problem, the enumerators were given two days of training and then conducted supervision of the main survey.

Starting point bias- This is mostly associated with bidding games. The choice of a low (high) starting point leads to a low (high) mean WTP. The starting bids used in this study were obtained from the pilot survey so as to minimize this problem.

Information bias- if there is insufficient information about the commodity being valued; the individuals' WTP response may not be equivalent to their actual WTP. In this study to minimize such bias the survey design was administered carefully and gave training to the interviewers.

In general, CVM is widely applicable and applied monetary valuation method despite its limitations. It has potential application to a wider range of environmental goods than any other valuation techniques. It has strong theoretical basis with unique advantage that it estimates income compensating welfare measures. When surveys are properly planned and executed, most of the CVM problems can be eliminated and it would be one of the best methods for estimating environmental benefits. In this study, the value of water supply reliability in Addis Ababa city is estimated by using contingent valuation method (CVM) to measure WTP. Domestic water consumers' were asked questions on their willingness to pay for improved water services.

3.2 Empirical Literature Review

The contingent valuation method (CVM) has found extensive application in recent years in valuing of environmental benefits, the benefit of reduced air pollution, valuing of water quality, valuing of improved solid waste management and the option or existence value of ecologically important species.

According to Carson et al. (1996) and Hanemann (1994,1996) cited by Alemu (2000) states that a number of theoretical and methodological issues and criticisms have been raised concerning the application of the CVM in general and in valuation in developing countries in particular. A look in to a literature indicates that, at least at the theoretical level, a large number of criticism were linked with problems in the details of specific studies, such as how the questionnaire is prepared and data are collected and analyzed.

Ten years ago only a handful of very rudimentary contingent valuation studies had been conducted in developing countries; at the time the conventional wisdom was that it simply could not be done. The problems associated with posing hypothetical questions to low income people and illiterate respondents were assumed to be so difficult that one should not even try (Whittington, 1998).

However, according to Whittington (1998) it is now assumed by many environmental and resource economists and policy analysts working in developing countries that contingent valuation (CV) surveys are straight forward and easy to do.

Generally, the reliability of the CVM method depends on the design of the questionnaire. For example, in order to come up with a realistic willingness to pay (WTP), estimates of the

hypothetical change in water supply should be clearly defined and the rules of the hypothetical market games should also be clearly understood. To increase the reliability of a CVM study, it is advised to increase the use of focus groups, the use of debriefing questions to see how well CVM respondents have understood the survey, and why they give that particular answer recorded.

3.2.1 CVM Applications in Water Related Studies: the Ethiopian Experience

The Ethiopian experience reveals that limited CVM studies have been conducted to investigate factors that influence households' willingness to pay for improved water supply in rural and urban areas including Addis Ababa. Some of the studies are given as follows.

Fisseha (1997) used a contingent valuation method to assess consumer's willingness to pay for an improved water supply service, on Meki town, Ethiopia. The study selected a sample of 246 households which were chosen randomly. The study used multinomial ordered probit model. In this study the researcher used double bounded elicitation format followed by open ended questions. But he did not give any justification regarding the application of OLS or tobit model from the open ended question values. The result showed only income and the time cost of fetching water to be significant determinants of WTP for improved water in the town.

Similarly, Assefa (1998) used contingent valuation survey on determinants of household demand for improved water services in Addis Ababa with a sample of 217 households using iterative bidding game. Methods used in the analysis were descriptive statistics, the binomial probit model for connection probability, and the ordered probit models for WTP.

In the connection probability model the variable household income, ownership of residing house, age and education level of household head are found to be significant determinants of households' decisions to connect to the improved water scheme. The t-statistics of the ordered probit model for private connection indicated that variables on the household income, sex, education level, household size, time, and household attitude on responsibility of water provision to be statistically significant. In addition, in the model for the public tap estimates on education level and household size were statistically significant.

Assefa selected two sites in his sample based on water supply problem, one site with critical and the other with partial critical water problems. However, the city shows much variation in both water supply services and economic status which was overlooked by the study. Thus, the study might be deficit to draw conclusion about the city regarding the real image of water supply problems. Furthermore, the study used iterative bidding game with out justification. Since this method which is boring for both the enumerators and the interviewees and could result in strategic and starting point bias.

Dunfa (1998) also employed contingent valuation method on estimating willingness to pay for rural water supply Ada'a-Liben district with a sample of 228 households, central Ethiopia. The study employed an iterative bidding game. The study utilized descriptive statistics and order probit model. The study result showed the peasant households' willingness to pay for improved rural water provision was positively influenced by income of the household, distance (time it takes to fetch water), quality of current water source and credit.

In Harar town eastern Ethiopia, Genanew (1999) analyzed determinants of households' willingness to pay and demand for improved water services. The study used iterative bidding game. Multivariate regression based on the ordinary least squares and the ordered probit

models were used to analyze the determinants of WTP for improved piped water service. Variables such as: household income, education level, sex, location of study site, starting point of the bidding game, main sources of water and serious problem of the existing water service were found statistically significant on willingness to pay for both models.

Both Dunfa (1998) and Genanew (1999) used iterative bidding game for WTP, but this method results very strong starting point bias. In connection to this, Genanaw tested initial bid bias in his study and he found that initial bid bias was significant at 1%.

Using the contingent valuation method, Tsegabrihan (1999) investigated WTP for irrigation water in Tigray, Ethiopia using OLS and ordered probit regression models. The study estimated WTP of small holder farmers for irrigation water particularly for small scale irrigation schemes. The survey results were included for the main irrigation seasons and the whole year, which depends on the 0.25 hectares of irrigable land.

The study reported that about 90% of respondents were willing to pay up to Birr 600 for the main irrigation system alone. The study further found credit availability, education, and fertilizer supply as the major determinants of respondents' WTP. The study employed a sample of 82 out of 1071 household heads. Thus, due to smaller sample size the estimated sample variance (δ^2) increase that could be the reason why many of the variables were found statistically insignificant results.

Using a contingent valuation method, Alebel (2004) also examined the affordability and willingness to pay for improved water supply in urban areas of Ethiopia taking Nazareth town as a case study. The value elicitation method used in the study was bidding game and a total of 307 sample households were covered during the survey. The study used a censored least

absolute deviation (CLAD) which does not need the normality and homoscedasticity assumption of the distribution of the error term to get consistent estimate. The study also used the probit model to see the effect of the explanatory variables on the choice of the household to the improved water service.

The results of the CLAD regression showed that income, monthly expenditure for water consumption, quality and time taken to fetch water from the existing source significantly affects the respondent's willingness to pay. While the probit estimation result indicated that wealth, income, education level, source the household is being used, quality and time taken to fetch water from the existing source affects the choice of the respondents to the improved water services. In this study the researcher used bidding game elicitation format with out any justification. But this method as mentioned previously results in different types of bias.

Jonse (2005) also used a contingent valuation method on valuing non-agricultural uses of irrigation water: empirical evidence from the Blue Nile River-Basin of the Amhara Regional State, Ethiopia. The study sets out to analyze determinants of households' WTP, estimate total WTP of and derive aggregate demand for non-crop uses of irrigation water. The study used cross-sectional data collected from 260 households through double-bounded value elicitation format with open-ended follow up questions under detailed descriptions of two different scenarios, namely, existing and improved irrigation water supply for domestic uses. The empirical models adopted by this study were probit and bivariate probit models.

Results of the study revealed that respondents' WTP were affected by a number of explanatory variables including institution-related variables such as water users associations, community-based water management, and socio-economic variables like income, wealth, ownership of ox, age, education and family size of respondents. Specific location of users

site, quantity and quality of irrigation water for domestic uses were other explanatory variables that affect consumers' WTP for non-crop uses of irrigation water. However, in contrast to many literatures the study did not improve the statistical efficiency of using double-bounded over single-bounded format.

A similar study was also made by Medhin (2006) using a contingent valuation survey on households demand for improved water service in urban areas: the case of Addis Ababa. She used 250 sample households. The elicitation method employed was single bounded format with an open-ended follow up question. She used probit and Tobit model to analyze the determinants of households' willingness to pay for improved water service. The descriptive analysis showed that only 30% of the respondents reported that they did not have private connection to the existing water service. About 70% of the respondents said that the existing service were not reliable.

In the Tobit model income, education, and sanitation facility were found positive sign and significant , whereas perceived water quality, age, and water related disease were negative and significant at the required level of significance. Concerning the Probit model, income, education, marital status, water related disease; years of stay in the area positively affect the probability of responding to the initial bid. The finding further indicated, the mean WTP was found 20 cents per Baldi (20 liters container) from single-bounded probit model estimates and 15.79 cents per Baldi from the open-ended format.

Medhin used a purposive sampling from three sites that believed to have very critical and partial critical water supply problems. However, the study did not include areas which relatively best in terms of water supply services. Similarly, there is a variation in the economic status of the people in the city which was not considered while sampling in the

study. Thus, the study needs appropriate sampling techniques to address real water supply situation of the city.

3.2.2. CVM Applications in Water Related Studies: the Developing Countries'

Experience

Whittington et al. (1990) estimated individuals' WTP for improved water services in rural areas of southern Haiti using the ordered probit model. The study concluded that WTP of individual respondents were affected by household wealth, education level of respondents, distance of the household from the existing water sources, quality of water and sex of respondent. The results of the study also suggested that it is possible to do a contingent valuation among a very poor, illiterate population and obtain reasonable answers.

In rural areas of Punjab in Pakistan Altaf et al. (1992) conducted a CV study with the main objective of identifying determinants of households' WTP for improved rural water supply and comparing the CV study results with market-based results. The authors found that wealth and education of respondents were among the major factors that affect respondents' WTP for improved rural water services. Empirical results of the study also confirmed that the CV study results seem consistent with revealed preference results.

Montes et al.(2003) conducted a study on assessing the willingness to pay for maintained and improved water supplies in Mexico city. The result showed the poorer households were primarily concerned with securing reliable services, while wealthier households which already enjoy better services were willing to pay higher amounts to avoided services deterioration than for improvements. The study demonstrates how WTP results can be used to create equity based policy of water tariffs reflecting income distribution. The aggregated

WTP amounts show that the authorities could collect sufficient resource for both service modernization and could also reduce existing subsidies by about 70%.

Abdalla (2003) also used CVM to estimate the value of improvements in water supply reliability in Zanzibar town. Random samples of 300 households were drawn from the survey. The study implements probit model and OLS regression model to statistically estimate the influence of different household socio-economic and other variables on the household decision on WTP for water services.

The probit analysis indicated that three variables were significantly correlated with the household decision to pay for improved services. These are education, past payment and experience on availability problem. While education and past payment have positive coefficient, experience on availability problem has a negative coefficient. Similarly, OLS analysis indicated that only one factor (experience on water availability problem) was significant at 0.05 level and has a negative coefficient.

In this study, 36% of the respondents were not willing to pay any amount due to true zero reasons. With this bulk zero responses, the study employed OLS regression which resulted in bias and inconsistent parameter estimates. For this study, censored maximum likelihood estimate (tobit model) was recommended instead of OLS regression.

3.2.3 CVM Applications in Other Resources: the Ethiopian Experience

Very much limited research activities are also done using CVM in Ethiopia related with environmental issues. Some of these studies are given as follows.

Alemu (2000) employed the CVM to analyze households' WTP for community forestry in Ethiopia using tobit model by correcting for sample selection bias in the empirical analysis due to invalid responses (protest zeros, outliers and missing bids). A total of 480 random sample of rural households were surveyed. The author concluded that income, family size, sex of household head, number of trees owned by respondents and distance of homestead to plantation are the main factors that influence households' WTP for community-forestry in rural Ethiopia.

Aklilu (2002) used CVM based on closed-ended with a follow up format to elicit willingness to pay for an improved solid waste management of households of Addis Ababa, Ethiopia. A random sample of 430 households was drawn out of which 141 (32.9%), 215 (49.9%) and 74 (17.2%) were from low-income, middle- income and high- income areas, respectively. From these, 18 (4.2%) were eliminated as 12 were protest answers with WTP zero and 6 with incomplete information. Therefore, 412 (95.8%) of the questionnaires were analyzed .The mean monthly WTP amount was 7.09, 7.76 and Birr13.07 for low-income, middle income and high income areas, respectively.

The tobit model, one of the two models used in the study showed that income of household, time spent in the area, quantity of waste generated, responsibility of solid waste management, education dummies, ownership of the house and the number of children had positive and significant effect on WTP.

Results of the probit model showed that age (with negative sign), number of children, income of the household, time spent in the area, quantity of waste generated and educational dummies had positive and significant effects on WTP.

In addition to this, the study interpreted the marginal effect of the tobit model. However, some literatures indicate that direct interpretation of the marginal effect is not easy.

According to Green (1997) a change in X_i for tobit model has two effects. It affects the conditional mean of the dependent variable Y_i^* (in our case maximum WTP) in the positive part of the distribution and it affects the probability that the observation will fall in that part of the distribution.

Tolina (2006) conducted a study on CVM to analyze households' willingness to pay for improved solid waste management: the case of Adama . For this purpose, a total of two hundred fifty (250) households were interviewed from all kebeles of Adama. A closed-ended with an open-ended follow-up elicitation technique was used. The tobit model was used to identify factors that affect the level of the willingness to pay (WTP) of households for the proposed improvement in solid waste management. The other model used in the study was a probit model which is employed to identify factors that affect the probability of having a positive WTP.

The major findings of the study were given as follows. The mean willingness to pay value were 8.26 and 13 Birr as calculated from the probit and tobit model, respectively. The tobit model showed income of the household, education dummies, marital status, time spent in the area, quantity of solid waste generated, case of disease and house ownership have positive and significant effects on WTP, under the existence of no, strong, and weak enforcement mechanisms, respectively. Results of the probit model indicate that income of the household, house ownership, status of respondent in the household (three of them with positive signs), sex, age, and waste receptacle (three of them with negative signs) have significant effects on the probability of getting a positive WTP.

CHAPTER FOUR

SCOPE AND METHODOLOGY

4.1 Scope of the Study

Due to limitations of, especially time and finance, the study has been limited to three sub-cities of Addis Ababa, covering only six kebeles. Addis Ababa city is selected to be the study area because it is among the urban centers in the country with various water supply problems in terms of quantity, quality and reliability. Urban water supply includes water services for domestic purpose, industries, institutional and commercial sectors. This research, however, deals with improved water supply service for domestic purpose only. Thus, water supply for industrial, institutional and commercial purpose is beyond the scope of the research.

4.2 Data Type and Source

The data used in this study are mainly primary and cross sectional for the year 2006. The main data source is a contingent valuation survey conducted in Addis Ababa city. The study employed CVM to solicit the respondents' WTP for improved water services. The primary data were collected through a face to face (personal) interview with the households by means of a CV questionnaire. The study was also supplemented by secondary data from the AAWSA, MoWR, BoFED, CSA and other relevant secondary sources.

4.3 The Sampling Design

The sample for the study was drawn from three out of ten administrative sub-cities in Addis Ababa, covering a total of six kebeles. Efforts were made to make the survey as representative as possible. As the survey methods do not stipulate a priori percentage or figure that is adequate in any study (Fowler, 1993 cited in Assefa, 1998), time and financial limitations were taken into account and a random sample of 240 households were used in the survey.

The three sub-cities were selected based on urban economic establishment census standard. All the sub-cities were categorized in to three standards: higher, medium and lower. The household standard of each sub-cities cluster was based on the following criteria:

1. Higher standard- the household standard was higher if the majority of the residents in each enumeration area (EA)⁵ have good private compound with villa or apartment. They also reside in areas which were not crowded and had a good entry and exit roads. Generally the majority of the residents live in a good economic status.
2. Lower standard- the household standard was lower if the majority of the residents in the enumeration area (EA) have no good private compound houses. They were live in a crowded area with poor access for entry and exit of roads. Generally the majority of the households live in a poor economic status.

⁵ EAs (Enumeration Areas) - is a unit of land delineated for the purpose of enumeration housing units and population with out omissions and duplication. It consists of 150 to 200 housing units in urban areas (CSA, 2004b).

3. Medium standard- the household standard was medium if the majority of the residents in each enumeration area (EA) are neither 1 nor 2 mentioned above. Generally the majority of the household were not in a good way of life but their health and social aspect were not at risk. The household in this category was neither at higher nor lower economic standards.

Accordingly, Addis-Ketema, Nefas-Silk Lafto, and Bole were selected from lower, medium and higher economic standards, respectively. Thus, to minimise variation of the standards of living and water supply situation of the household, a stratified two-stage cluster sample design was adopted. At the first stage 3 sub-cities based on the economic establishment standards were selected which called Primary Sampling Units (PSUs) (see annex1). The household in each sub-city was selected proportionally. From the total 126,108 households, Addis Ketema , Nefas-Silk Lafto and Bole were selected 44,921 (35.6%), 42,978 (34.1%), and 38,209 (30.3%) households, respectively. Accordingly, from the sample of 240 household 85, 84 and 71 were from Addis-Ketema, Nefas-Silk Lafto and Bole, respectively (see table 4.1).

At the second stage, 2 kebeles were selected from each sub-city based on the water supply service from AAWSA Map (Zerihun, 2005), which is the Second Stage Unit (SSU). The AAWSA map indicates that each kebele of the city is segregated to the respective water supply situations (see annex for AAWSA Map). Hence, from Addis-Ketema, kebele 14 and 19 were selected based on water supply situation of 7-16 and 17-24 hrs/day, respectively. Moreover, out of the total 16,268 households of the six kebele, 1,287 and 1,670 households were from kebele 14 and 19, respectively. Finally, from a sample of 85 households in Addis-Ketema, 37 and 48 households were randomly drawn from kebele 14 and 19 on the base of

proportions, respectively (see table 4.1). The sampling procedure for both Nefas-Silk Lafto and Bole sub-cities were similar steps to that of Addis-Ketema sub-city.

The households in each kebele were identified by their house number from their kebele. After obtaining the total number of households from each kebele, we randomly selected the sample households from each kebele on the basis of the proportions (see table 4.1).

Table 4.1: Summary of sample households (HHs) from each sub-city and kebele

<i>Sub-cities</i>	<i>Total No. of HHs</i>	<i>% of HHs from total</i>	<i>No. of HHs in the sample</i>	<i>Sampled Kebele based on water services</i>	<i>water supply situations (hrs/week)</i>	<i>Total No. of HHs in each kebele</i>	<i>No. of sampled HH in in each kebele</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>	<i>(6)</i>	<i>(7)</i>	<i>(8)</i>
Addis ketema	44921	35.60	85	14	7-16hrs/day	1287	37
				19	17-24hrs/day	1670	48
Nefas-Silk Lafto	42978	34.10	84	03	7-16hrs/day	2228	35
				05	1-6hrs/day	2631	49
Bole	38209	30.30	71	05	7-16hrs/day	2232	19
				14*	Least of all	6220	52
Total	126108	100	240			16268	240

Source: Own survey, 2006

4.4 CV Elicitation Method

In this study, among various elicitation formats, the single-bounded dichotomous choice format with a follow up question was chosen to obtain a household's willingness to pay for a proposed improvement in water supply services. According to Green et al. (1995) cited by Alemu (2000) indicated that the main reason for using this format is to provide far more information on WTP and information on plausibility of responses than other alternatives.

* In Bole kebele 14, out of 6220 households 2220 were with House No. and 4000 were with list but with out house No.

AAWSA map put no water supply for the same kebele but during the survey there was least supply of all kebeles.

4.5 The Study Instruments

The CV survey questionnaire was developed based on Mitchell and Carson (1989) techniques with some modification to adapt it to this specific study. Accordingly, the CV survey questionnaire used in this study was designed to include the following sections (see Annex 4).

1. Information regarding personal characteristics of household members (for example, income, age, education, sex, assets and so on). This section includes a series of questions about socio-economic and demographic characteristics of households.
2. Existing water supply situation.
3. Single bounded dichotomous elicitation format followed by open ended questions on willingness to pay for improved water supply services. This section includes a hypothetical description of the circumstances under which the improved water is made available for those who have private pipe and to those who are willing to have private pipe.
4. Water usage and general perception questions.

4.6 The Field Work Procedure

After designing the draft questionnaire, the field procedure consisted of pre-testing the questionnaire, sampling, administering and implementing of the actual survey in the selected 6 kebeles. Pre-testing was made in each of the 6 kebeles. We selected a random sample of three households from each kebele and a total of 18 household heads were interviewed under the pilot survey. This was done by three experienced interviewers and the researcher himself. The purpose of the pre-testing were to make some possible modification in the design of the questionnaire based on the responses so as to make it understandable for respondents and to enable the interviewers to meet the objectives of the survey. Furthermore, the purpose of the

pilot survey was to set the starting price in the elicitation part of the questionnaire. During the pilot survey, the willingness to pay part was open ended.

The pre-test showed that people were reluctant to answer questions regarding income, wealth and expenditure before the actual problems of water supply was discussed. Therefore, the questionnaire was restructured making the economic characteristic questions categorical to be asked at the later section of the questionnaire. Similarly, during the pilot survey on willingness to pay, different answers were observed ranging from 2.5 cents to 20 cents per *Baldi*⁶. However, the pilot survey revealed that 5, 10 and 15 cents per *Baldi* were the most frequent prices. Out of 18 sample households that were used during pilot survey, the frequency of 5, 10 and 15 cents per *Baldi* were 6, 5 and 4, respectively. The frequency for 2.5 and 20 cents per *Baldi* were found to be 1 and 2, respectively. Thus, we used the most frequent prices as starting points of the WTP for a single bounded dichotomous choice.

In connection to this, the total sample household was randomly divided in to three groups of equal size and each contained 80 households and the three different starting points were assigned to households in the different groups. The other questions in the questionnaire remained the same in all the three groups.

Before the actual survey, the researcher together with the supervisors visited all the six sample kebele areas and assessed the existing general water supply situation. In addition to this, the researcher contacted the kebele officials and AAWSA branch office managers in the sampled sub-towns for further information regarding the water supply situation and other socio-economic conditions. Finally, the researcher visited the main water sources of Addis

⁶Baldi is a 20 liter bucket

Ababa: Legedadi, Dire and Geffersa dams with their treatment plants which are 33, 35 and 18 km away from Addis Ababa, respectively.

Finally, the modified questionnaire was developed and a two day training of enumerators was conducted. A total of five enumerators and two supervisors including the researcher participated in the actual survey. All the enumerators were selected based on their previous experience in household survey. To select the respondent from every kebele, the kebele itself was chosen as a starting point. The first household was selected based on random method. After the selection of the first household, the remaining households were selected on equal paced interval (every 15th) of random sampling method based on spatial distribution till the households in each kebele were drawn totally. The survey started on the 9th September 2006 and continued for 15 successive days. The pre-test results were not included as an input in the final analysis.

4.7 Empirical Models

From the total sample of 240 households, 235 (97.9%) were analyzed. From the result of the study, only 5 (2.1%) of the respondents were classified as "protest zero". There were no incomplete or misused responses. In this study the researcher employed two models depending on the nature of the dependent variable and the type of elicitation method (dichotomous or open ended). The analysis incorporates descriptive statistics, tobit and probit models.

4.7.1 The Tobit Model

The tobit model is a censored regression model. Observations on the Latent variable Y are missing (or censored) if Y^* is below a certain threshold level. One of the applications of the tobit model is when the dependent variable (for our case Maximum WTP) is zero for some individuals in the sample (Maddala, 2002). Thus, in the study we have a problem of censoring in the open-ended questions and the appropriate model is censored tobit model, where there is censoring from below at zero willingness to pay. The OLS estimates of the parameters obtained from such observations will be biased as well as inconsistent (Gujarati, 2003).

The tobit model is used to identify factors that affect the willingness to pay (WTP) of households for the proposed improvements in water supply services. In addition to this, in the tobit model our interest is in finding out the amount of money a respondent spends on improved water services in relation to socio-economic and demographic variables. According to Greene (1997), the general formula of the tobit model is given as follows

$$Y_i^* = \beta'X_i + u_i \text{-----}(4.1)$$

Suppose Y^* is observed if $Y_i^* > 0$ and is not observed if $Y_i^* \leq 0$.

Then the observed Y_i^* will be defined as

$$Y_i = Y_i^* = \beta'X_i + u_i \quad \text{if } Y_i^* > 0 \\ = 0 \quad \text{if } Y_i^* \leq 0 \text{-----}(4.2)$$

Where

β' = A vector of coefficients ,

X_i = A vector of explanatory variables ,

u_i = The error terms that are independently and normally distributed with mean zero and a common variance δ^2 .

Estimation of the tobit model is similar to that of truncated regression. Following Green (1997) the log likelihood for the censored regression model is

$$LnL = \sum_{yi>0} -\frac{1}{2}\left(\ln(2\pi) + \ln \delta^2 + \frac{(yi-B^1 x i)^2}{\delta^2} \right) + \sum_{yi=0} \ln \left[1-\phi \frac{(B^1 x_i)}{\delta} \right] \text{-----}(4.3)$$

The two parts correspond to the classical regression for the non limit (continuous) observations and the relevant probabilities for the limit (zero) observations, respectively. Based on the above behavior of the model, tobit analysis is appropriate for this study. The equation in this tobit model is indicated as follows.

$$\begin{aligned} MWTP_i^* = & B_0+ B_1INCH +B_2SIZF + B_3WEAH + B_4SEXR + B_5 AGER + B_6 OCCR + \\ & B_7 ATTR + B_8LOC_{AK} + B_9 TANK + B_{10} STAT + B_{11} INFO + B_{12} IB + \\ & B_{13} STAY +B_{14} STAT + B_{15} SATI + B_{16}EDUC_1 + B_{17} EDUC_2 + B_{18} EDUC_3 \\ & + B_{19} LOC_{BO_i} + U_i \text{-----}(4.4) \end{aligned}$$

$MWTP_i^*$ = maximum willingness to pay for improved water services. And $MWTP^*$ is a latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero.

$B_0, B_1, \text{-----}$ = are coefficients, $i = 1, 2, 3, \text{-----}$

Note-the description of all variables are defined in section 4.8

4.7.2 The Probit Model

In the probit model of single bounded dichotomous format, households are given initial bid which they may accept or reject. The basic model for analyzing dichotomous CV responses is the random utility model. A study by Hanemann (1984) cited by Haab and McConnell (2002) indicated that he were constructed the basic model. The central theme of this theory is that although an individual knows his/her utility certainly, it has some components which are unobservable from the view point of the researcher. As a result, the researcher can only make probability statement about respondent's 'yes' or 'no' responses to the proposed scenario.

The indirect utility function for the j^{th} respondent can be specified as follows:

$$U_{ij} = U_i(Y_j, X_j, \varepsilon_{ij}) \text{-----}(4.5)$$

Where $Y_j = j^{\text{th}}$ respondent's income

$i=1$ denotes the final state and $i=0$ the status quo (or the initial state)

X_j = vector of household characteristics and attributes of a given choice

ε_{ij} = random component of the given indirect utility

If a payment (the initial bid, β_i^*) is introduced due to improvement in water supply service, the household accepts the proposed bid only if the utility with the CV program, net of the required payment, exceeds utility of the status quo.

$$U_1(Y_j - \beta_i^*, X_j, \varepsilon_{1j}) > U_0(Y_j, X_j, \varepsilon_{0j}) \text{-----}(4.6)$$

For the researcher, however, the random components of preferences cannot be known and he/she can only make probability statement of 'yes' or 'no' responses.

Thus, the probability that the respondent says 'yes' is the probability that he/she

thinks that he/she is better off in the proposed program. For individual j , the probability is:

$$\Pr (Y_{esj}) = \Pr (U_1 (Y_j - \beta_i^*, X_j, \varepsilon_{1j}) > U_0 (Y_j, X_j, \varepsilon_{0j})) \text{-----} (4.7)$$

This probability statement provides an intuitive basis to analyse binary responses. Assuming the utility function is additively separable in deterministic and stochastic preferences:

$$U_i (Y_j, X_j, \varepsilon_{ij}) = U_i (Y_j, X_j) + \varepsilon_{ij} \text{-----} (4.8)$$

With the additive specification of equation (4.8), the probability statement for respondent j becomes:

$$\Pr (Y_{esj}) = \Pr [U_1 (Y_j - \beta_i^*, X_j) + \varepsilon_{1j} > U_0 (Y_j, X_j) + \varepsilon_{0j}] \text{-----} (4.9)$$

The goal of estimating econometric (or parametric) models from dichotomous choice CV responses is to calculate mean WTP for the services described. In addition, parametric models allow for the incorporation of respondent characteristics in to the willingness to pay functions (Haab and McConnell, 2002). In this study we discuss the effect of socio-economic and demographic factors of the respondent on WTP with the help of tobit model. In connection to this, the probit model in this study is used to calculate mean willingness to pay for the closed -ended format.

The Probit model can be defined as:

$$Ti^* = \beta'X_i + u_i$$

Where

β' = Vector of the parameter of the model coefficients

X_i = Vector of explanatory variables

u_i = The error term assumed to have random normal distribution with zero mean and a common variance δ^2 (Greene,1997)

T_i^* = Unobservable households' actual WTP for improved water supply services. T_i^* is simply a latent variable. What we observe is a dummy variable WTP_i , which is defined as:

$$WTP_i = 1 \text{ if } T_i^* \geq \beta_i^* \quad WTP_i = 0 \text{ if } T_i^* < \beta_i^* .$$

In the single bounded elicitation format, the i^{th} respondent is asked if s/he would be willing to pay the initial "bid", (β_i^*) to get improved water supply services.

4.8 Description of Explanatory Variables

The hypothesis that is being tested in this analysis indicates how households' socio economic and demographic factors affect the household's decisions on WTP for improved water services. This study collected several households' demographic and socioeconomic factors as well as current status of water services. Therefore, the following variables are considered to determine the willingness to pay and willingness to connect to the new improved water supply services.

1. **Income (INCH):** total monthly income of the household. The monthly income of the household includes the income of the head and all other members of the household from different sources. It is a continuous variable. Households with higher income have a greater ability to pay and have a greater preference for an improved water services. This is based on empirical results done in different areas and economic theory that shows quantity demanded and income are positively related in case of normal goods. So we expect a positive coefficient. We are looking at the household's disposable income (in birr).
2. **Family Size of the Household (FAMS):** two rationales are forwarded. The first indicate that as family size is higher, there will be a higher need for water in the family and hence more preference for an improved water provision, and WTP is higher. The

second indicate that when ever water is fetched from outside compound, the preference for private connection to the improved water service decline for larger family size since there is an excessive labour to fetch water. But a household with lower family size prefers to have a private connection to the improved water service.

3. **Wealth of the Household (WEAH):** ownership of house is a proxy for wealth. Wealthy households are more willing to pay and prefer to have a private connection to the improved water service. Thus a positive sign is expected. It is a dummy variable, 1 if the house is owned by the household, 0 otherwise (that is, if rented from individuals, kebeles or public agency).
4. **Sex of Respondent (SEXR):** fetching water primarily relays on women in most developing countries. Thus, it is hypothesized that women are more likely to pay for improved water supply than men. It is a dummy variable, 1 if the respondent is female, 0 other wise.
5. **Age of Respondent (AGER):** continuous variable in number of years. Older people who used to live with free water supply or less prices, may be reluctant to prefer new improved services and could be less willing to pay for it. Thus, a negative relationship is expected between the age of a respondent and WTP for new improved scheme.
6. **Occupation of Respondent (OCCR):** This is a dummy variable, taking 1 if the respondent is employed in a government or private organization, NGO's, owns a business, and other related areas ; 0 otherwise (that is if not employed). The employed respondents are expected to be more willing to pay than their unemployed counter parts as they are expected to earn a better income. Thus we expect a positive sign.

7. **Attitude of Respondent about the Responsibility of Water Supply (ATTR):** It is a dummy variable, and takes 1 if the respondent says the government should administer, 0 otherwise. We expect a negative sign. If the respondent says the government should administer (manage) the water service, it might be expected that the government will provide the service at lower price and thus less WTP.

8. **Location of the Study Sites (LOC):** LOC_{Bo} is dummy variable taking 1 if it is Bole sub-city, 0 otherwise. LOC_{AK} is dummy variable taking 1 if it is Addis-Ketema sub-city, 0 otherwise. It is expected that households in a sub-city with more problem of water supply are willing to pay more for improved water supply scheme than those household in kebeles with less problem of water supply. Both are to be tested.

9. **Education Level of the Respondent (EDUR):** WTP for improved water service is expected to have a positive relation with the level of education, since respondents with higher education have more awareness of the value of water services. $EDUC_1$ is a dummy variable taking 1 if the respondent's educational level is primary education; 0 otherwise. $EDUC_2$ is a dummy variable taking 1 if the respondent's educational level is secondary education; 0 otherwise. $EDUC_3$ is a dummy variable taking 1 if the respondent's educational level is tertiary education; 0 otherwise.

10. **Household use of Tanks as Storage for Water (TANK):** It is assumed that households with no tank as a storage for water may be willing to pay more for improved water services than households who use tank for water storage, since the severity of water supply disturbance is higher for the former. A dummy of 1 is specified for

household with no tank as a storage for water; 0 otherwise. The coefficient is expected a positive sign.

11. **Status of the Respondent (STAT):** This variable helps to examine whether the representative of the household gives similar opinion with that of the head of the household on willingness to pay or not. It is a dummy variable taking 1 if the respondent is the head of household; 0 otherwise. We expect a negative sign since the head of the household is concerned more about the management of his /her limited finance that he/she could allocate, based on prioritized activities.
12. **Respondent's Information about Tariff Increment on Domestic Water Consumption (INFO):** Dummy variable 1 if the respondent has the information, 0 otherwise. We expect a positive sign. Households who know tariff increment are more responsible about cost sharing than their counter parts. Hence, respondents that have the information regarding tariff increment on domestic water consumption are more willing to pay for improved water service than respondents with no information.
13. **Initial Bid (IB):** this will help to examine whether the initial bid do have an impact on the respondent's WTP for improved water services or not. It is to be tested for initial bid bias.
14. **Household Year of Stay in the House (STAY):** continuous variable in a number of years. It is expected to be a positive coefficient. Those households who have stayed in the house for long year are more aware about the severity of the water supply service and thus are willing to pay more for improved water services than those households who have stayed short in the house.

15. **Level of Satisfaction of the Household with the Existing Water Services (SATI):**

dummy variable 1 if the household is not satisfied with the existing water service; 0 otherwise. It is expected with a positive sign. This is since households that are not satisfied with the existing water services show greater preference for improved services and more willing to pay to connect for improved water service.

CHAPTER FIVE

EMPERICAL RESULTS AND DISCUSSIONS

This section presents the empirical findings of the contingent valuation survey, and discusses the results obtained. Both descriptive analyses and multivariate regression analyses are performed. In the descriptive analyses, an overview of the households' attitudes towards the existing water supply service in the city and their preferences towards improving water supply in the city are discussed. In addition to this, the demographic and socio-economic factors that were supposed to have influence on improving water supply services and the willingness to pay for improving the services are discussed. In the multivariate regression analyses, factors that influence households' willingness to pay for improved water supply services are identified.

5.1. Descriptive Analysis of the Survey Data

5.1.1. Household Characteristics and Major Source of Water for household

Consumption

A total of 240 sample households were interviewed in the survey. Out of this total sample, only 235 were analyzed and the remaining 5 were removed due to protest zero. Thus, from the total of 235 sample respondents, 140 (59.6%) are head of the households and the rest 95 (40.4%) are not. Out of total respondents, 167 (71%) are female and the rest 68 (29%) are male. The average family size of the total sample household is 4.79 and ranges from 1 to 10. The data about the respondents' age show that the average age is 34.9 and the age range 18 to 85. Their level of education ranges from none to higher education graduates. Out of the total respondents, 52 (22.1%) were categorized under illiterate group. Those with formal education of grade 1 to 6 grades (primary education) constitute 57 (24.3%) of the total respondents.

Those with formal education from grade 7 to 12 grade are 81 (34.4%) and grouped under secondary school. Only 45 (19.1%) of the respondents have attained formal education above grade 12 of higher education (tertiary school).

Data regarding the occupation of the respondents reveal that 147 (62.6%) of the respondents were not working (unemployed) while 88 (37.4%) were employed in different areas such as government sectors, non governmental organizations, private organizations or own businesses.

The survey result also indicated that 100% of the household used piped water as the main source of water for domestic purpose. Regarding the source, water supply incorporates tap connection in house, tap connection in compound (private), tap connection in compound (shared), public tap and private vendors (see table 5.1).

Table 5.1: Source of water for domestic uses

Source of water	No of households	percentage
Pipe in house	16	6.81
Pipe in compound (Private)	128	54.47
Pipe in compound (Shared)	30	12.76
Public tap	44	18.73
Private vendors	17	7.23
Total	235	100

Source: Own survey, 2006

Table 5.1 indicates that more than half (54.47 %) of the households obtain piped water in compound (private) . 18.73 % of the households gets water from public taps. 12.76 % of the respondents said they get water from pipe in compound (shared) . Similarly, 7.23 % and 6.81% of the respondents get access for water services from private vendor and private pipe in house, respectively.

Further more, the survey result indicates that out of the total household who use public tap , 36 (81.8 %) are from lower economic standard groups (Addis ketema), 7 (15.9%) are from the medium economic standard groups (Nefas-Silk Lafto). And the rest 1 (2.3%) are from the higher economic standard groups (Bole). The reason is, many of the residents in Addis Ketema especially kebele 14 live in a rented houses from kebele and public taps are constructed for them to use. So, time spent to fetch water from public tap for those households in Addis-ketema is more as compared to the other two sub-cities.

Of the total, 91 (38.72%) of the households do not have own private pipelines and 27 (29.67 %) have applied to have access to private pipe line for the past 32.09 months on average. The main reasons why the household do not have private connection includes reside in rented house, unplanned houses that are unrecognized by kebele, and high connection fees.

5.1.2. Income, Expenditure and Wealth of Surveyed Households

The average monthly income of the sampled household was Birr 1339.33 ranging from the minimum of Birr 110 to the maximum of Birr 8,500 per month. Out of this, the means monthly incomes of the households were Birr 1,634.69, 1,789.92 and 606.02 for higher, medium and lower economic standard areas respectively. Note that the mean income of households living in the medium economic group was more than higher economic group. This would be probably the larger proportion of the rich households (HHs) were included in the medium economic group than higher economic group in the survey.

The mean household consumption of water was 9 *Baldi* per a day which is 180 liters per a day (see table 5.2). Based on this information, the average households' water consumption

per month was 5,400 liters (which is 5.4 m³/month). For the year 2006/07, the minimum water consumption block tariff rate of AAWSA for < 7 m³ is birr 1.75/m³ (see table 2.2). Thus, on average, the household's water consumption expenditure is Birr 9.45 per month.

As compared to the mean monthly income of the households (that is, Birr 1339.33), households in the sampled area spend only 0.71% (excluding meter fees) of their income on water. Though, this is within the range of the World Bank's recommendation, which states a household should not spend more than 5% of his monthly income on water, it is far below the recommended level. This suggests that the households in the sampled area can spend for improved and reliable water supply services.

The other finding of the study showed the mean per capita consumption of the sample household was around 1.88 Baldi per a day or 37.6 liters per a day (see table 5.2). A similar study also indicated that the average per capita water consumption per a day in Addis Ababa for the year 1998-2004 was 38.28 liters (AAWSA, 2004). Another study was undertaken by Assefa (1998) states more lower figure (13.4 liters). A similar study made in Dare es Salaam indicated that per capita water consumption of piped water was 80.2 liters (Mujwahuzi, 2001 cited in Abdella, 2003). This result is higher than the study area.

However, according to Gleick (2001) cited by Abdella (2003) states that the absolute minimum per capita per a day of water is 50 liters based on the United Nation's target. The amount in the study area is below this minimum requirement.

Table 5.2: Total and per capita water consumption by categories of economic standard (in liters).

Economic standard status	Liters per day	No of Households	Households consumption/day	Per capita* consumption /day
Higher	9,480	71	133.5	27.9
Medium	26,380	84	317.8	66.4
Lower	6,420	80	80.2	16.7
Total	42,280	235	180	37.6

Source: Own survey, 2006

The per capita per a day of water consumption was found 27.9, 66.4, and 16.7 liters from higher, medium and lower economic standard groups, respectively (see table 5.2). It indicated that the per capita consumption of medium economic group (Nefas Silk Lafto) was higher than the higher economic group (Bole). The reason is, there were few households in the medium economic group which rear livestock. Thus, these households use more of pipe water for livestock drinking in addition to other domestic uses.

Similarly, the mean household consumption of water was 133.5, 317.8, and 80.2 liters per a day for higher, medium, and lower economic groups, respectively (see table 5.2). Based on this information, the average households' water consumption per month would be 4,005 liters (4.005 m³/month), 9,534 liters (9.534 m³/month), and 2,406 liters (2.406 m³/month) for higher, medium, and lower economic groups, respectively. Thus, based on 2006/07 tariff rate of AAWSA which is Birr 1.75 for consumption less than 7 m³/month and Birr 3.15 for 7-20 m³/month, the average water consumption expenditure of the households were Birr 7.0, 30.03, and 4.20 per month for high, medium and lower economic groups, respectively.

* The calculation for per capita consumption is based on the average house hold size of 4.79 which is obtained from own survey.

The households' average monthly expenditure of water was 0.43%, 1.7% and 0.69% (excluding meter fees) of their income for higher, medium and lower economic group, respectively. This indicated that the average monthly water expenditure out of income was higher for households in the medium economic group than the rest groups due to higher monthly water consumption for the former as mentioned above. However, the average monthly water expenditure out of income was higher for the lower economic group (Addis Ketema) than the higher economic group (Bole) despite its lower monthly water consumption. This is due to the fact that the average monthly income of households for lower economic group (Addis Ketema) were much lower than the higher economic group (Bole) as mentioned previously.

Furthermore, as a means to verify that households' income figure is reasonably acceptable the survey incorporates household monthly expenditure on the various activities. Out of the monthly income of the household, the monthly expenditure on food, health, education, transport, telephone, electricity and other purposes were Birr 435.56, 56.40, 121.97, 94.6, 42.37, 54.23 and 13.56 respectively. In general, for almost all households in the sample the average expenditure was less than their respective income that indicated the income figures was acceptable.

Data for the wealth of the households, which was proxy by whether the household owns house or not, showed that 99 (42.2%) live in rented houses from individuals, kebeles and government while 136 (57.8%) of the interviewed households live in their own houses. Among those who live in their own houses 65 (47.79%), 45 (33.08%) and 26 (19.135) were from higher, medium and lower economic standard groups, respectively.

5.1.3 Water Quality, Quantity, and Reliability

According to the survey results, out of the total 235 respondents, 197 (83.82%) indicated that they were not satisfied with the existing water services. The rest 38 (16.18%) of the total respondents said that they were satisfied.

Of those respondents who were not satisfied with the existing water services, 24 (12.18%) of the respondents indicated that water quality was the most serious problem to the households. 84 (42.64%) of the respondents indicated that low water quantity as the most serious problem to the household and they hardly used for showering, dish washing and other purposes. With regard to reliability, from the total households who were not satisfied with the existing water services, 27 (13.70%) said water supply unreliable is the most serious problem to them. The rest of the total respondents gave different water service problems as the most serious challenge to the households such as: higher volume charge, distance from home, availability problem, high connection fees and other reasons.

A total of 174 respondents who use tap inside house and yard⁷ connection were interviewed whether they practiced purification method or not. From this respondents, 58 (33.33%) of the households were using purification method such as boiling, filtering, and adding lemon juice. The remaining 116 (66.67%) households did not use any purification method. Of those households who did not use purification method, 61 (52.59%) of them believe that the water is clean for drinking, 41(35.34%) believe that the water is not clean for drinking but purification method for them is costly and time consuming. 8 (6.8%) of the respondents believe that the water is not clean but harmless to health. The rest of the household 6 (5.18%) gave different reasons for not using purification method.

⁷ yard tap connection-includes tap in compound (private or shared).

Similarly, out of the total households who use tap inside house and yard connection, 21 (12.06%) of the respondents indicated that the member of their households were suffer from disease by impure water such as: diarrhea, cholera, typhoid and vomiting caused in the past one year. The remaining 153 (87.94%) of the household members, were not affected by water related disease in the past one year. Those members of household who were sick 3 (14.29%) responded that at least one family member was sick due to vomiting under 15 years old. 8 (30.09%) responded that at least one family member was sick by cholera under 15 age. 1 (4.76%) indicated that only one member of the family was affected by diarrhea over 15 years old. 9 (50.86%) showed at least one member of the family were affected by cholera over 15 years of age. The survey further included an assessment on water availability and requirement as shown table 5.3

Table5.3: Water availability by categories of economic standards

Economic standard status	Hours per day	Days/week
Higher	5.9 -8.9	4.9
Medium	6.5 -9.2	4.8
Lower	8.4-12.6	4.8

Source: Own survey, 2006

174 households who have tap inside house and yard connection indicated that the higher economic standard group (Bole) gets water on average 4.9 days/week and 5.9-8.9 hours /day. The medium economic standard group (Nefas-Silk Lafto) of the household has been provided water supply service 4.8 days/ week and 6.5-9.2 hours/day. Finally, Addis ketema which is the lowest economic standard group of the sample revealed that the household on average gets 4.8 days/week and 8.4 -12.6 hours/days.

This result confirms that households who use tap inside house and yard tap connections were provided better water supply availability for lower economic groups than the other groups (see column 6 of table 4.1). However, it should be noted that many households in the lower economic groups were public tap users. That is, 38 out of 80 (45%) households were public tap users.

Of those households who use tap inside house and yard connection, only 10 (5.73%) said they get water service all the time. 164 (94.27%) said they did not get water service all the time, out of which 100 (60.97%) usually gets water during night time, 33 (20.12%) usually get water during day time and the rest 31 (18.91%) of the household said it is unpredictable. When pipe water was not available, 89 (51.15%) of the household indicated that they incur an extra cost of buying vended water with a mean price of 31.32 cents per *Baldi* (20 liter bucket) of water. However, the lower block tariff rate of the authority is only 3.5 cents per *Baldi* which is equivalent to 1.75 cents /m³ of water. This indicates that the price of vended water is almost 9 times more than the corresponding lower block tariff rate of the authority. The finding further indicated that, on average, these households spent 30.65 minutes per trip to collect water from outside sources when pipe water was not available.

Those households who usually use public tap buy water with a mean price of 10.89 cents per *Baldi* while households who usually buy vended water pay 25 cents per *Baldi*. These households usually spend 19.63 and 30 minutes per trip in fetching water from public tap and vended water, respectively. In general, these households spend much of their time in fetching water which could have been used for other purposes.

5.1.4 Water Use Characteristics and Household's Year of Stay in the House

The majority of the respondents in the study area use the pipe water for drinking, washing clothes, cooking, bathing and house cleaning. In addition to this, households use the pipe water for livestock drinking, gardening, car washing, and other domestic uses. Regarding year of stay in the house (the number of years a household has lived in a particular house) respondents for the whole sample indicated that, on average, the household stay in the house around 20 years with a minimum 0.75 years and a maximum of 60 years. The survey result showed on average the years of stay was about 17, 20 and 23 years for higher, medium and lower economic standard groups, respectively. From the time a household has been living in the house, 3 (1.27%) of the respondent said water service has been greatly improved, 89 (37.87%) of the respondents said the service has been improved, 61 (25.96%) of the respondents said no change, 71 (30.21%) of the respondent said the service has been worsened, 11 (4.66%) of the respondent said water service has been greatly worsened.

5.1.5 Household Use of Tank as Storage for Water

The study also tried to look whether the household uses tank as storage of water or not. The survey finding indicated that out of total households in the survey area, 71 (30.21%) of the respondents said they own tanks for water storage to cope with low water pressure and water outage. Out of this, 23(32.39%), 32 (45.07 %) and 16(22.54%) are from high, medium and lower economic standard sub-cities, respectively (see table 5.4).

Table 5.4: Household use of tank for water storage

Economic standard status	No of Tanks	%
Higher	23	32.39
Medium	32	45.07
Lower	16	22.54
Total	71	100

Source: Own survey, 2006

Out of those households who have tanks as a storage of water 42 (59.15%) of the respondents said the storage allow them continuous water supply while the remaining 29(40.85%) of the respondent said the storage does not allow them continuous water supply.

5.1.6 Households' Rank for Social Services

All respondents were given six different social services to rank based on the priorities of their preferences. The finding showed that the respondent ranked water services first by 45.96%, second by 30.21%, third by 16.17%, fourth by 4.25%, fifth and above around 3.41% of the total respondents. Out of the total sample health service was ranked first (40.85%), second (19.14%), third (14.17%), fourth (14.89%), fifth and above (6.80%). Out of the total respondents, toilet facility (sanitary service) was ranked first (1.7%), second (2.6%), third (20.85%), fourth (39.15%), fifth and above (35.7%).

Education service also ranked first by 0.43%, second by 4.20%, third by 9.36%, fourth by 16.17%, and the rest ranked fifth and above by 69.84% of the total respondents. From the total respondents, electricity service was ranked first by (0.43%), second by (2.13%), third by (3.40%), fourth by (7.23%), fifth and above by (86.81%) of the respondents. Finally, Out of total respondents telephone service was not ranked as their first and second choice. It was ranked third by 0.43%, fourth by 1.27%, fifth and above by 98.30% of the respondents.

The above data showed that potable water and health service are more important to the inhabitants of the city as compared to other service. This indicates that the majority of the people of Addis Ababa concerns more for water and health services and may be committed to have such improved social services.

5.1.7 Respondent's Information about Tariff Increment on Domestic Water

Consumption

One of the questions in the household survey questionnaire was, “Do you know that the rate of tariff has been increasing since the past five years?” Out of the total respondents, 183 (77.90%) said they know tariff rate has been increasing since then while 52 (23.10%) of the respondent said they don't know.

Out of those households who know tariff rate increment, 73(39.89%) said AWSAA'S tariff rate increment is high, 99(54.09%) said AAWSA'S tariff rate increment is medium, the remaining 11(6.01%) of the households said the tariff rate increment is low. With regard to households' water consumption due to increase in tariff rate, 148(80.88%) of the household responded that no change in their consumption, 35(19.12%) said their consumption decrease. This implies that the households' water consumption would not be affected by tariff rate increment. Hence, if AAWSA revised a new tariff rate for cost recovery system, the households' water consumption may not be affected and, hence, might be affordable by the majority of the residents.

5.1.8 Respondent's Perception Regarding Water Supply

Responses regarding the attitude of the respondents towards the responsibility of the water supply service indicated that, out of 235 respondents, 184 (78.29%) said that the government should be responsible to administer water supply service. 39 (16.59%) of the respondents think that water supply should be under the responsibility of the community. 10(4.26%) of the respondents said water supply service should be the responsibility of both the government and society. Only 2 (0.85%) of the respondents said it should be given to the private sector.

51 (21.70%) of the households in the total sample perceive that the current provision of piped water as an issue worth critical discussion. And 43 (18.29%) believe that the current provision of piped water as an issue worth very serious discussion. 45 (19.15%), 83 (35.32%) and 13 (5.54%) of the respondents perceive the issue worth serious, less serious and not important for discussion.

Similarly, out of 235 respondents, 17 (7.23%) believe that the administrative body has given a lot of attention in solving the problems in the provision of potable water to the households. 79 (33.62%) of the household think that the administrative body has given some attention in solving the problem. 104 (44.25%) of them said the administrative body has not given too much attention in solving the problem. And the remaining, 35 (14.89%), of the respondents said that the administrative body has given no attention in solving the problem.

5.1.9 Households' Willingness to Pay for Improved Water Services

From the total 240 observations of the sample, 14 (5.83%) were not willing to pay any amount. To know the reasons why they are not willing to pay any amount, and to decide

whether their response is protest or true zero, a follow up question was asked. From the results of the study, it indicated that only 5 (2.08%) of the respondents can be classified as a "protest zero." These are the ones who believe that the existed service was satisfactory or the government should pay. Thus, we say both these responses are protest zero and they are eliminated from analysis.

However, 9 (3.75%) of the respondents were not willing to pay any amount for the reasons such as inability to pay (too poor to pay). These are a true zero and all are included in our analysis. Among the true zero responses 7 and 2 are from lower and medium economic standard groups, respectively. 226 (96.17%) of the households gave positive amounts as they are willing to pay for improved water service. Table 5.5 summarizes households' WTP obtained during the survey based on economic standard groups.

Table 5.5: Summary of households' WTP by economic standard

Economic standard status	Mean WTP (in cents/bucket) *
High	18.96
Medium	12.33
Low	15.23
Total	15.34

Source: Own survey, 2006

The mean willingness to pay for the whole sample is 15.34 cents (ranging from 0 to 50cents) per bucket of water, which implies that the sample sub-cities were willing to pay more than the current tariff rate which is 3.50 cents per bucket of water for the lowest consumption block and 7.60 cents per bucket for the highest consumption block. Genanaw (1999) and Medhin (2006) were found 15.22 and 15.79 cents per bucket respectively, are similar with

*The exchange rate at the time of survey was 1USD = Birr 8.38 and 1Birr = 100 cents

our figure. But our figure is higher than Alebel (2004) which was 6.80 cents per bucket.

Of the three clusters, it was found that the highest mean WTP of 18.96 cents per bucket in area with higher economic standard. The mean WTP from the medium economic standard and lower economic standard groups were 12.33 and 15.34 cents per bucket, respectively (see Table 5.5). The result showed that households from the low economic standard group were willing to pay more than households in the medium economic standard group. The reason is out of the total public taps in the sample, 81.85 % of the public tap users were in the low economic standard group as mentioned previously. Thus, these households are more willing to pay for improved water service to avoid long queue.

The other finding of the survey indicated that, out of the total observations 91 (38.72%) of the households have no private pipe lines, out of which 11(12.09%), 27(29.67%) and 53 (58.24%) are from higher, medium and lower economic standard groups, respectively. Where as the remaining 144 (61.28%) of the households have private pipe lines, out of which 61 (42.36%), 56 (38.89%) and 27 (18.75%) were from higher, medium and lower economic standard groups, respectively (see table5.6).

Table 5.6: Households (HHs) access to private pipe line by economic standard status

Economic standard	HHs with access to private pipe		HHs with out access to private pipe	
	No	%	No	%
Higher	61	42.36	11	12.09
Medium	56	38.89	27	29.67
Lower	27	18.75	53	58.24
Total	144	100	91	100

Source: Own survey, 2006

The other observation from the study result indicated that households' with no access to private pipe line were more willing to pay than households' with access to private pipe lines. The reason is probably households who don't have private pipe line spend a lot of time to fetch water from outside source. Moreover, these households may buy water from vendors at relatively higher price than the authority's tariff rate. Hence, households with no access to private pipe lines show more preference to the improved service than the latter households (see table 5.7).

Table 5.7: Willingness to pay based on access to private pipe lines

Access to private pipe lines	Households		Mean WTP
	No	%	
Without access to private lines	91	38.72	16.24
With access to private lines	144	61.28	14.77
Total	235	100	15.34

Source: Own survey, 2006

Regarding the initial bid in the scenario the survey result was based on the assessment of the pre-test survey. Accordingly, each 80 respondents were given the bid prices of 5.00, 10.00 and 15.00 cents per bucket, respectively. Finally, the bid prices were mixed uniformly and distributed randomly to the respondents to see the effect of initial bid bias.

The survey result indicated that excluding protest zero, a total of 235 respondents were interviewed. 200 (85.12%) gave a "yes" response to their respective initial bid while 35 (14.82%) gave a "no" response for the initial bid. Out of 80 respondents, 76(95 %) gave a "yes" and 4 (5 %) a "no" response for the first price of 5.00 cents per bucket. Whereas out of 75 respondents, 67 (89.54%) and 8 (10.45 %) gave a "yes" and "no" response for the initial bid of 10.00 cents, respectively. Finally, out of 80 respondents 57 (71.25%) and 23 (28.75%) of the respondents gave "yes" and "no" for the initial bid 15.00 per bucket, respectively. This

result indicated that the probability of a "yes" response decreases when the bid increases, which is in line with theory and empirical findings.

5.1.10. Summary of Descriptive Statistics of the CVM Survey

Annex 2 shows the summary of descriptive statistics for the variables used in the multivariate regression analysis. The descriptive statistics of all variables in annex 2 is discussed in section 5.1.

5.2 Econometric Results and Discussions

In this section results obtained from regression estimation of willingness to pay equation are presented. As mentioned under sub-section 4.7, two maximum likelihood estimates are made. The Tobit model used to identify the socio- economic and water supply related factors that affect the amount of money households are willing to pay for the proposed improvement in water supply services. The Probit model in this study is employed to calculate the mean willingness to pay for the proposed service.

The presence of multicollinearity between (among) variables reduces the precision of estimating the coefficients of the strongly correlated variables. In practice, when we collect data for empirical analysis there is no guarantee that there will not be correlations among the regressors (Gujarati, 2003).

According to the rule of thumb, if the pair wise or zero order correlation coefficient between two regressors is high, say, in excess of 0.8, then multicollinearity is a serious problem. However, a test was made to check whether or not the problem existed is severe or not. The

result indicated multicollinearity is not a serious problem as the correlation matrix results are less than 0.8 (see Annex 3).

A test for the presence of heteroscedasticity problem in the model was also done. The test result shows that the null hypothesis of homoscedasticity is rejected implying that there is heteroscedasticity problem in the model, which is expected from survey of the cross sectional data (see Annex 4). Because of this problem the study can not use a simple tobit model but a heteroscedastic tobit model (results corrected for heteroscedasticity) using LIMDEP Version 7.0.

A test for measures of model goodness of fit was also done with model chi-squared statistic (LR_{Model}). The LR chi-squared measures the overall significance of the model with the null hypothesis that all parameters associated with covariates are zero is rejected at 1% significance level. Thus, the model is statistically acceptable. It implies that the model is acceptable to explain the relation between willingness to pay and its explanatory variables (see Annex 5).

To check for the existence of starting price bias, the starting bid is used in the model as an explanatory variable. To check whether or not asking representatives of the households rather than the heads affects the willingness to pay responses, a dummy variable (status of the respondent) taking 1 if the head is the respondent; 0 otherwise is included in the model. To capture the effect of stratification, the location of the study area LOC_{Bo} is dummy variable taking 1 if it is Bole sub-city, 0 otherwise. LOC_{AK} is dummy variable taking 1 if it is Addis-Ketema sub-city, 0 otherwise are included in the model.

5.2.1. Tobit Model: Results and Discussion

The Tobit results obtained using a Limdep Version 7.0 are given in Table 5.8

Income of the Household

The variable consistent with a priori expectations is monthly income of the household. It is significant at 1% and has the expected positive sign. This result confirms with economic theory, which states that an individual's demand for a particular commodity depends on his/her income, and that income and quantity demanded are positively related, except in the case of inferior goods. The result of the survey shows higher income group are more willing to pay for an improved water supply service than lower income group. Thus, income is a strong determinant in explaining willingness to pay for improved water services. Hence, the income of the households needs to be considered to introduce a new tariff rate structure which will help to cover the financial costs of the proposed improvements. The result is also consistent with other similar studies. Fisseha and Assefa found positive and significant at 1% level of significance.

Status of Respondent in the Household

The coefficient of status of the respondent is positive but insignificant and indicating that head of a household is more willing to pay for improved water service than non-head respondents. This result is opposite to the hypothesis that head of the household is less willing to pay for improved water services than non head respondent due to his/her responsibility for saving and allocating limited financial and other resources economically. The possible reason for this could be that head of the household is more concerned about water supply problems and its consequences so that he/she shows higher preferences for improved water services than his/her representative.



Education Level of the Respondent

From the four categories of educational level, the illiterate group is taken as a bench mark group to avoid a dummy variable trap. The other three educational dummies show positive effect on willingness to pay amount as compared to the bench mark group. The primary education dummy is not significant at 10% level of significance. This shows that the primary educational level is not a significant determinant of the amount households are willing to pay for the proposed service. The secondary and tertiary education dummies are significant at 10% level of significance. This may be due to the fact that as compared to the bench mark group the households of secondary and tertiary education groups are more aware about health and sanitation benefits of the improved water services. This result also shows the higher level of education lead to a higher willingness to pay for the proposed scheme.

Occupation of the Respondent

The variable occupation of the respondent is found to be positive and significant at 10%, as expected. The result is consistent with the idea that those respondents who are employed in government organization, private organization, NGO's, own business and other related areas for some amount of money are more willing to pay than their unemployed counter parts. This is because those respondents who are employed in different organizations are expected to earn more as compared to the unemployed group.

Initial Bid

The variable initial bid was included in the estimation to see whether the initial bid creates a bias on the response of the respondents' WTP. Questionnaires were randomly distributed to households with low, medium and high initial bids. The test result shows that it is with a positive sign but is insignificant at 10% level of significance. That is, the initial bid given to the respondent is not a major determinant of the amount the households are willing to pay for

the proposed improvement in water supply services. But the positive sign implies that respondents' willingness to pay increases as initial bid increases. This test result which is insignificant at the conventional test level could be due to the plausibility of responses for value elicitation format that the study employs and the use of pilot survey for some modification made on the questionnaire.

Attitude of Respondent about the Responsibility of Water Supply

There is a negative relationship between this variable and the WTP amount as expected but it is insignificant at the conventional level of significance. Households who believe it is responsibility of the government are less willing to pay than those who believe it is society's alone or both (society and government) responsibility.

Age of Respondent

As expected, age of the respondent has a negative sign but it is insignificant. The sign indicates that as age of respondent increases, the willingness to pay for improved water service decreases.

TABLE 5.8 : Tobit estimates for the determinants of WTP for improved water supply services (Heteroscedastic Tobit)

Variable	Coefficient	Std. Er	b/St.Er.	P-Values	Mean of X
CONST	4.449472436	2.2901043	1.943*	.0520	
INCH	.0001715432	.0000533710	3.214***	.0013	1339.3285
SEXR	.2582252614	.14324646	1.803*	.0714	.71063830
AGER	-.0022208961	.0059684669	-.372	.7098	34.974468
FAMS	-.0845664581	.036997020	-2.286**	.0223	4.7872340
EDUC ₁	.2114814859	.18721616	1.130	.2586	.24255319
EDUC ₂	.3564540480	.21652342	1.646**	.0997	.34468085
EDUC ₃	.4393207847	.22956193	1.914**	.0557	.19148936
STAY	.01643804708	.0056196780	2.925***	.0034	19.952837
TANK	.5254671750	.16506017	3.183***	.0015	.69787234
ATTR	-.1906904134	.14743595	-1.293	.1959	.78297872
WEAL	.5896728854	.16945571	3.480***	.0005	.57872340
OCCR	.2621695535	.15043565	1.743*	.0814	.37446809
INFO	.1029382746	.16798658	.613	.5400	.77446809
SATI	.3998056983	.17182031	2.327**	.0200	.83829787
IB	.02389464906	.015496762	1.542	.1231	9.9787234
STAT	.1276074785	.16764284	.761	.4465	.59574468
LOC _{AK}	.6530232215	.18891336	3.457***	.0005	.34042553
LOC _{Bo}	.1933452929	.17510182	1.104	.2695	.30638298
No of Observations = 235					
Log likelihood=-773.2196 Restricted log likelihood =-836.6690					

***, **, * indicate significance at 1%, 5%, and 10% levels respectively.

Note-description of each variable is given in section 4.8.

Wealth of Respondent

In this study ownership of house is used as a proxy to wealth. As expected, this variable is found positive and highly significant at 1% level of significance. That is, those households living in their own houses are more willing to pay for the proposed improvements than those living in rented houses. This may be the fact that households who own private house concerns

more to pass the improved water services to their children (bequest value) than those households who do not own private houses. Moreover, as mentioned previously the study includes sampled households where house number are not entitled for their house they reside. These household members have not still recognized by their kebeles and AAWSA could not allow private tap connection for these members of the households. Such households who own private house are also more willing to connect to the proposed improvements of water supply services. This variable is one of the major factors determining the amount households are willing to pay for improved water supply services.

Sex of Respondent

This variable has a positive sign as expected and is significant at 10% level of significance. This shows that female respondents are more willing to pay to connect improved water services than their male counter parts. This result really tells us the experience of most developing countries with regard to gender. It indicates that female headed households are primarily responsible for the task of fetching water and hence greater preferences for improved water services by paying more as compared to their counter male headed households.

Moreover, women are almost exclusively concerned in country like ours regarding cooking, house cleaning, cloth washing, and children bathing which requires improved water services and hence likely to pay more as compared to men for the proposed improvements.

Family Size of the Household

Family size of the household variable was found to be significant at 5 % with a negative parameter estimates. This suggests willingness to pay for improved water services decreases as family size of the household increases. This is due to the fact that given income of households, if family size of the household increases the per capita income of the member household decreases and hence willing to pay less to the proposed improvement services. Another reason could be large family size of households' increase their water consumption which could discourage the family due to high bill charge services and hence willing to pay less for the proposed improvements than their counter parts. So, for the city of Addis Ababa those households with less family size are more willing to pay for an improved water supply services than those households with more family size.

Household Use of Tank for Water Storage

Households who do not use tank as storage for water was another variable found to be significant at 1% level of significance. Since the parameter estimate is positive, it implies that households who don't use tank as storage for water tend to be willing to pay more than their counter households who use tank as storage. This indicate that households who do not use tank as a storage for water are frequently suffer from low water pressure and water tap interruptions than households who use tank as a storage. These households are forced to buy water from vendors at higher price than the AAWSA tariff rate. Hence, the strong positive relation between the household who do not own tank as a storage for water and willingness to have private connection to the improved water service may be arise due to the need to avoid water supply distortions.

Household Year of Stay in the House

The variable household's year of stay in the house is positive and it is significant at 1% level of significance. That is, those households who have been stayed in a particular house for long year are more willing to pay for the proposed improvements than their counter parts. The possible reason could be those households that are staying for a long year in that house are mostly in the older quarter of the city. The majority of the houses in this old quarter of the city are also poor in terms of infrastructure and social facilities. A related problem especially in the old quarter of the city is that un-planned houses and overlapping lots contribute to a high rate of UFW due to leakage and illegal connection. The replacement and maintenance services due to old age of pipe for the household in the old settlement is poor since AAWSA at this time focus to expand service for un-served households. The above mentioned reasons exacerbate the existing water supply problem in the old quarter of the city and thus the households that are staying long in that area are more willing to pay for improved water services than the counter parts.

Location of the Study Sites

Addis Ketema site dummy was positive and significant at 1% level of significance, suggesting that household in this site is in general willing to pay more than the bench mark (Nefas-Silk Lafto) site , keeping all other things constant. The possible reason could be that considerable part of the households in the former sub-city use public tap and hence they incur high costs in terms of time and labour for fetching water from the existing water sources. Thus, households from Addis Ketema site are more willing to pay for the new improved water systems to avoid the high opportunity costs than the bench mark site.

The coefficient of the dummy variable for Bole site is also positive but it is insignificant at the conventional level of significance. Keeping other things constant, the positive sign

implies households from Bole site are more willing to pay for the proposed improvements of water services as compared to those the bench mark (Nefas-Silk Lafto) site.

In general, stratification is found partially important in this study for valuation of the proposed improvements in water supply services. The impact of stratification in this study could not be much prominent due to the fact that focus was given to minimize variation in water supply service in each sub-city while sampling. The impact of stratification in this study could have been more than the obtained results if the variation in water supply problem was not minimized while sampling.

Respondent's Information about Tariff Increment on Domestic Water Consumption

Consistent to our a priori expectation the coefficient of respondent's information about tariff increment on domestic water consumption is positive but it is insignificant. The result shows those respondents having information about tariff increment on domestic water consumption are more willing to pay for an improved water services than households with nothing information about tariff increment on water services.

Level of Satisfaction the Household with the Existing Water Services

The coefficient for the level of satisfaction the household with the existing water services has the expected sign and statistically significant at 5% level of significance. One possible reason could be those households who are dissatisfied with the current water service due to poor quality, less quantity, unreliability and absence of own private pipe are likely to pay for improved water services than those households who are satisfied with the existing services. The fact that, it is significant shows that the variable level of satisfaction the household with the existing water services are a major determinant of the willingness to pay amount for the proposed water supply services.

5.2.2. The Probit Model: Calculating Mean WTP

In this study we have already discussed the effect of socio-economic and demographic factors of the respondent on WTP using the tobit model. Thus, the probit model in this study is used to calculate mean willingness to pay for the closed-ended format. According to Hanemann et al.(1991) cited by Jonse (2005) states that one of the main objectives of estimating an empirical WTP model based on the CV survey responses is to derive a central value (or mean) of the WTP distribution. Similarly, Carlsson et al. (2002) cited by Mahmud (2005/06) states that the main reason for estimating the probit model is to obtain an estimate of mean WTP. The result is obtained by regressing the willingness to pay variable on intercept and initial bid variable. The regression result shows the following values.

Table 5.9: The probit model to calculate mean WTP

Variable	Coefficient	Std. Er	b/St.Er.	P-Values	Mean of X
CONST	2.330989231	.34074517	6.841	.0000	
IB	-.1154249357	.027824861	-4.148	.0000	9.9787234
Dep. var. = yes/no (Y/N) Mean =.8553191489 S.D.= .3525296318					

Mean WTP (μ) using the model for the closed -ended format is defined as follows:

$$\mu = - \frac{\alpha_0}{\alpha_1}$$

Where:

α_0 = the constant term

α_1 = the bid coefficient

$$\begin{aligned}\mu &= - \frac{2.330989231}{-.1154249357} \\ &= 20.20\end{aligned}$$

Thus the mean WTP (μ) calculated from the closed-ended probit model is 20.20 cents per a bucket of improved water services. However, the mean WTP is 15.34 cents per a bucket of water from responses to the open-ended CV survey questions, which is a bit lower than the mean values obtained from the closed-ended probit model estimates. Thus, the finding of the study showed the respondents willingness to pay was in the range of 15.34 – 20.20 cents per Baldi (a 20 liters bucket) for the proposed improvements of water supply services. The similarity of the mean WTP under the open-ended and closed-ended formats indicates the validity and reliability of the CV outcomes in the empirical analysis. Based on the mean WTP of open-ended format, the total values of water services have been estimated in the following section under the improved scenario.

5.2.3 Estimating Total Willingness to Pay and Total Revenue

In this section the total willingness to pay and the total revenue at different prices that households in the three sub-cities of Addis Ababa are willing to pay is computed. The demand curve for improved water service has also been derived.

There were around 432,967 households and 2,211,552 residents in Addis Ababa in 2004 with an average family size of 5.1 (CSA, 2004c). In the study area, the three sub-cities (Bole, Nefas-Silk Lafto and Addis Ketema) were included with a total of 126,108 households (HHs) and 678,645 residents. The average family size of the study area was found 5.38, which is similar with the CSA result mentioned above. To make the aggregation, class boundaries for the maximum willingness to pay values have been utilized (see Table 5.10).

Table 5.10: Total WTP and total revenue (in cents) from improved water services

Class bound. For WTP amount	Class mark for WTP amount	Sample Dist. of HHs		Total No. of HHs	Total WTP (in cents)	Sample HHs WTP at least that amount (cumm.)		Total HHs WTP at least that amount (Cumm.)	Total Revenue
(1)	(2)	(3) No.	(4) %	(5)	(6)	(7) No.	(8) %	(9)	(10)
0-5	3	27	11.48	14,477	43,431	235	100	126,108	378,324
6-10	8	69	29.36	37,025	296,200	208	88.51	111,618	892,944
11-15	13	54	22.97	28,967	376,571	139	59.14	74,580	969,540
16-20	18	57	24.25	30,581	550,458	85	36.17	45,613	821,034
21-25	23	13	5.53	6,974	160,402	28	11.91	15,019	345,437
26-30	28	8	3.40	4,288	120,064	15	6.38	8,046	225,288
31-35*	33	0	0	0	0	7	2.97	3,745	123,585
36-40	38	3	1.27	1602	60,876	7	2.97	3,745	142,310
41-45**	43	0	0	0	0	4	1.70	2,144	92,192
46-50	48	4	1.74	2,194	105,312	4	1.70	2,144	102,912
Total		235	100	126,108	1,713,314				

Source: Own survey, 2006

Note- * and ** indicate class boundary of WTP where there is no sample distribution of households.

From the class boundaries (intervals) for the willingness to pay amounts, the class marks (the mid willingness to pay amounts) have been calculated and the results are shown in the second column of table 5.10. The third and the fourth columns show the number and the percentage of the sample households whose maximum willingness to pay amounts fall within the given intervals, respectively.

The total number of households in the three sub-cities of Addis Ababa has been multiplied by the proportion of sample households falling in each boundary to obtain the total number of households whose WTP amount lies in each boundary (column 5 of the Table). Total willingness to pay (column 6 of the table) has been obtained by multiplying the mid willingness to pay amount by the total number of households willing to pay that amount.

Summation of the total WTP values in column 6 gives the grand total willingness to pay amount. Thus, 126,108 households in the three sub-cities of Addis Ababa are expected to pay 1,713,314 cents (17,133.14 Birr) if every household use only one Baldi. But survey data on section 5.1.2 indicate that the mean water consumption per household per a day to be 9 Baldi. Based on this calculation the total willingness to pay is estimated to be Birr 154,198.26 per day⁸. This is, on average, 13.59 cents per household per a Baldi if the proposed improvement in water supply services is implemented. This result is almost similar with the average WTP of 15.34 cents per household per Baldi from the open-ended formats mentioned previously.

Columns 7 and 8 of Table 5.10 indicate the number and the proportion of sample households willing to pay at least the amount in each boundary and the figures continuously diminish as class mark for WTP amount increases (with the exception of * and ** in Table 5.10). Similarly, the total number of households who are willing to pay at least the amount in each interval (column 9) falls as the mid willingness to pay amount rises (excluding * and ** in table 5.10). This relationship can be easily depicted by deriving a demand curve for the improved water supply services.

Total revenue (10th column of the Table) has been obtained by multiplying the mid WTP amount (column 2) by the corresponding total number of households willing to pay at least that amount (column 9). As can be seen from the total revenue columns, total revenue initially increases as payment per Baldi (a 20 liters bucket) increases and reaches a maximum of 969,540 cents per Baldi with the payment of 13 cents per a Baldi per a household. After that it decreases and reaches a minimum of 102,912 cents per a Baldi at the highest service charge of 48 cent per a Baldi per a household due to relatively small number of households (only 2,144) willing to pay these amounts (excluding * and ** in Table 5.10).

⁸ $17,133.14 \times 9 = \text{Birr } 154,198.26 \text{ per a day.}$

The revenue estimation in this study is very important since it allows water utility to determine how many households can afford the provision of improved water services on charge base. The administrative body can also undertake cost-benefit analysis of a project which is meant to improve the water services in the city. From table 5.10 there is a very wide room for cost recovery by improving the existing water supply services in the city.

5.2.4 Derivation of Aggregate demand and Estimation of Consumer Surplus for Improved Water Services

The aggregate demand for this study has been derived from the above WTP payment scenario. The aggregate demand curve is derived using the mid willingness to pay amount along the vertical axis and the number of households' willingness to pay at least that mid value per Baldi (a 20 liters bucket) along the horizontal axis (see figure 5.1). The figure shows the aggregate demand curve for the improvements in water supply services using the observations in the study. Any point on the curve shows all the households that prefer the improved water service but do not bid more than the corresponding value on the mid WTP axis.

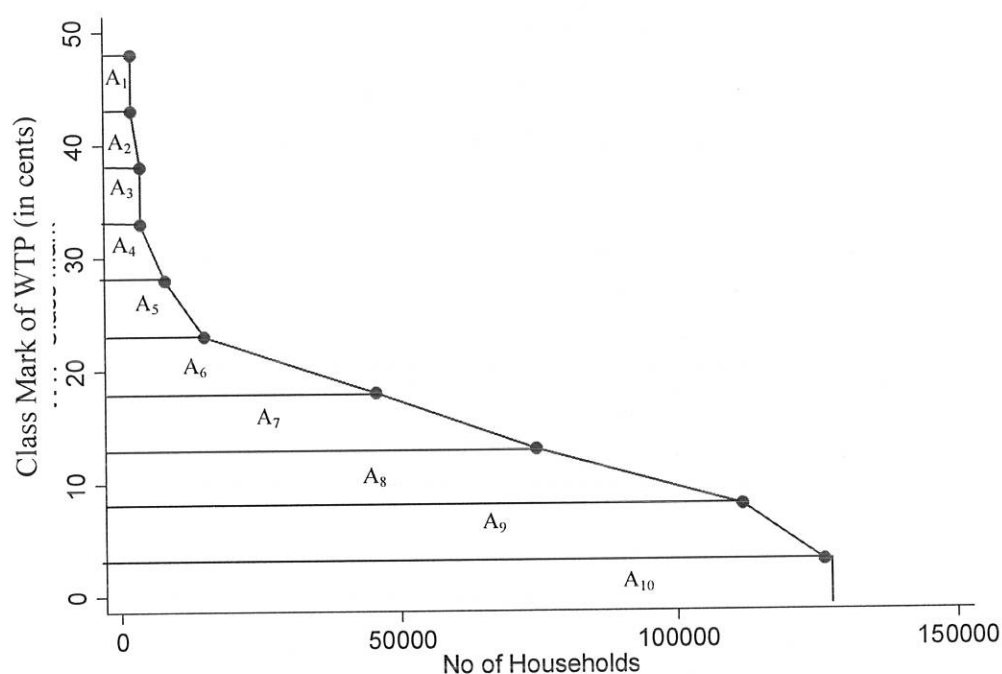
The demand schedule that has been obtained from our survey is basic information for policy makers. The information helps them to make sound water tariff decisions and investment. The information on the frequency distribution of WTP bids is also useful information in estimating the demand for improved water services in terms of the tariff versus number of households.

As shown in figures 5.1, the demand curve is negatively sloped indicating the fall of the demand for improved water supply service as user charges increase, like most other economic

goods, other things remaining the same. If water is considered as a free resource to the society, the consumers' surplus would be the total area under the demand curve. The area under the demand curve represents the gross value of consumers' surplus if the tariff rate of the authority is zero. The sum of all the areas under the demand curve (A_1-A_{10}) is 2,021,504 cents per a Baldi (see figure 5.1). This shows the gross consumer surplus is estimated 2,021,504 cents or Birr 20,215.04 if every household is using only one Baldi per a day for the improved water services, with supply left unrestricted (see its computation Annex 6). But based on the survey data the gross consumer surplus has been estimated to be 18,193,536 cents per a day or Birr 181,935.36 per a day.

The study further analyses the allocation of the total benefits which has been derived from the service charge fees on each household per a Baldi by improving water supply services. The current tariff rate of AAWSA is 3.50 cents per a bucket of water for the lowest consumption block (which is less than 7 m³ /month) and 7.60 cents per a bucket for the highest consumption block (for more than 20 m³ /month) that cover only operation and maintenance costs. But the current tariff policy of the water authority could not meet financial sustainability. Thus, if AAWSA propose a new flat tariff rate for the improved water at 8 cents per a Baldi, which is well below the mean WTP of own survey with supply left unrestricted. This new tariff rate may help to cover the authority costs (operation and maintenance costs plus capital investments). This will help to implement the proposed improved water supply service.

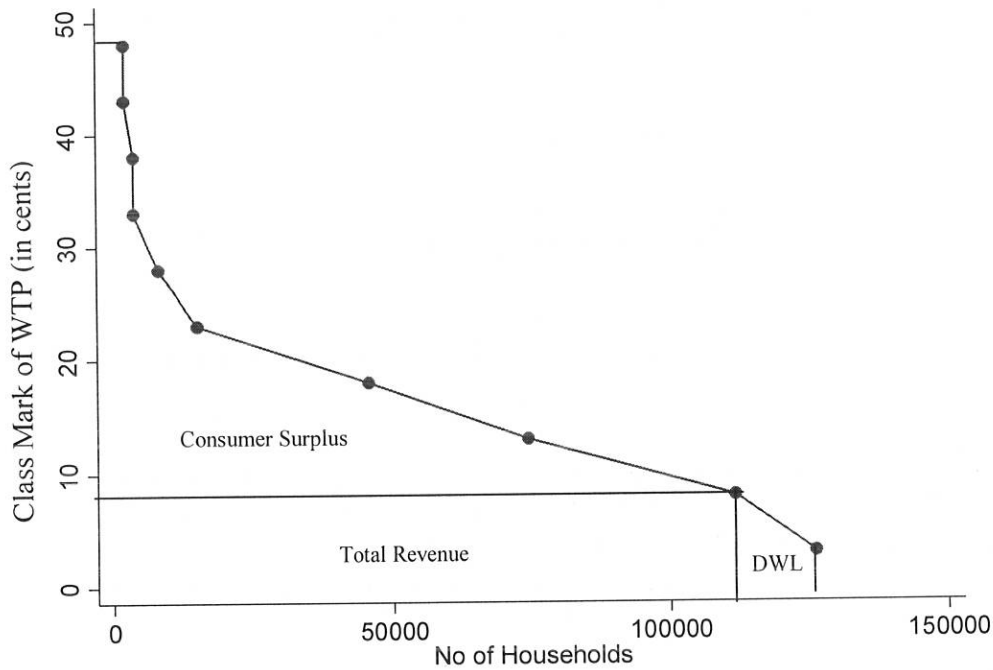
FIGURE 5.1 Estimated Demand Curve for Improved Water supply Service in Addis Ababa



The finding indicated that out of the total 126,108 households in the study area, 111,618 (88.51%) of households are assumed willing to pay at least the new proposed tariff rate of 8 cents per a Baldi for the improvement in water services. In relation to this, a rise in revenue of the authority is anticipated and a large increase in the consumers' surplus in turn, will help for implementing an improved water project. Hence, the allocation of the total benefits of improved water services at the proposed tariff rate can be depicted using figure 5.2.

The total benefits of the improved water supply services are the sum of expected revenue of AAWSA, consumer's surplus of the society, and the dead weight loss. If tariff is set for water supply services, the consumers' surplus discussed previously can be minimized by shifting consumer surplus partly to dead weight loss and partly to the revenue of AAWSA.

FIGURE 5.2 Estimated Total Benefit for Improved Water supply Service in Addis Ababa



As indicated in figure 5.2, if a new tariff rate of 8 cents per a Baldi is implemented the consumers' surplus (CS) decreases from 2,021,504 cents to 1,048,865 cents per a Baldi or from Birr 181,935.36 to Birr 94,397.85 per a day. The rest of the benefit is distributed to the AAWSA authority, 892,944 cents in the form of revenue and 79,695 cents as a dead weight loss (DWL)⁹ per a Baldi, which is equivalent to Birr 80,364.96 in the form of revenue and Birr 7,172.55 as a DWL per a day. The dead weight loss of the study result indicate that only 14,490 (11.49%) out of 126,108 households could not offer for the proposed new tariff rate. The DWL is part of the aggregate benefit of improved water service that belongs neither to the consumer surplus nor revenue to the service delivery authority. However, there is a possibility of cross subsidy to this households who are unable to pay by those households who are giving higher willingness to pay.

⁹ DWL- measures the value to the consumer of the lost output (Varian, 1992).

In general, the results of the study in this chapter open a room to any interested individuals or groups in the area of improving water supply services in the city. The aggregated WTP amounts shows that the authorities could collect sufficient resource for both service modernization and could also reduce existing subsidies.

Chapter Six

SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

6.1 Summary and Conclusion

Urban water supplies provided by public utilities are facing an acute crisis in many developing countries. As such, the urban centers of Ethiopia are also characterized by poor water supply services. At the moment, Addis Ababa, the capital city of Ethiopia, which accounts for over a quarter of the nations urban population, is facing unreliable and inadequate supply of water and sanitation services. However, the existing water supply of AAWSA from Gefersa, Legadadi, Dire Surface Water Development (SWD) dams and reservoirs , Akaki ground water sources (GWS) as well as wells and springs are inadequate to meet the present and the near future water needs of the population of Addis Ababa.

Some of the major reasons for the incompatibility between the water demand of Addis Ababa and supplying capacity of AAWSA include: the rapid population growth, system leakage, financial constraints, administrative and technical problems and fast expansion of metropolitan area, which is accompanied by unprecedented level of industrial growth. Hence this study is trying to indicate the possibility of cost recovery for the improved water service by looking at the demand side of consumers in Addis Ababa, through revised tariff rate service charges.

To this end, a contingent valuation method (CVM) is employed to estimate the value that households in Addis Ababa attach to the proposed improvement in water supply service. For this purpose, a total of two hundred forty (240) households were interviewed after stratifying sub-cities and kebeles based on economic standard and water supply situations, respectively.

A closed-ended with open-ended follow-up elicitation technique was used. In the closed-ended elicitation format, the respondents were asked a "yes" or "no" question for the given bid; whereas for the open-ended elicitation technique, households were asked to give their maximum willingness to pay values for the proposed service. Information obtained from the survey was analyzed using descriptive statistics and econometric models.

The descriptive analysis showed that out of the total 235 respondents 197 (83.82%) indicated they were not satisfied with the existing water services. Some of the reasons for their dissatisfaction with the existing water service include: poor quality, low quantity, unreliability, distance from home, availability problem, and higher volume charge. 51 (21.70%) of the households in the total sample perceived that the current provision of potable water as an issue worth critical discussion. 43(18.29%) believe that the current provision of potable water as an issue worth very serious discussion. 45(19.15%), 83(35.32%) and 13(5.54%) of the respondents perceive the issue to be more worth serious, less serious and not important for discussion, respectively.

The results of the study showed that about 38.72% of the respondents reported that they do not have private connection to the existing water service. Out of 174 households who use tap inside house and yard tap connection, 164(94.27%) did not get water service all the time, out of which 100 (60.97%) usually get water during night time, 33 (20.12%) usually get water during day time, the rest 31 (18.91%) of the household said it is unpredictable. The mean household consumption of water in the study was found to be 180 liters per a day and the mean per capita consumption is 37.6 liters per a day. Responses regarding the respondents' attitude towards the responsibility of the water supply service, the majority of the respondents (78.29%) indicated that the government should be responsible to administer water supply service.

Responses to the valuation questions revealed that 96.17% of the households gave positive amounts as they are willing to pay for improved water service, with a mean WTP of 15.34 cents per bucket from the tobit model. This willingness to pay amount is twice larger than the higher consumption block of the existing tariff rate of AAWSA. This figure in general indicates there is a wide possibility for cost recovery or even profit if water supply improvement is implemented to the inhabitants of the city.

The total willingness to pay amount from the total of 126,108 households in the study area of Addis Ababa is Birr 17,133.14 per *Baldi* or Birr 154,198.26 per a day at different service fees. The maximum total revenue that can be collected per *Baldi* is 969,540 cents when a service fee of 13 cents per *Baldi* is charged. The area under the demand curve represents the gross value of consumers' surplus which is Birr 20,215.04 per *Baldi* if water is considered as a free good (zero tariff rates for water). Based on the survey data of the mean water consumption per household per day the gross consumer surplus is estimated to be Birr 181,935.36 per day. But water is an economic good and if a new tariff rate of the authority propose to be 8 cents per a *Baldi* the consumers' surplus will be reduced to Birr 94,397.85 per a day. The rest of the benefit is distributed to the water authority Birr 80,364.96 in the form of revenue and 7,172.55 as a dead weight loss per a day. This proposed new tariff rate can help the water authority to implement the proposed improvement of water supply service.

Based on the nature of the data, a tobit model is employed due to censoring of WTP amount at zero. This model is used to identify factors that affect the amount of money households are willing to pay for the proposed improvement in water supply service. The Probit model is used to calculate the mean WTP for the improved water service with which to evaluate the validity and reliability of the CV outcomes in empirical analysis.

The tobit model shows that there are several factors that affect the WTP value. Income of the household, sex of the respondent dummy (female=1), education dummies (both secondary and tertiary education), households year of stay, households not using tank as a storage, wealth of a household, occupation of the respondent, households satisfaction with the existing service, and location of the study site (Addis Ketema) have positive and significant effects on willingness to pay. Family size has negative and significant effect on willingness to pay amount. Education dummy (primary education), status of the respondent in the household, respondents' information about tariff increment on water, location of the study site (Bole) and initial bid have been found to be positive but insignificant effects on WTP amount . The remaining variables, age of respondent and his/her attitude about the responsibility of water have negative but insignificant effects on WTP amount.

The identification of factors that can affect the WTP of households for improved water supply service is crucial in formulating feasible projects where the community together with the stakeholders can contribute their best in implementing the proposed improvement in water supply service. The mean willingness to pay value is 20.20 cents per bucket for the improved water supply service as calculated from the probit model. Hence the mean willingness to pay value ranges between 15.34 and 20.20 cents. The similarity of the mean WTP under tobit and probit models indicate the validity and reliability of the CV outcomes in empirical analysis.

6.2 Policy Implication of the Study

- ❖ Since income and willingness to pay for the proposed improvement in water supply service are positively related, development policies should target at increasing income per household that address the low income members of the society.

- ❖ Education helps increase individuals' awareness of the importance of improved water service in general and the ownership of private tap connection, in particular, as it has been witnessed by the positive coefficient of education dummies (secondary and tertiary education levels) on willingness to pay for the proposed improvement of the project. In general, the water authority in particular needs to launch strong public awareness to the local community on an economical use of the available water supply.
- ❖ The strong positive relation between the wealth of the household and the willingness to pay for improved water service indicate the necessity to consider households' wealth status in designing and implementing the policies of water supply services.
- ❖ Another strong positive relation between the year of stay of household at a particular area and the willingness to pay for the proposed improvement in water supply service reveals for development policies to be focused towards the oldest quarters of the city. In this old quarter of the city, poor infrastructure due to old age network pipe lines exacerbate leakage and malfunction of the existing water tap services.
- ❖ Labor and time cost to fetch water from PFs are high, since many of these sources for water are located at distance for most of the users. Thus, this shows the need to provide the majority of low income households with private connection in long-term credits.

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Annex 1 : Information on Urban Economic Establishment Census

	Standard	Households	Population	Number of EAs	% of Standard
Arada	High	615		4	2
	Midle	14577		93	36
	Low	25827		160	62
	Total	41019	198345	257	
Addis Ketema	High	1723		13	4
	Midle	13244		92	32
	Low	29954		190	64
	Total	44921	248228	295	
Lideta	High	1254		7	4
	Midle	11898		69	37
	Low	19940		109	59
	Total	33092	194347	185	
Kirkos	High	2419		19	7
	Midle	17372		104	37
	Low	27194		157	56
	Total	46985	208667	280	
Yeka	High	4253		17	7
	Midle	30247		149	58
	Low	19721		91	35
	Total	54221	268819	257	
Bole	High	6340		46	24
	Midle	22759		107	56
	Low	9110		38	20
	Total	38209	198403	191	
Akaki Kaliti	High	828		4	3
	Midle	14577		70	48
	Low	14667		71	49
	Total	30072	121163	145	
Nifas Silik Lafito	High	2121		13	6
	Midle	28444		139	67
	Low	12413		54	27
	Total	42978	232014	206	
Kolfie	High	7211		34	15
	Midle	17330		78	33
	Low	28070		122	52
	Total	52611	310844	234	
Gulelie	High	721		4	2
	Midle	21107		112	48
	Low	27025		115	50
	Total	48853	230722	231	
		432961	2211552		

Source: Urban Economic Establishment Census (CSA, 2004a).

Annex 2: Summary of Descriptive Statistics of Variables

Variable	Observ.	Mean	Std.Dev	Min	Max
Income of the households (INCH)	235	1339.329	1481.214	110	8500
Primary education of the respondents (EDUC ₁)	235	.2425532	.4295419	0	1
Secondary education of the respondents(EDUC ₂)	235	.3446809	.4762785	0	1
Tertiary education of the respondents(EDUC ₃)	235	.1914894	.3943131	0	1
Information about tariff (INFO)	235	.7744681	.4188242	0	1
Status of the respondents (STAT)	235	.5957447	.4917948	0	1
Wealth of the households (WEAH)	235	.5787234	.4948177	0	1
Occupation of the respondents (OCCR)	235	.3744681	.4850183	0	1
WTP	235	15.34468	8.529131	0	50
Attitude of the respondent (ATTR)	235	.7829787	.4130971	0	1
Initial bid (IB)	235	9.978723	4.147337	5	15
Yes/no (Y/N) to initial bid	235	.8553191	.3525296	0	1
Age of respondents (AGER)	235	34.97447	14.88328	17	85
Family size of the households (FAMS)	235	4.787234	1.891684	1	10
Sex of respondents (SEXR)	235	.7106383	.454434	0	1
Households year of stay in the house (STAY)	235	19.952837	12.57216	.75	60
Households use of tank as a storage of water (TANK)	235	.6978723	.4601604	0	1
Location of the study site Bole (LOC _{BO})	235	.306383	.4619747	0	1
Location of the study site Addis-Ketema (LOC _{AK})	235	.3404255	.4748637	0	1
Location of the study site N. Silk Lafto (LOC _{NL})	235	.3531915	.4789818	0	1
Level of satisfaction to the existing water services (SATI)	235	.8382979	.3689632	0	1

Note-the description of each variable is given in section 4.8.

Annex 3 : Pair-wise Correlation for Improved Water Supply Services

	locak	locbo	locnl	sexr	stat	fams	sati	stay	ib	mwtp	tank	attr	info	ager	educ1	educ2	educ3	occr	weah	inch
locak	1.00																			
locbo	0.48	1.00																		
locnl	0.53	0.49	1.00																	
Sexr	0.06	0.02	0.08	1.00																
Stat	0.12	0.09	0.03	0.03	1.00															
Fams	0.18	0.08	0.26	0.19	0.15	1.00														
Sati	0.07	0.22	0.28	0.01	0.16	-0.10	1.00													
Stay	0.20	0.22	0.02	-0.10	0.05	0.04	-0.10	1.00												
Ib	0.01	-0.02	0.01	0.25	0.07	0.07	0.11	0.08	1.00											
mwtp	-0.01	0.28	-0.36	0.26	0.03	-0.01	0.17	-0.12	0.20	1.00										
Tank	0.16	-0.03	-0.13	0.06	0.19	-0.02	0.01	0.09	-0.01	-0.05	1.00									
Attr	-0.01	-0.08	0.09	0.01	0.17	0.06	0.08	0.05	0.08	-0.02	-0.01	1.00								
Info	0.28	0.14	-0.41	-0.01	-0.03	-0.13	0.15	0.07	-0.04	0.34	-0.07	-0.04	1.00							
Ager	-0.01	-0.04	0.05	-0.16	0.60	-0.08	0.04	0.26	0.03	-0.11	0.14	0.08	-0.08	1.00						
Educ1	0.01	0.03	-0.04	-0.01	0.04	-0.09	0.01	0.02	-0.04	-0.03	0.05	0.06	-0.05	-0.06	1.00					
Educ2	-0.05	-0.04	0.08	0.07	-0.22	0.17	-0.09	-0.14	-0.04	-0.08	-0.09	-0.05	0.11	-0.23	-0.39	1.00				
Educ3	-0.10	0.14	-0.04	-0.05	-0.17	-0.12	0.01	-0.07	0.01	0.15	-0.12	-0.08	0.03	-0.19	-0.28	-0.35	1.00			
Occr	0.04	-0.09	0.05	0.05	0.08	-0.02	0.03	-0.11	0.06	0.13	-0.08	-0.08	0.04	-0.09	0.10	-0.12	0.20	1.00		
weah	-0.37	0.44	-0.05	0.03	-0.11	0.09	0.05	-0.06	0.01	0.16	-0.19	-0.09	0.08	-0.04	-0.04	0.11	-0.12	0.20	1.00	
Inch	-0.36	0.13	0.22	0.08	-0.16	0.15	0.05	-0.26	-0.04	0.28	-0.37	0.01	0.07	-0.16	-0.09	0.11	0.22	0.20	0.29	1.00

Note-description of each variable is given in section 4.8.

Annex 4 : Test of Heteroscedasticity

One of the important methods used to test the existence of heteroscedasticity in Tobit model is the log – likelihood ratio test (LR) test. The LR statistics of testing the null hypothesis of homoscedasticity assumption is obtained by

$$\lambda_{LR}=2[\text{Log Lu}-\text{LogLr}]; \text{ Where}$$

log Lu is the value of unrestricted log-likelihood function and

log Lr is the value of restricted log –likelihood function

λ_{LR} has a $X^2(n)$ distribution with n degrees of freedom where n is the number of explanatory variables. If the data do not support the null hypothesis (homoscedasticity assumption), then the value of the test-statistic becomes large and null hypothesis is rejected; i.e, if $\lambda_{LR} \geq X^2(n)$. The result of the test for the model is shown below

$$\begin{aligned}\lambda_{LR} &= 2[\text{Log Lu}-\text{LogLr}] \\ &= 2[-773.2196 - (-836.6690)] \\ &= 2[63.4494] \\ &= 126.8988\end{aligned}$$

The critical value of the chi-square at 18 degree of freedom is 28.87 at 95% level. Comparison of the result (test statistic) with critical table value shows that the test statistic (computed value) is found to be larger than the critical table value. This implies that the null hypothesis of homoscedasticity is rejected, i.e. heteroscedasticity is the problem for the model.

Annex 5: Goodness of Fit for Tobit Model

The model chi-squared statistic is a special case of likelihood ratio statistic with all relevant parameters restricted to be equal to zero

$$LR_{\text{Model}} = -2[\ln Lr - \ln Lu]$$

The statistic is distributed as a chi-squared with degrees of freedom equal to the number of parameters restricted to be equal to zero.

Where
 ln Lr is the restricted log-likelihood function
 ln Lu is the unrestricted log- likelihood function

$$LR_{Model} = -2 [-836.6690 - (-773.2196)]$$

$$= 126.8988$$

The null hypothesis that all parameters associated with covariates are zero is rejected at 1% significance level. Since the test statistic (LR_{Model}) exceeds the critical value of chi-square at 18 degree of freedom at 1% level which is 34.81. Hence, the model is statistically acceptable.

Annex 6: Calculating of consumer's surplus using figure 5.1

Area	Computation	Value of consumer's surplus (in cents)
A ₁	2144×5	10,720
A ₂	(2144×5) + ½(1601×5)	14,722.5
A ₃	3745×5	18,725
A ₄	(3745×5) + ½(4301×5)	29,477.5
A ₅	8046×5 + ½(6973×5)	57,662.5
A ₆	15019×5 + ½(30594×5)	151,580
A ₇	(45613×5)+ ½(28967×5)	300,482.5
A ₈	(74580×5) + ½(37038×5)	465,495
A ₉	(111618×5) + ½(14490×5)	594,315
A ₁₀	126108×3	378,324
Total		2,021,504

A_{4a}. Who is the head of the household? Ato/ W/o _____

SECTION B: EXISTING WATER SUPPLY QUESTIONS

B₁. What is your household's main source of water for domestic purpose?

a) Piped water **GO TO Q. B₂**

b) Others (specify) _____ **SKIP TO Q. B₄₄ (B₄₄ - B₅₃)**

IF "PIPED WATER" TO Q.B1 ASK Q.B₂ . OTHERWISE SKIP TO Q. B₄₄

B₂. What kind of piped water service is your household using?

a) Tap inside your house - **SKIP TO Q. B₄ (B₄-B_{14a})**

b) Tap in the compound, private - **SKIP TO Q. B₄ (B₄-B_{14a})**

c) Tap in the compound, shared with neighbors - **SKIP TO Q.B₃ (B₃-B_{14a})**

d) Tap outside compound – **SKIP TO Q. B₁₅**

B₃. How many household use the shared tap in the compound? _____ household.

B₄. How much water does your household consumes per day? _____ Baldi.

(Baldi is a 20 liter container).

B₅ For what purpose(s) is the water from this source mainly used by your household?

TELL THEM TO RANK WITH THE MAIN PURPOSE

a) _____ Drinking

b) _____ Washing clothes

c) _____ House keeping (cleaning house, gardening , etc)

d) _____ Others (specify) _____

B₆. Concerning its quality, amount and reliability, how would you rank the existing water service from this source?

a) Quality: _____ 1. Good 2. Satisfactory 3. Poor

b) Quantity: _____ 1. Good 2. Satisfactory 3. Poor

c) Reliability: _____ 1. Reliable 2. Unreliable

ASSESSMENT ON WATER QUALITY (Q.B₇-Q.B_{7a})

B₇ Does your household uses any purification method (such as boiling) to clean the water before drinking

___ 1. Yes

___ 2. No

B_{7a}. If "yes", what method (s) do you often use?

a) Boiling

b) Others (specify) _____

B_{7b}. If "No" what is/are the main reason not to use any purification method?

a) The water is clean for drinking

b) The water is not clean but it is costly and time taking to use purification method

c) The water is not clean but harmless to health

d) Other (specify) _____

B₈. Have any of your household members suffered from disease caused by deficient water quality such as diarrhea, typhoid, cholera etc. in the past one year?

___ 1. Yes

___ 2. No

B_{8a}. If "yes" what type of diseases have effected any members of your family over and under 15 years old , in the last one year?

INSERT NUMBER OF PEOPLE THAT WERE AFFCTED BY EACH DISEASE(S)

>15 years old	Yes number	≤ 15 years old	Yes number?
Diarrhea	a) _____	Diarrhea	a) _____
Vomiting	b) _____	Vomiting	b) _____
Cholera	c) _____	Cholera	c) _____
Typhoid	d) _____	Typhoid	d) _____
Others (specify) _____		Others (specify) _____	

ASSESSMENT ON WATER RELIABILITY AND AVAILABILITY

QUESTIONS (Q.B₉-Q.B_{14a})

B₉ How often your household does get water service?

a) All the time -**SKIP TO Q. B₁₄ (B₁₄-B_{14a})**

b) Not all the time -**GO TO Q. B_{9a} (B_{9a}-B_{14a})**

IF “b “To Q. B₉ , ASK

B_{9a} During which time is water usually available?

____ 1. Day time

____ 2. Night time

____ 3. Unpredictable

B_{9b} When pipe water is not available , which alternative water source does your household usually uses ?

a) Your own reserve

b) Other pipes where water is available

c) Spring and wells

d) Others (specify) _____

B_{9c} How much do you pay for this service? _____ cents per Baldi.

INTERVIEWER: IF NO PAYMENT WRITE ZERO

B_{9d} How much time (travel and collection time), on average, do you spend to get this service at a time? _____ minutes.

B₁₀ How many days per week do you receive water from the piped system? _____ days.

B₁₁ How many hours per day do you receive water from the piped system?
_____ to _____ hours.

B₁₂. How would you rate reliability of supply of water from AAWSA?

- _____ 1. Excellent
- _____ 2. Good
- _____ 3. Average
- _____ 4. Poor
- _____ 5. Very poor

B₁₃. How would you rate your water pressure? (sufficient for showering and washing dishes at the same time)

- _____ 1. Excellent
- _____ 2. Good
- _____ 3. Average
- _____ 4. Poor
- _____ 5. Very poor

B₁₄. Are you satisfied with the existing water services?

- _____ 1. Yes
- _____ 2. No

B_{14a}. If no, what is/are the cause(s) of your dissatisfaction?

RANK STARTING FROM THE MOST SERIOUS CAUSE.

- a)_____ Poor quality
- b)_____ Less quantity
- c)_____ Unreliability
- d)_____ Higher connection charges
- e)_____ Higher service charges
- f)_____ Other (specify) _____

IF “TAP OUTSIDE COMPOUND” TO Q.B₂ ASK

B₁₅. Is your house covered with water supply net work of AAWSA?

___ 1. Yes

___ 2. No

B₁₆. From which source do you get water currently?

a) Public tap - **GO TO Q.B₁₇ (B₁₇- B₃₂)**

b) Private vendors – **SKIP TO Q.B₃₃ (B₃₃- B₄₃)**

c) Other organizations (specify) _____ **SKIP TO Q.B₃₃ (B₃₃- B₄₃)**

IF “PUBLIC TAP” TO Q.₁₆, ASK

B₁₇. How many times on average do you go to the public tap per day? _____ times.

B₁₈. How much time do you spend fetching water at a time? _____ minutes.

B₁₉. How many persons from your household go to the public tap at a time? _____ Persons.

B₂₀. Who goes to the public tap?

a) girls b) boys c) women e) men f) others (specify) _____

B₂₁. How many public taps, on average, function most of the time?

a) one b) two c) three d) four e) five f) six g) others (specify) _____

B₂₂. How much water, an average, do you collect at the public tap on a day?

_____ Baldi/Jerry can (Jerry can is a 20 liter container)

B₂₃. How much do you pay per baldi /Jerry can? _____ cents.

B₂₄. How much money do you spend per month to collect water from this source?

_____ birr per month.

B₂₅. When do you prefer the public tap to be open?

a) early morning b) afternoon c) evening d) all day long

B₂₆. What is the present status of the public tap service?

1) Quality a) good b) average c) poor

2) Quantity a) good b) average c) poor

3) Convenience of service hours? a) good b) average c) poor

B₂₇. For what major purpose(s) do you use water collected from public tap? **IDENTIFY AND RANK**

- a) _____ Drinking
- b) _____ Housekeeping
- c) _____ Washing clothes
- d) _____ Others (specify) _____

B₂₈. Why do you prefer this source? **IDENTIFY AND RANK**

- a) _____ No access to the existing pipe system
- b) _____ I can not afford the costs to the existing system
- c) _____ Its reliability
- d) _____ lower volume charge
- e) _____ Shorter distance than other sources
- f) _____ Others (specify) _____

B₂₉. Had there been any interruption of water supply from the public tap?

- ____ 1. Yes
- ____ 2. No

B_{29a}. If "yes", on average, how frequent was this interruption?

- a) daily
- b) weekly
- c) bi- weekly
- d) monthly
- e) seasonally
- f) others(specify) _____

B₃₀. Whenever there is an interruption, from where do you get water?

- a) buying from neighbors/vendor
- b) buying from another public stand pipes
- c) others (specify) _____

B₃₁. Are you satisfied with this source of water?

- ____ 1. Yes
- ____ 2. No

B₃₂. If no, why are you dissatisfied? **IDENTIFY AND RANK**

- a) _____ Poor quality
- b) _____ Low quantity
- c) _____ Unreliability
- d) _____ Higher volume change
- e) _____ Far away from home
- f) _____ Availability problem
- g) _____ Others (specify) _____

IF "PRIVATE VENDOR OR OTHER ORGANIZATIONS" TO Q.B₁₆ ASK

B₃₃. Whom do you buy water from?

- _____ 1.Private vendors
- _____ 2.Other organizations (specify) _____

B₃₄. Why do you prefer this source? **IDENTIFY AND RANK**

- _____ a) No access to the existing pipe system?
- _____ b) I can not afford costs to the existing system
- _____ c) Its reliability
- _____ d) Lower volume charge
- _____ e) Shorter distance than other sources
- _____ f) Other (specify) _____

B₃₅. How much time do you spend for collecting water at a time?

_____ minutes.

B₃₆. How many persons go to collect at a time?

_____ persons

B₃₇. who goes to collect water from this source?

- a) Girls
- b) Boys
- c) Both
- d) Other (specify) _____

B₃₈. How often do they go per day?

_____ times.

B₃₉. How much do you pay per Baldi/ Jerry can?

_____ cents.

B₄₀. How much water do you collect on the average on a day?

_____ Baldi/Jerry can.

B₄₁. How much do you spend per month on the average for buying water from this source? _____ Birr per month.

B₄₂. Are you satisfied with the services from this source?

_____ 1 Yes

_____ 2. No

B₄₃. If "No" , why are you dissatisfied ? **IDENTIFY AND RANK**

_____ a) Poor quality

_____ b) Low quantity

_____ c) Unreliability

_____ d) High volume charge

_____ e) Far away from home

_____ f) Availability problem

_____ g) Others (specify) _____

IF "OTHERS" TO Q .B₁ ASK:

B₄₄. What other sources do you often use for water collection?

a) River

b) Well

c) Spring

d) Others (specify) _____

B₄₅. Do you pay for water from this source?

_____ 1. Yes **Go to Q. B₄₆ (B₄₆-B₅₃)**

_____ 2. No **Go to Q. B₄₇ (B₄₇-B₅₃)**

B₄₆. How much do you pay per Baldi/Jerry can? _____ cents.

B₄₇. How much water do you collect, on average, on a day? _____ Baldi/Jerry can.

B₄₈. How much time do you spend fetching water at a time? _____ minutes.

B₄₉. How many members of the household go to fetch water at a time? _____ person (s)

B₅₀. Who goes to this source?

- a) Girls
- b) Boys
- c) Both
- d) Others (specify) _____

B₅₁. How often do they go per day? _____ times.

B₅₂. Are you satisfied with this source of water ?

- ___ 1. Yes
- ___ 2. No

B₅₃. If "No", why are you dissatisfied? **IDENTIFY AND RANK**

- ___ a) Poor quality
- ___ b) Low quantity
- ___ c) Unreliability
- ___ d) High volume charge
- ___ e) Far away from home
- ___ f) Availability problem
- ___ g) Others (specify) _____

SECTION C: HOUSEHOLD'S WILLINGNESS TO PAY FOR IMPROVED WATER SUPPLY SERVICES

This section concerns on how much value you are prepared to pay for an improved water provision. That is, it concerns on how much the provision of improved water worth to you, in monetary terms.

INTERVIEWER: READ THE FOLLOWING INTRODUCTION

I want you to consider the following hypothetical improvement to your water supply situation. It is crucial that you answer honestly. If you and others say that you will not pay for improvement, it may be impossible for changes to occur. If you and others suggest that you will pay more than you are able to, you may not be able to afford the improvement, should they happen. Please, therefore, be truthful in stating your maximum willingness to pay. By an improved provision of water, we mean:

- Good quality of water which is safe for health is provided.
- Good quantity of water is available for 24 hours per day, throughout the year.
- Collection of water need not take much of your time and effort.

Suppose you have an option to such an improved water supply scheme. Let us also assume that you will be charged a monthly water fee based on the volume of water your household consumes in the month. The tariff per volume will be the same for all consumers, but it is progressive. The more you consume the higher will be your monthly bill.

C₁. What is the main source of water for this household for domestic purpose?

- a) Private piped water
- b) Shared piped water
- c) Others

IF "PRIVATE PIPED WATER" TO Q.C₁ ASK Q.C₂. OTHERWISE SKIP TO Q.C₃

WILLINGNESS TO PAY FOR IMPROVED WATER SUPPLY SERVICE

C₂. Are you willing to pay any amount to the improved water provision?

- ___ 1. yes **GO TO Q. C_{2a} (C_{2a}-C_{2b})**
- ___ 2. No **SKIP TO Q. C₅ (C₅ only)**

C_{2a}. If "yes" suppose that AAWSA presented the improved Water service, would you be willing to pay _____ cents per Baldi (Jerry can) to obtain improved water from this new scheme?

- ___ 1. yes **GO TO Q.C_{2b}**
- ___ 2.No **GO TO Q.C_{2b}**

C_{2b}. What is the maximum you could pay for one Baldi (Jerry can) of water for the improved water scheme? _____ cents per Baldi (Jerry can).

IF "b" OR "c" TO Q. C₁ ASK Q. C₃

WILLINGNESS TO PAY (WTP) FOR IMPROVED PRIVATE PIPE CONNECTION

Assume also that you have private water connection together with the improved water supply scheme. Notice also that you may not be required to pay initially the costs of connection to the new scheme. Instead, the AAWSA (Addis Ababa water and sewerage authority) will cover the costs with insignificant increase in the tariff rate.

C₃. Are you willing to pay any amount to have private pipe connection with the improved water provision?

___ 1. yes **GO TO Q. C_{3a} (C_{3a}-C_{3b})**

___ 2. No **SKIP TO Q. C₄ (C₄-C_{4b})**

C_{3a}. If "yes" suppose the authority presented the improved water service with private pipe connection, would you be willing to pay ___ cents per Baldi (Jerry can) to connect improved pipe water from this new scheme?

___ 1. Yes **GO TO Q. C_{3b}**

___ 2. No **GO TO Q. C_{3b}**

C_{3b}. What is the maximum you could pay for one Baldi (Jerry can) of water for this improved pipe water scheme? ___ cents per Baldi (Jerry can).

WILLINGNESS TO PAY FOR IMPROVED PUBLIC TAP QUESTIONS

C₄. Are you interested in the provision of public tap?

___ 1. Yes **GO TO Q. C_{4a} (C_{4a}-C_{4b})**

___ 2. No **GO TO Q. C₅ (C₅ only)**

C_{4a}. If "yes" suppose that a new scheme of improved water system will be provided using a public tap as near as possible to your home. With this public tap good quality water will be provided as much as you wish at any time of the day through out the year. Would you be willing to pay ___ cents per Baldi (Jerry can) of water from such public tap?

___ 1. yes **GO TO Q. C_{4b}**

___ 2. No **GO TO Q. C_{4b}**

C_{4b}. What is the maximum you could pay for one Baldi (Jerry can) of water for this improved water scheme? _____ cents per Baldi (Jerry can).

C₅. Are you totally not willing to pay because you believe that:

- a) The existing system is satisfactory
- b) You can't afford the new scheme
- c) The government should pay
- d) Other reasons (specify) _____

SECTION D: WATER USAGE AND PERCEPTION QUESTIONS

D₁. Do you have your own private pipe line?

- ____ 1. Yes **SKIP TO D₃ (D₃-D₁₃)**
- ____ 2. No **GO TO D_{1a} (D_{1a}-D₁₃)**

D_{1a}. If no, have you applied to have your own pipe line?

- ____ 1. Yes **GO TO Q. D_{1b}**
- ____ 2. No **SKIP TO Q. D₂**

D_{1b}. How long is it since you applied to get the access? _____ months.

D_{1c}. State the reason why you did not get private connection so far?

- ____ a) Inefficient bureaucracy
- ____ b) Shortage of meter
- ____ c) Shortage of pipes
- ____ d) Do not know
- ____ e) Others (specify) _____

D₂. What is the main reason for not having private pipe line?

- a) Connection fee too high
- b) Monthly charges too high
- c) Connection is not available due to rented house
- e) Land tenure is not secured
- f) Near by stand pipe
- g) Cheaper from stand pipes
- h) Others (specify) _____

D₃. How long have you lived in this house? _____ years and _____ months

D₄. How has the water service changed since you have been living in this house?

- a) _____ Greatly improved
- b) _____ Improved
- c) _____ No change
- d) _____ Worsened
- e) _____ Greatly worsened

D₅. Do you have tank for water storage?

- _____ 1. Yes
- _____ 2. No

D_{5a}. Does your storage allow you a continuous supply?

- _____ 1. yes
- _____ 2. No

D₆. To what extent do you perceive the current provision of piped water as an issue worth discussion?

- a) Critical
- b) Very serious
- c) Serious
- d) Less serious
- e) Not important

D₇. Who do you think is mainly responsible for water supply?

- a) Government
- b) Community
- c) Private
- d) Others (specify) _____

D₈. Do you believe the administrative body so far done enough in solving the problems in the provision of piped water to household ?

- a) a lot of attention to the problem
- b) Some attention to the problem
- c) Not too much attention to the problem
- d) No attention at all

D₉. Do you know the rate of tariff on water has been increased since the past five years?

- ___ 1. yes
- ___ 2. No

D_{9a}. If "yes" what do you suggest on the increment?

- a) The increment is high
- b) The increment is medium
- c) The increment is low
- d) others (specify) _____

D_{9b}. How does your water consumption change due to increase in tariff?

- a) Decrease in consumption
- b) No change in consumption
- c) Others (specify) _____

D₁₀. What measures do you suggest to ensure safe improved and reliable water supply to the city.

D₁₁. Please list the following services in order of importance.

- ___ a) School
- ___ b) Health
- ___ c) Water
- ___ d) Sanitation (toilet)
- ___ e) Electricity
- ___ f) Telephone

E₁. Would you please tell me the age, sex, marital status, education level, occupation of every member of your household, household's asset, housing condition, monthly income, monthly expenditure and relationship to you?(see table 1 below)

RECORD THE ANSWER FOR Q.E₁ IN THE HOUSEHOLD MEMBER CHARACTERISTICS TABLE (TABLE 1) BELOW. START RECORDING FROM THE RESPONDENT HIM/HERSELF. INTERVIEWER: BEFOR YOU FILL THE TABLE READ THE FOLLOWING POINTS

FOR THE SEX COLUMN
WRITE 1. IF FEMALE
2. IF MALE

FOR RELATIONSHIP COLUMN
WRITE 1. IF FATHER
2. IF MOTHER
3. IF SON
4. IF DAUGHTER
5. OTHER

FOR OCCUPATION COLUMN
WRITE
1. IF GOVERNMENT EMPLOYEE
2. IF NGO_s EMPLOYEE
3. IF PRIVATE BUSINESS
4. IF SELF EMPLOYEE
5. IF HOUSEHOLD WIFE
6. IF NO EMPLOYMENT
7. IF RETIRED
8. IF STUDENT
9. OTHERS

FOR EDUCATION COLUMN
WRITE -THE LEVEL OF EDUCATION COMPLETED
-0 IF UNEDUCATED
13 FOR CERTIFICATE
14 FOR COLLEGE DIPLUMA
16 FOR COLLEGE DEGREE AND ABOVE

MONTHLY INCOME OF MEMBERS
WRITE- INCOME FOR EACH MEMBER
-OTHER INCOME OUT OF MEMBER

MARITAL STATUS
WRITE 1. IF MARRIED
2. IF UNMARRIED
3. IF DIVORSED
4. IF WIDOWED

FOR AGE COLUMN
WRITE-AGE FOR EACH

TABLE 1: HOUSEHOLD CHARACTERISTICS, INCOME AND EXPENDITURE

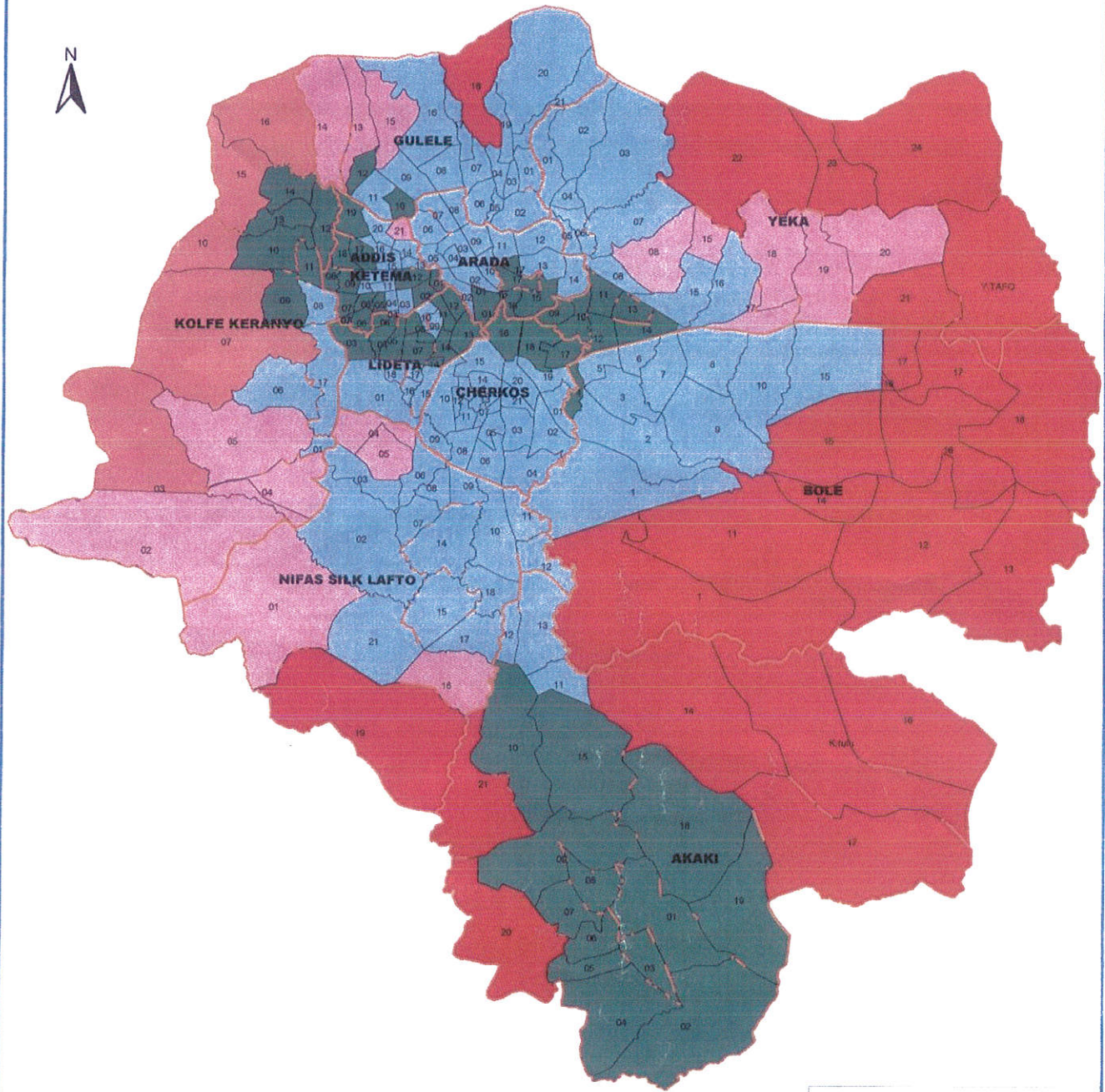
No	Name	Relationship to respondent	Sex		Age	Marital status	Education level	Occupation	Household's asset	Housing condition	Household's income (in Birr)	Household Monthly expenditure (in Birr)	Remark
			M	F									
1		Respondent							Radio	Owned by HHs		Food	
									Television	Rented from kebele		Health	
									Tape	Rented from public		Education	
									Telephone	Rented from private		Transport	
									Refrigerator	Others		Telephone	
									Elec.Stove			Electricity	
												House rent	
												Entertainment	
												Others	

Thank you for your time!

ADDIS ABABA WATER AND SEWERAGE AUTHORITY

WATER SUPPLY SITUATION MAP(Catagorized)

(DECEMBER, 2005)



- Sub City Boundary
- Kebele Boundary

Water Supply Situation Of Addis Ababa(December 2005)

- No Supply - Estimated Population = 58,136 - Area = 203.89Km²
- Supplied For one day/Week - Estimated Population = 89,671- Area = 29.81Km²
- Supplied For 1-6hrs/day - Estimated Population = 419,914 - Area = 76.21Km²
- Supplied For 7-16hrs/day - Estimated Population = 1,408,865 - Area = 124.80 Km²
- Supplied For 17-24hrs/day - Estimated Population = 866,191 - Area = 85.89 Km²

ADDIS ABABA WATER & SEWERAGE
AUTHORITY



ENGINEERING SERVICES DEPARTMENT
GIS UNIT

Prepared By: Zenhun Amdemariam
Date: December, 2005

DECLARATION

I, the undersigned, declare that this thesis is my original work, has never been presented for a degree in any other university and that all source of materials used for this thesis have been dully acknowledged.

Declared by:

Kinfe G.egziabher
Candidate

Signature 

Date: March 25, 2007

Confirmed by:

Dr. Berhanu Adnew
Advisor

Signature 

Date: March 25, 2007

Place and date of submission: Addis Ababa University, March 25, 2007