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## Determination of Basic Household Water Requirements (Revised)

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Philippine Institute for Development Studies

## Determination of Basic Household Water Requirements

*Arlene B. Inocencio, Jose E. Padilla  
and Esmyra P. Javier*

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## **Determination of Basic Household Water Requirements<sup>\*</sup>**

A. B. Inocencio, J. E. Padilla, and E. P. Javier<sup>1</sup>

### **Abstract**

The concern for determining the basic or minimum water requirement for a person to maintain good health and proper sanitation comes about in the light of the current state of water resources and the growing scarcity against a rapidly rising population. This paper's contribution is the determination of this basic or minimum water requirement which is necessary to sustain human life and other basic human activities through a record keeping approach and use of an econometric tool. Specifically, the study (1) obtains actual per capita water consumption by activity based on household water usage and (2) determines household and per capita water requirement that cuts across income classes, water sources and cost of water, and location. Results of this study provide a valuable input in water-sector planning (i.e., for water supply infrastructure), allocation of available water supply between domestic and other uses (i.e., industrial and agricultural), and in determining the appropriate water tariff consumption block and structure for domestic consumption as the paper gives an empirical basis for the lifeline or minimum consumption block of about 10 cubic meters per month for a family of 6 members.

**Keywords:** basic water/minimum requirements, water demand, water consumption by activity, record keeping approach

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<sup>\*</sup> This report was prepared under contract by the Resources, Environment and Economics Center for Studies, Inc. (REECS) for the Sectoral Task GROUP (STG), Water Sector, Population Policy Operations Project (PPOP) administered by the Commission of Population (POPCOM) with the financial assistance of the United Nations Fund for Population Activities (UNFPA). The views expressed here are those of the authors' and do not necessarily reflect those of the STG, PPOP, POPCOM, UNFPA, and REECS.

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## **Determination of Basic Household Water Requirements<sup>\*</sup>**

A. B. Inocencio, J. E. Padilla, and E. P. Javier<sup>1</sup>

### **Introduction**

The focus on water as a necessity for life obscures the fact that in present societies only a very small fraction of water consumption is used for drinking and for sustaining human life. A large proportion of water usage is for convenience, comfort and aesthetics. For example,<sup>2</sup> it was found that for residential water use exceeding 400 liters per capita per day (l/c/d), nearly half is used for watering lawns and gardens and most of the remainder for flushing toilets, bathing, and washing cars.<sup>3</sup> While this usage may seem normal, it certainly goes beyond the basic human requirement for water. The concern for determining the basic or minimum water requirement for a person to maintain good health and proper sanitation comes about in the light of the current state of water resources and the growing scarcity against a rapidly rising population. The growing problem of sustainability of current use has become a matter of great importance.

Available planning projections made use of varying assumptions on the per capita water usage. Available estimates of water usage in the Metro Manila by sources of water and quality of water service show that daily per capita consumption ranges from a low of 20 liters up to a high of 400 liters (Arellano, 1994; JICA, 1992, 1996, 1998; MWSS Corplan, 1995; Haman, 1996; David and Inocencio, 1996). While the lower end of this range may exhibit a very constrained demand for water due to non-availability or to excessively high prices, the upper bound may illustrate usage way beyond the basic water requirement and perhaps sheer wastage. The importance of estimating a more realistic water requirement even for planning purposes is illustrated in the following (Young 1996):

*Forecasting of water use into the distant future is fraught with difficulties. The simplistic extrapolation of trends in per capita "requirements" in water system planning has resulted in many cases in which future water use was greatly overestimated.*

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<sup>2</sup> While this usage is a (arid western) US example, the proportion of usage may not differ much from those of rich households in the country who have large lawns and swimming pools.

<sup>3</sup> Gleick (1993) in Water Resources Handbook, 1996.

The country's current planning standard<sup>4</sup> for domestic water consumption of about 250 l/c/d may need to be reexamined in the light of increasing supply constraints and growing population. Even relative to the available estimates, this figure is certainly higher due to the fact that it includes non-revenue water or systems losses which David (1997) argues is a supply side variable and should therefore be excluded from demand estimates. Weakness in water demand estimation and projections is partly due to availability of limited data and paucity of empirical studies and econometric estimation of water demand functions typical in developing countries (David 1997). With additional relevant information on water usage, water planning may be made more efficient and responsive to current conditions.

Determination of this basic or minimum water requirement through record keeping serves as the contribution of this study. It is noted that no study has, so far, objectively estimated basic water requirement by household activity such as drinking, personal hygiene, washing, cooking, and sanitation, among others, for the Philippines. This study estimates the household basic water requirement which is necessary to sustain human life and other basic human activities needed to maintain good health and proper sanitation through record keeping. Specifically, the study aims to: (1) obtain actual per capita water consumption by activity based on household water usage and (2) to determine household and per capita water requirement that cuts across income classes, water sources and cost of water, and location. Results of this study may provide a valuable input in water-sector planning (i.e., for water supply infrastructure), allocation of available water supply between domestic and other uses (i.e., industrial and agricultural), and in determining the appropriate water tariff consumption block and structure for domestic consumption.

In this paper, water is treated as essential to life and clean water and sanitation, essential to health. Moreover, it is assumed that access to clean water at an affordable price is a basic right<sup>5</sup>. Even up to now, water is still viewed "as contributing special cultural, religious and social values" and often treated as a free resource and not as an economic good. An extreme view is that, "the sacredness of water as a symbol of ritual purity exempts it somewhat from the dirty rationality of the market." In this study, issues on equity and affordability are also discussed but with a view that water is both a social and an economic good.

The next section reviews the literature on water usage by household activity and by source as well as estimates of basic water needs. This discussion is followed by the presentation of the framework and methodology of the study which includes the concepts of water demand versus water requirement and the components of basic water needs, sampling procedure and survey approach. The profile of the sample and the sample's perceived impact of the El Nino follow while estimates of existing basic water requirements are discussed in the

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<sup>4</sup> The planning standard of 0.0029 liters per second per capita for domestic use provides allowance for the water system losses often termed as non-revenue water.

<sup>5</sup> Dublin Conference on Water and Environment in January 1992 as cited in Water Resources Handbook, 1996.

succeeding section. The penultimate section is devoted towards the establishment of a basic water requirement and the last section gives the conclusion and some policy implications.

## **Review of Household Water-use Literature**

Most of the available estimates of water consumption by households for specific domestic uses for other countries are quite dated but the few more recent ones either just cited the old estimates or are generally consistent with the old. A review of water usage literature shows that while the absolute quantities vary, there is an observable pattern of use across sources, income levels and locations. Depending on the type of technology used, consumption for a specific activity can differ greatly. This review provides benchmark figures with which to compare estimates of water consumption by activity obtained in this study.

### **Water Usage by Household Activity**

A World Bank (1980) study<sup>6</sup> on basic needs and the urban poor reported that "neither personal hygiene nor public health" would require water for domestic consumption greater than 100 liters per capita per day (l/c/d). This estimate was corroborated by the United States Department of Agriculture study in 1991, which indicated that basic household activities such as cooking, drinking, and washing can be met by less than 94.5 liters. More recent studies (Falkenmark 1992, Gleick 1996) give estimates of basic water requirement between 50 and 100 l/c/d.

**Drinking.** The amount of water for human survival depends on surrounding environmental conditions and human physiological characteristics but the overall variability of needs across individuals is small. According to Clarke (1993), an average person would need to drink about a liter of water a day to stay alive. Estimates of average daily intake of water are given in **Table 1**. A minimum of 1.8 l/c/d was reported in White *et al.* (1972) while majority of the available studies estimated about 2 to 2.5 l/c/d. In physiological studies, it is estimated that the minimum water requirement is about 3 l/c/d under average temperate climate conditions. Saunders and Warford (1976) and Gleick (1996) propose to use the maximum estimate of 5 l/c/d. Gleick argues that since substantial populations live in tropical and subtropical climates, the 3 l/c/d minimum has to be increased to 5 l/c/d to be more realistic.

A more detailed illustration of how water is spent inside an American home shows the range of use from conservative to normal. Drinking water is shown to range from as little as a quarter of a liter to about 4 l/c/d while brushing of teeth can use water as low as 2 l/c/d to as much as 10 times when it is done with a running tap (US DANRCS 1997). For purposes of

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<sup>6</sup> As cited in Kirke, J. and J. Arthur (1984).

planning, an affluent subdivision<sup>7</sup> in Metro Manila estimated water usage of its residents by main household activity for 1997. Drinking water was estimated to be consistent with the estimated minimum for tropical climates and about three fourths that of the normal use in a U.S. household at about 3 l/c/d.

**Food Preparation.** By the standards of WHO (1972) and according to the studies<sup>8</sup> of White, et al. (1972), the NRC (1989) and Black (1990), food preparations in both developed and developing countries would require about 10 to 20 l/c/d (**Table 2**). While this range is said to satisfy most regional standards, 10 l/c/d is claimed to be enough to meet basic needs. Brooks and Peters<sup>9</sup> (1988) estimated a higher range of 10 to 50 l/c/d, averaging to 30 l/c/d, for wealthy regions. For a U.S. household, an estimate for cleaning vegetables ranges from a conservative use of about 2 l/c/d to 11 l/c/d for a normal use (US DNARCS 1997). An estimate for California gives a total of 26.5 l/c/d for both cooking and dishwashing. More than half of this total is used for dishwashing (East Bay Municipal Utilities District,<sup>10</sup> 1991). In the case of Maldives and Nepal, cooking and dishwashing including drinking and house cleaning water requirement is about 15 l/c/d for those with piped connections while average use for those sourcing water from standpipes is only about 10 l/c/d (Dangerfield 1983). For households getting water from private wells, the range is from 7 to 15 l/c/d. The available estimate for Metro Manila for cooking is much lower at about 6 l/c/d (UBFHOA 1996).

**Bathing.** Depending on the technology associated with a household activity, usage can vary greatly. For instance, for showering or bathing alone, an average American household spends about 15 to over 150 liters per capita depending on whether a regular or a Navy shower or a full tub is used (US DNARCS 1997). For Nepal and Maldives (Dangerfield 1983), while usage by activity shows a similar pattern with that of an average U.S. household (US DNARCS 1997) with toilet flushing for households with piped connection constituting the highest use, ablutions or cleansing of the body is shown to require the most amount of water for those sourcing water from public standpipes and private wells ranging from 18 to 40 l/c/d (**Table 3**). The estimate for bathing requirement for a Metro Manila household (UBFHOA 1996) of about 38 l/c/d is much lower than the usage for households with piped connection in Maldives. Gleick (1996) cites that developed countries generally use from 27 to 99 l/c/d, averaging between 60 and 70 l/c/d, for bathing. Bathing for developing countries is estimated to be much lower at 5 to 15 l/c/d while showering would need 15 to 25 l/c/d.

**Sanitation.** **Figure 1** shows a residential water use in the U.S. by main water using activities. According to Hughes (1996), water used for toilets including leakage constitutes the bulk of water used at 33 percent of total domestic use. Specifically, toilet flushing (US

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<sup>7</sup> The estimate was done by the subdivision itself for planning purposes. However, a village official indicated that the total daily per capita demand of about 216 liters cannot be supplied by village's private waterworks. The shortfall is supplied by privately installed wells and water vendors.

<sup>8</sup> As cited in Gleick 1996.

<sup>9</sup> As cited in Gleick 1996.

<sup>10</sup> As cited in Gleick 1996.

DNARCS 1997) per use can consume from 15 to 26 l/c/d (**Table 4**). Also, as in the studies for the U.S., toilet flushing for Metro Manila (UBFHOA 1996) is estimated to comprise the biggest percentage of actual water usage requiring about 60 l/c/d or 28 percent of total daily consumption per capita. Overall, sanitation requirements differ by technology used and can even exceed 75 l/c/d. Pit latrine requires the least amount of water of one to two l/c/d while pour and flush toilets consume 6 to 10 l/c/d. The most inefficient technologies are the small-bore and the conventional sewerage consuming from 50 l/c/d to over 75 l/c/d.

It has been shown that the lack of clean water and sanitation services has led to millions of cases of water-related diseases and caused about 5 to 10 millions deaths per year among children (as cited in Gleick, 1996). Epidemiological studies related to water and sanitation have shown that after providing a minimum amount of water for metabolic activity and hand washing, provision of adequate sanitation services was the most direct determinant of child health. While sanitation technologies that do not require water are available, it has been argued that additional health benefits are identifiable with up to 20 l/c/d of clean water for sanitation purposes (Esrey and Habicht,<sup>11</sup> 1986).

**Laundry.** Figures on laundry are not as plentiful as that for other uses of water. Water requirement for laundry varies depending on the technology used ranging from hand washing to a half or full cycle machine washing. Also, for a given technology, use may differ by source. Users with piped connection may consume more per cloth than a household which buys the more expensive water from vendors. Available estimates for Maldives and Nepal (Dangerfield 1983) for minimum water requirement show that they are much less than the minimum estimate for developed countries (**Table 5**). Also, laundry usage of households are lower when sourced from private wells (at 8 to 10 l/c/d) than when sourced from piped and standpipes. Use rates for Sweden is thrice the maximum estimate for Maldives and Nepal at about 30 l/c/d. The available estimate for Metro Manila is however, even much higher than that of Sweden and selected American cities at 38 l/c/d (UBFHOA 1996). For the U.S., washing clothes uses about 29 to 71 l/c/d (Gleick 1996). More recent estimates show that it can reach to a hundred liters per capita per day to more than double depending on whether a short or a full cycle is used.

### **Water Usage by Source of Water and Income**

**Table 6** shows that actual water consumption per capita varies with the mode of water connection (Dangerfield 1983). Households with water connections are reported to consume more, ranging from 100 to 150 l/c/d. For households who are getting water from hand pumped wells and carry the water over about 100 to 500 meters and those getting from single stand pipes serving 250 to 500 persons, water consumption is much less at about 10 to 15 percent of those with piped connections.

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<sup>11</sup> As cited in Gleick 1996.



Some studies (e.g. Kirke and Arthur 1984) observed that when water is carried over long distances or purchased from itinerant water-vendors, consumption even falls to about 5 l/c/d, which is assumed as the minimum necessary to sustain life.<sup>12</sup> When water is from a shallow well, the level of consumption ranges from about 5 to 28 l/c/d. If water is from public standpipes, consumption per capita per day ranges from 9 to 47 liters. With an easier access to water supply, consumption tends to rise such that households with multiple taps consume between 28 and 283 l/c/d of water. Single tap households tend to consume between 57 and 94 l/c/d. The authors however, believe that under most circumstances, 28 to 38 l/c/d would be enough to maintain a reasonable level of personal and community health.

Other studies noted similar observations as above. Clarke (1984) also reported that when water was carried, only 20 l/c/d was consumed while those with taps consumed an average of 78 l/c/d, both within the ranges cited above. A more recent study (Intermediate Technology Development Group in Swaziland 1993) obtained consistent results where per capita use for delivered water is about 12 liters while those with tap water consume 28 to 94 liters per capita daily.

Estimates of minimum water requirements for major uses of water for Maldives and Nepal differ across source, ranging from a total of 40 l/c/d for those getting water from standpipes to a maximum of 118 l/c/d for those getting water from piped connections (Dangerfield 1983). Consumption from private wells ranged from over 40 to 80 l/c/d.

Domestic per capita consumption is also reported to differ by household income using housing class as proxy for income (**Table 7**). Connal (1982) shows that for those living in lower housing class such as tenements and government housing with at least one tap, the per capita consumption is from 55 to 70 l/c/d. Those living in detached and luxury apartments were shown to consume about thrice those living in lower housing class.

In terms of level of economic development, Argawal (1981) observes that in third world countries where piped connection is scarce, people only use about 4 to 38 liters of water per person per day while in cities in developed countries, people consume about 83 to 227 l/c/d. Estimates of total domestic water use for selected Asian countries and the WHO regions (**Table 8**) show a range of about 10 to less than a 100 l/c/d. Cambodia consumes the least at 9.5 l/c/d. On regional averages, the Western Pacific region reaches a high of 95 l/c/d. The world average water consumption for developing countries ranges from 35 to 90 l/c/d (Argawal 1981).

From the discussions above, it is shown that those which source their water from piped connections have much higher per capita consumption compared to those who are getting water from public standpipes (picked up or delivered) or those who buy from itinerant water vendor,

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<sup>12</sup> World Bank: 1976. "Village Water Supply," A World Bank Paper (Washington, D.C.), as cited by Kirke and Arthur.

which consume the least. Also, the poor are reported to consume only about one third those of rich households.

## **Framework of Analysis**

### **Water Demand versus Requirement**

In theory, water demand is defined as a function of own price, price of other related goods, income and other socio-economic variables. Household characteristics which may also influence demand include household size, technologies affecting water use such as water closet, showers, and washing equipment, and other socioeconomic variables such as ownership of a car or maintenance of a big garden or lawn. Empirical studies show that household water demand is largely determined by changes in the price of water and income growths (Young 1996, Elston 1997). Demand for water moves in opposite direction as its own price and in the same direction as household income.

Studies of residential water demand in the United States have shown long run price elasticity to fall between -0.3 and -0.7 which means that doubling the price of water, i.e., increasing price by 100 percent, will decrease demand by 30 to 70 percent. The estimate of David and Inocencio (1996) of price elasticity for water in Metro Manila of -0.5 is consistent with that for other countries. Available estimates generally show inelastic demand for water.

For this study, it is necessary to distinguish water "demand" from water "requirement". To empirically determine the basic water requirement, it is important to understand the concept of price elasticity of demand. The price elasticity of demand for water measures the responsiveness of demand to price, i.e., it is the percentage change in the quantity of water consumed due to a percentage change in its price. Demand is elastic<sup>13</sup> if for a given percentage increase in the price of water, a larger percentage decrease in the quantity of water results. The converse is true for an inelastic<sup>14</sup> demand. Note that the degree of elasticity or inelasticity can vary<sup>15</sup> from one price range to another. Water requirement is the amount of which remains constant for any change in price, i.e., price elasticity is zero.

Defining household "demand" for water, ( $D_w$ ), as a function of a vector of prices, ( $P$ ), representing its own price and the prices of its substitutes, income, ( $I$ ), household size, ( $N$ ) and other socioeconomic variables, ( $Z$ ), i.e.,

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<sup>13</sup> This implies a price elasticity of greater than one.

<sup>14</sup> Or a price elasticity of greater than zero but less than unity.

<sup>15</sup> Empirical works often calculate demand functions assuming a constant price elasticity or a point elasticity (or elasticity at a point on a demand curve) which is constant at all points on a curvilinear demand.

$$D_w = f ( P, I, N, Z ) ,$$

"requirement" can be defined as the quantity of water used which remains the same regardless of the price (Young 1996). That is, water requirement,  $(R_w)^{16}$  can be written as

$$R_w = D_w \text{ where } dD_w/dP = 0.$$

### Components of Basic Water Requirements

Gleick (1996) identified four components of basic water requirements: (1) drinking water for survival, (2) water for human hygiene, (3) water for sanitation services, and (4) modest household needs for preparing food. In accordance with local practices and situation, this paper expands Gleick's framework in the following respects: the second component is expanded to include water used for brushing of teeth and washing of face and hands while the third component defined as requirements for sanitation, which is primarily toilet flushing, is expanded to include cleaning of toilet and the house. Water requirements for food preparation is defined to include not only cooking but also other kitchen requirements such as washing of dishes and cleaning of kitchen. A fifth component is added which is that for laundry since wearing clean clothes is deemed part of personal hygiene.

To validate the results of this study, estimates are compared with established standards or estimates of previous studies. Gleick's (1996) basic water requirement of 50 l/c/d is used as a reference point while the cited NASA minimum is treated as a lower bound.

### Sampling Procedure and Survey Approach

A two-stage sampling was implemented. The first stage involves the selection of sample barangays while the second stage involves the identification of sample households. Prospective sample barangays were chosen so as to get representatives from the different income classes<sup>17</sup> (predominantly rich, middle income and poor), sources of water<sup>18</sup> and quality of water service, and location (rural and urban). The barangay stratification is shown in **Table 9**. Metro Manila and Pangasinan were chosen as the sampling sites, ten barangays were surveyed in Metro Manila and 4 barangays in Pangasinan.

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<sup>16</sup> Young's definition of requirement, however, only includes the minimum daily amount of water that the body requires for survival, which he posits to be a very small fraction of the amount "normally" used.

<sup>17</sup> For example, barangays or areas with both middle and high-income households but with more middle incomes, are classified as generally middle income.

<sup>18</sup> As to source, an area or barangay which is known to have mostly piped connections is classified as served by a piped source and those which are served primarily by private waterworks (PWW) but also buy from vendors for drinking or car washing, are generally classified as sourcing from PWW.

In the second stage, 10 households in each barangay are selected. While an effort was made such that each cell in the stratification table would be represented, the nature of a record-keeping survey required that households which were most cooperative be picked. This was done with the assistance of the barangay or village officials. A total of 100 sample households were interviewed in Metro Manila and 40 in Pangasinan (**Appendix Table 1**). Note that the resources available for the conduct of this study limited the number of sample barangays and households.

Metro Manila<sup>19</sup> was chosen for several reasons. First, it is a major urban area with different classes of households obtaining water from varied sources. Second, the area is well studied and has sufficient information necessary for sampling and for better understanding of the results. The third reason is the administrative ease and budgetary constraint. Barangays in Pangasinan were chosen for the rural sample for their proximity to Manila and the logistical and manpower support for the survey extended by the POPCOM regional office located in the province.

The record keeping approach is employed to estimate the volume of water consumption by activity. The length of record keeping is 7 days. On the first visit, the interviewers ask the household for the basic and socioeconomic information including the source and uses of water. The record forms which contain questions on the amount of water used daily per activity for seven days were left with the households. On the fourth day, the interviewer went back for a second visit to the households to retrieve the filled out forms. The remaining forms were then retrieved at the end of the seventh day. While this record keeping approach has advantages, it has also disadvantages. A major weakness of this type of survey is that it is beset with problems that may arise from half-hearted cooperation from the households, i.e., respondents may not have enough incentive to record and keep track of all water usage in the household by activity. However, this approach is certainly better than a one-visit recall survey. It may be the case that in many instances the interviewers had to assist respondents in filling out the forms, doing it three times in a week may allow for corrections in the estimates as respondents are able to give fuller and more accurate accounts in the succeeding visits. Thus, the record-keeping approach may provide a more accurate record of actual usage than a one-time recall interview and therefore, may contribute to a better knowledge and understanding of the household's water consumption for each activity which is essential in establishing the basic water requirement.

## **Sample Profile**

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<sup>19</sup> With the privatization of the water utility in Metro Manila, one concern for choosing it is the possible effect of the reduced prices on consumption and that with the very low water rates relative to other urban areas, the area may not be representative of an average urban area. At the time of the survey, the MWSS privatization was only 5 months old and it may be pointed out that there is yet no evidence of an increased consumption because of the reduced price of water.

### a. Profile of Households

**Table 10** gives the distribution of households according to source and location. Over 40 percent of the Metro Manila respondents source their water from MWSS. If households with combined sources but with MWSS as the main source are included, this total increases to about 50 percent, still lower than the official service coverage of MWSS of 60 to 65 percent in 1998. The second important source is private wells at 17 percent of total households while about one fifth of the households from both urban and rural areas resort to combined sources either due to the inadequacy of the main source or the need for specific quality of water for certain usage. Less than 5 percent of the urban households buy water from vendors but among the households with combined sources, over 70 percent buy vended water mostly to complement their main sources. For the Pangasinan sample, the common sources are the private and public tubewells, which are mostly not motorized.

According to ownership of the water source, households are divided into: (1) sole owners; (2) share owners with source being co-owned with other households who are mostly relatives; (3) common owners with source serving the whole area or community, and (4) "others", where water source is owned by neighbors or non-neighbors or non-relatives. Table 10 shows this information for urban and rural households. While most urban and rural respondents own their water source, significant proportions (45 and 46 percent) of the sample either share the ownership or get water from a common source. For households sourcing water from MWSS with increasing block tariff structuring, the sharing of source through sharing of water connection and even selling of water to other households would have serious equity implications. With the increasing block tariff, poor households sharing an MWSS connection end up paying more per cubic meter than those whose connections are for own use only.

The distribution of households over income class<sup>20</sup> and location (Table 10) reveals that majority of the Metro Manila and Pangasinan respondents are in the middle class. Note that this distribution is of course largely determined by the way middle income households are defined. It appears that the sample of defined poor households in Metro Manila is 2.5 times the NSO poverty incidence (percentage of the population below the poverty line) of 7.1 percent. For Pangasinan, the sampled poor households are 1.5 times the NSO poverty incidence estimate of 37.6 percent.

As to distribution of the sample by location, income class and water source (**Table 11**), over one third of the poor source water from public faucets/pumps while about the same

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<sup>20</sup> The poor households in Metro Manila are defined as those who fall below the poverty threshold which is ₱14,360 per capita per year for 1997 times 6, assuming a family of 6 members. The middle incomes are those at least earning the threshold amount to less than a million while the rich are those earning at least one million a year. The NSO figure indicates that 7.1 percent of the Metro Manila population is below the poverty line. For Pangasinan, a similar definition was applied using the 1997 poverty threshold for Region I of ₱11,980. The estimated poverty incidence in the region for 1997 is 37.6 percent.

proportion of the middle income households source water from MWSS and from private waterworks. An interesting observation is that over 80 percent of the rich households have combined sources which only shows that where water maybe inadequate in terms of quality and quantity, the rich need not be constrained since they can easily afford to tap alternative sources. Most of the rural poor obtained water from public/cooperative pumps while most of the middle income respondents get water from private tubewells without motor.

The distribution of the sample by ownership of lot and house (**Tables 12**) shows that in Metro Manila most of the respondents own their houses and lots. In Pangasinan, most of the respondents are occupying the lots for free with the owner's consent but most owned their houses. Reported sanitation practices (Table 12) show that majority of the households have pour flush toilets for exclusive use and only less than 5 percent share toilet facilities with others. **Table 13** gives the distribution of households' sanitation practices by income class and location. The table shows that while majority of the urban poor and middle income households use pour flush toilets, a substantial number of the middle income respondents have flush toilets. As expected, most of the urban rich have flushed toilets.

Descriptive statistics for other key household variables such as monthly income, per capita water consumption, household size, floor and lot areas, and water price are shown in **Table 14**. Average water consumption (for all household activities) increases as incomes increase as shown by the 48 liters per capita per day consumption of the Metro Manila poor and 108 l/c/d of the rich.<sup>21</sup> The mean consumption by income class for the Pangasinan does not seem intuitive, as the poor appear to consume more than the middle income households. This can be explained by the large consumption of a one-person household, which has a 1,700 square meters of land which maybe using much of the water, thereby pushing up the average. The generally high mean total consumption for the rural area must be due to the inclusion of water used for some subsistence production which by definition is not part of basic water requirements for survival and health.

The mean per capita monthly incomes by income class for both Metro Manila and Pangasinan appear reasonable. It is however, apparent that many of the urban middle income respondents must be at the higher end of the distribution to account for the relatively high average income of over ₱35,000. Note that a substantial number of the middle income respondents come from middle to upper middle class subdivisions. Average household size for Metro Manila is quite high relative to that of Pangasinan.

Trends in average floor and lot areas across income classes seem plausible although for each income class, Pangasinan has higher averages. This can explained by the fact that most of the Pangasinan respondents do not own their lands (which are often times big and must be owned by some rich relatives or landlords and are only occupying them for free), while a substantial proportion also occupy the house for free such that the income data and the sizes of

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<sup>21</sup> The relatively high maximum consumption for the middle income is due to one household with big house and lot areas and owns three cars but whose declared income fell short of the one million pesos cut off.

houses and lots may appear inconsistent. Also the materials used for housing may help explain the discrepancy in the size of houses and incomes between rural and urban respondents.

Price data are shown across source. Note that unlike in demand functions where prices are important, in this study, prices were not used in the estimation of the "requirement" functions.

### **b. Perceived Effects of El Niño**

Since the survey was conducted in the middle of an El Niño phenomenon, a question on its perceived impact was included in the questionnaire. Results show that 65 percent of total sample believed that their water consumption has been affected by the presence of El Niño. However, of this total, many perceived that the effect on them was minimal or negligible. About 48 percent of the 140 households claimed to be adversely affected with a reduction in consumption ranging from 10 to 80 percent. Almost half of the households who perceived to be affected claimed to have a maximum of 25 percent reduction in their total water consumption.

**Tables 15 to 17** look at the effect of El Niño by source of water, income class, and location, respectively. For water usage across source, households getting from private waterworks and from vendors claim to have not been affected at all. For those served by MWSS only less than 30 percent claimed they were not affected at all or the effect has been very minimal. Over 70 percent of the sample getting water from all the other sources expressed that El Niño did not affect them at all. Understandably, the rich households were least affected although a substantial proportion of the poor were also not affected, probably by sheer luck or they just failed to notice the difference having been used to the little amount of water available to them. Compared to urban, the rural sample claimed to be affected more by the El Niño although over half did not perceive any affect on their consumption.

### **Estimates of Basic Water Requirements**

In **Table 18**, the estimated basic water requirements of NASA and Gleick (1996) are reported. One main difference between the two estimates is the non-provision in Gleick for washing of hand and face, dish and clothes. Whether these are already embedded in his four classifications of human needs is not indicated in his paper. Despite this shorter components list for Gleick's basic water requirement, NASA's estimate of a minimum is much lower with washing of clothes comprising the bulk of water use in contrast to toilet flushing in Gleick's basic water requirement. Even if the expanded definitions are used, i.e. include hand and face washing in personal hygiene and dish washing in food preparation, the NASA estimates would still be a much lower than those of Gleick.

To see how these estimated basic requirements compare with the data from the survey, the percentages of the sample that fall within the specified minimums for each activity are

shown. Almost 100 percent of the sample households are within Gleick's minimum for each type of use except for bathing where only 34 percent of the households consume at most 15 l/c/d. It appears that the bathing and urinal requirements set by NASA are unrealistic as none of the household respondents consumes amounts below them. Food preparation requirement by the NASA is also too small as only 10 percent of the sample fall within this consumption level. While the NASA estimates provide some bases for comparison, it should be noted that the obtained water requirements were intended for a space settlement design which may be too different from real world situations and environment and should therefore be treated with caution.

### **Towards Establishing a Basic Water Requirement**

**Table 19** shows the estimates of basic water requirement by activity which were obtained using an iterative generalized least squares (GLS) procedure.<sup>22</sup> The choice of this estimator is due to the fact that the data used for the estimation is from a cross section and in estimating equations for consumption quantities with income as one of the regressors, heteroskedasticity is more of a rule rather than an exception. This problem of non-constant variance across equations would render the ordinary least square (OLS) estimator less efficient.

The column for minimum shows the lowest possible consumption per activity based on the survey. The minimum for all activities combined of 16 l/c/d is only about half of the NASA total but is consistent with those of water scarce countries or areas where access to water is difficult and with water being carried for several hundred meters and many people sharing the same source. However, this amount is even less than the WHO suggested minimum for sanitation of 20 l/c/d. Considering that this amount already includes all uses, it is apparent that desired or proper personal hygiene and sanitation necessary for maintaining good health cannot be achieved. The last column representing the maximum consumption has a total for all basic uses of about 247 l/c/d. While this derived maximum value for basic water requirement is higher than the estimated average requirement for an affluent subdivision in the country, it is in fact consistent with the current planning standard for domestic water consumption specified in the Philippine Water Code. The estimated range of 15 to 247 l/c/d comprises the earlier estimate of Falkenmark and the World Bank technical study on the requirement for survival and maintaining proper sanitation and good health.

The other column showing the mean values of water consumption per activity has a total which is close to the suggested basic water requirement of Gleick (1996). In fact, it is well within the minimum water consumption bracket in the tariff structures of water utilities in the country (**Appendix Tables 13 to 16**). Comparing the components however with those of Gleick, one is markedly different from the other. The estimated mean value of water for

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<sup>22</sup> **Appendix Tables 3 to 12** show the estimating equations used in obtaining the basic water requirements for each activity.



drinking based from the sample is so low compared to what Gleick is proposing, which is over 8 times. This consumption pattern implies that respondents may not be drinking enough as required by the body and this may have some adverse health implications.

Cooking, even with other kitchen requirements added, is less than half of the suggested 10 l/c/d at only about 4 l/c/d. One way to explain this is that perhaps the type of food prepared for most of the sample households must be very simple, requiring less water. Also, for most middle income households which comprise the majority of the total sample, lunch is seldom eaten at home especially on working days, reducing average water requirements for cooking. Estimated total for sanitation services defined to include toilet and house cleaning is also much too low than Gleick's proposed amount for toilet flushing of 20 l/c/d. It may be noted that for most of the respondents, a pour flush toilet, a technology requiring much less water than the standard flush toilets, is common, which may account for the lower estimate relative to that of Gleick.

While in the above mentioned activities, the estimates were smaller than those proposed by Gleick, it is not the case for human or personal hygiene. The estimated bathing requirement alone is much higher than the 15 l/c/d of Gleick. Including hand and face washing and brushing of teeth, which is not done in Gleick (1996), raises the estimated requirement by 50 percent more. While this pattern of use may be reflective of a general consciousness for keeping the body clean, this amount is in fact only about half the estimate for an affluent subdivision in Metro Manila. Also, it is within the estimate for developing countries of 5 to 25 l/c/d. The last component which is laundry, an item not included in Gleick's proposed basic requirement, is estimated to be about 5 l/c/d. This estimate is consistent with that for other developing countries. Also, note that for most of the respondents, laundry is done by hand which often requires less water than machine washing which is connected to piped water.

**Table 20** gives the proposed basic water requirements to maintain good health and proper sanitation. From the drinking pattern of respondents, it appears that a substantial number is not drinking enough water. Based on the FNRI determined daily dietary allowance for Filipinos for energy of about 2000 kilocalorie (**Appendix Table 17**) and on the findings of the NRC – NAS (USA) that between one and one-and-a-half milliliters of water is required for every kilocalorie of energy, the body needs 2 l/c/d to 3 l/c/d for drinking. A basic requirement of 2 l/c/d for drinking is then proposed.

For personal hygiene, a total of 23 l/c/d is proposed. This amount which is about 1.5 times that of Gleick, includes usage for bathing/showering, washing of face and hands, and brushing of teeth. If the fact that majority of the sample households are middle income earners who spend most of the day during weekdays in the work place is considered, the 20 l/c/d for sanitation as suggested by WHO, maybe more likely. Also, if maintaining proper sanitation and good health is to be seriously considered with allowance for cultural and societal preferences, this amount has been recommended to maximize benefits from waste disposal and related hygiene (Gleick 1996). For cooking and kitchen, 4 l/c/d is proposed as obtained in the

study. For laundry requirements, 5 l/c/d is recommended which is consistent to estimates for other developing countries. The proposed total basic water requirement is 54 l/c/d (or about 10 cu.m./month per household for a family of six), not so far from the 50 l/c/d of Gleick (1996) and much lower than that of Falkenmark (1992). This proposed basic water requirement primarily based on empirical results provides a basis for the 10 cu.m. minimum consumption bracket in the water tariff structures of most water utilities in the country.

## **Conclusion and Some Policy Implications**

Despite the shortcomings, the results of the study provide empirical evidence that would help resolve some key issues and on-going debates in the water sector specifically with respect to the water tariff structure, water allocation, and water resources planning. A caveat is in order in that while the El Niño is perceived not to affect much the consumption of most of the respondents, the estimates may have a downward bias.<sup>23</sup> This was however, taken into account by recommending a basic requirement which reflects more reasonable amounts especially for drinking and sanitation purposes.

### **a. Water Tariff Structure**

In the tariff rate structure of all water districts in the country, the initial block of 10 cubic meters for domestic use is implicitly assumed to represent the minimum water requirement of households and is thereby charged a subsidized rate per cubic meter, recognizing water as a social good. This study argues that this amount in fact satisfies the basic monthly water requirements of households. In this sense, as is often claimed, the increasing block tariff structure promotes equity as rich households who consume larger amounts, cross-subsidize the poor households. Rich households use more water because they have gardens, more water-using appliances, and cars to wash and are therefore paying a higher average price for water as their use occurs in the higher priced blocks. In addition, the increasing block tariff is said to promote conservation and sustainable water use as it discourages wasteful usage which is beyond the basic requirement.

However, while the 10 cu.m. provides a basis for setting the initial block, this minimum quantity which is priced cheaply, can also be anti-poor for households which share connections with other households. The poor often obtain water through shared connections from neighbors with private connections or from water vendors while middle and upper income households have private water connections for own use. For households sharing a metered connection, the consumption can easily exceed the initial block volume. This pushes the water use into higher priced blocks. Poor households may end up paying higher average prices for water than the rich. From the survey, it is shown that a substantial number of households share water connections.

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<sup>23</sup> If the El Niño effect is taken into account which is perceived to reduce consumption by 25 percent for about half of the 48 percent of total households which claimed to be affected, the monthly requirement for a household of six would still be about 10 cu.m. (rounding off 10.3 cu.m.).

Thus, this issue of shared connections has to be addressed first for the basic water requirement estimate to be useful and relevant. In this case, it is ideal for the water utility to provide separate connections for each household. As connection fees have been found to be constraining poor households in applying for separate connections, the utility may devise schemes to make it more affordable. On the other hand, the utility can opt to provide a common source which is free of connection charges, i.e., a public tap, which would service the need of those without private connections. Water from this public tap can be priced differently (e.g. a flat rate) from those with privately piped water such that the possible inequity of the increasing block tariff can be addressed but not at the expense of promoting too much inefficiency. While the result of this paper does not provide direct support to the increasing block tariff structure, it is not inconsistent with marginal cost pricing which can be applied at amounts beyond the 10 cu.m. minimum requirement.

### **b. Water Allocation**

The Water Code and its implementing rules and regulations set the priorities in allocation of water resources across competing uses. While the best use of water resources is sought at all times, the priority in times of water shortages favors domestic or municipal use. With the rapid increase in population, an increasing pressure on the scarce resource is felt. This is apparent in the more frequent and prolonged water shortages especially during drought years. Such shortages have been critical in urban centers like Metro Manila and Cebu than in rural areas. Allocating water resources across competing uses has become increasingly important. In times of crisis, for water sources with multiple users, water allocation involves negotiation among the different users (e.g. in the case of water from Angat, the MWSS which supplies water for domestic, commercial and industrial use, the National Irrigation Administration in behalf of the farmers, the National Power Corporation for power generation uses, with the National Water Resources Board serving as arbiter). Historically, the basis for allocating for domestic use has been the planning standard of 0.0029 liters per second per capita or 250 liters per capita per day.

The findings of the study may be useful in providing a more realistic basis for deciding how much water to allocate for domestic use in times of crisis. The study suggests a basic water requirement of about 54 l/c/d, which is only about 20 percent of the current planning standard. In times of water shortage, while domestic use has priority over other uses, other users like the farmers need not be totally deprived of their allocation considering that no compensation is given in exchange. However, since water has a lower value for agricultural use than for domestic use, a compensation scheme for farmers should eventually be developed and implemented.

### **c. Water Resources Planning**

Planning for water infrastructure are generally based on planning standards. The results of the study suggest a reexamination of the planning standard for domestic water consumption. While planners of water resources infrastructure are concerned with meeting domestic water demand, such projections should be based on more accurate estimates to minimize overestimation (or underestimation) of water requirements and consequently excess (or under). This study points

to the need to refine the standard for domestic use to make it reflective of actual domestic requirements.

At the minimum, government must aim to provide all households this basic water requirement for maintaining human survival and health. With this information, the total water requirement of the population can be determined more accurately and government would have a better sense of how much water to produce taking into account of systems losses, which with improvements in the distribution system, may be reduced.

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**Table 1. Range of Average Daily Water Requirements for Survival**

<b>Sources</b>	<b>Daily Intake (liters/capita/day)</b>
White, et al. (1972)	1.8 - 3.0
US EPA (1976), NAS (1977)	2.0
Vinograd <sup>a</sup> (1966), Roth <sup>a</sup> (1968), WHO (1971)	2.5
US DANRCS (1997)	0.23 - 3.78
UBFHOA (1996)	3.15
NRC - NAS <sup>b</sup> (1989)	2.0 - 4.5
Saunders & Warford (1976), Gleick <sup>c</sup> (1996)	5.0

<sup>a</sup> This represents actual fluid requirements for early space flights. For Apollo astronauts under routine conditions in the command module, the recommended minimum intake was 2.9 liters per capita per day.

<sup>b</sup> This minimum requirement range was estimated by correlating water intake with energy intake in food. The recommended minimum water intake was between one and 1.5 milliliters (ml) of water per calorie of food (kcal of energy). Under typical temperate climates with normal activity the minimum water requirement for human survival is set at 3 liters/person/day.

<sup>c</sup> Gleick justifies this consumption level by noting that substantial portions of the population live in tropical & subtropical climates.

Sources: Except for UBFHOA and US DANRCS, all the other authors were cited in Gleick (1996) .  
UBFHOA (1996).  
US DANRCS (1997).

**Table 2. Estimated Water Requirements for Food Preparation**

<b>Location/Source</b>	<b>Requirement (l/c/d)</b>
<b>By Region</b>	
Average for developed and developing countries	10 - 20
Wealthy regions	10 - 50
<b>Selected Countries</b>	
Metro Manila, Philippines	6
Male, Maldives	7 - 15
Kathmandu, Nepal	10.5
California, U.S.A. <sup>a</sup>	11 - 26.5
<b>By Source</b>	
Private wells <sup>b</sup>	7 - 15
Piped connection <sup>b</sup>	15
Standpipes <sup>c</sup>	10.5

Note:

<sup>a</sup> The higher range includes dishwashing.

Sources: Gleick (1996)

Dangerfield (1983) is the reference for water source with notes <sup>b</sup>.



**Table 3. Estimated Water Requirements for Bathing**

<b>Location/Source</b>	<b>Requirement (l/c/d)</b>
<b>By Region</b>	
Developed Countries	27 - 99
Developing Countries	5 - 25
<b>Selected Countries</b>	
Philippines	37.8
Maldives	20 - 44.5
Nepal	17.5
U.S.	15 - 150
<b>By Source</b>	
Private wells	20 - 40
Piped connection	44.5
Standpipes	17.5

Sources: Gleick (1996).

Dangerfield (1983).

UBFHOA (1996).

**Table 4. Estimated Water Requirements for Sanitation**

<b>Technology/Type &amp; Source/Location</b>	<b>Requirement (l/c/d)</b>
<b>By Technology</b>	
VIP, ROEC, VIDPL, DVC, CC <sup>a</sup>	very minimal
Pit Latrine, Vault toilets & cartage, Pour/Flush toilets/septic tank	1 - 7.5
Small - bore sewerage	> 50
Inefficient Conventional Sewerage	> 75
<b>By Type and Source</b>	
<b><i>Hand flush</i></b>	
Private wells	8
Piped connection	17.5
Standpipe	2.5
<b><i>Cistern flush</i></b>	
Private wells	15
Piped connection	45
<b>Selected Countries</b>	
Philippines	60.5
Maldives	8 - 45
Nepal	2.5
U.S. (per flushing)	15 - 26

Note:

<sup>a</sup> These are the sanitation technologies that require no water except for minimal washing: Ventilated Improved Pits (VIP), Reed Odorless Earth Closets (ROEC), Ventilated Improved Doubled Pit Latrines (VIDPL), Double-Vault Composting Toilets (DVC), & Continuous Composting (CC).

Source: Gleick (1996).

Dangerfield (1983).

UBFHOA (1996).

**Table 5. Estimated Water Requirements for Laundry**

<b>Location</b>	<b>Requirement (l/c/d)</b>
<b>Selected Countries</b>	
United States	29 - 71
Netherlands and Sweden	17 - 30
Maldives	5 - 10
Nepal	5
Philippines	38
<b>By Source</b> (for developing countries)	
Private wells	8 - 10
Piped connection	5 - 38
Standpipes	5

Sources: Gleick (1996)

Dangerfield (1983).

UBFHOA (1996).

**Table 6. Water Consumption Per Capita for Ethiopia  
by Mode of Water Connection**

<b>Level of Service</b>	<b>Consumption (liters/capita/day)</b>
Hand pumped wells and single public standpipes. Water carried 100-500 m or more 250-500 persons per tap.	15
Public standpipes with taps. Water carried not greater than 100 m Not greater than 200 person per tap	16 - 35
Shared external standpipe, yard tap Public standpipes with taps not greater Than 25 persons per tap	16 - 60
House connections	100 - 150

Source: Dangerfield (1983).

**Table 7. Domestic Per Capita Consumption  
by Housing Class for Selected<sup>a</sup> Countries**

<b>Housing Class</b>	<b>Description</b>	<b>Water Consumption (liters/capita/day)</b>
High Income	Detached houses, luxury apartments having 2 or more WCs,* and 3 or more taps per household	150 - 260
Middle Income	Houses and apartments having at least 1 WC and 2 taps per household	110 - 160
Lower Income	Tenements, government rehousing, shared houses, having at least 1 tap per household but sharing WC	55 - 70**

<sup>a</sup> Values refer to data from Turkey, Saudi Arabia, Africa, Egypt, Indonesia, Hong Kong, Egypt, and Bolivia.

\* WC means Water Connection.

\*\* Frequency higher due to wastage.

Source: Connal (1982) as cited Dangerfield (1983).

**Table 8. Total Domestic Water Use for Selected Asian Countries  
and WHO Regions**

<b>Country</b>	<b>Water Consumption (liters/capita/day)</b>
<u>Selected Asian Countries<sup>a</sup></u>	
Bangladesh	17.3
Cambodia	9.5
Indonesia	34.2
Nepal	17.0
Myanmar	19.8
Sri Lanka	27.6
Vietnam	28.8
<u>WHO regions<sup>b</sup></u>	
Southeast Asia	30-70
Western Pacific	30-95
Eastern Mediterranean	40-85
World average for developing countries	35-90

Source: <sup>a</sup> Gleick (1996).

<sup>b</sup> Argawal (1981).

**Table 9. Stratification of Respondent Households**

<b>Water Availability</b>	<b>Rich Households</b>	<b>Middle Income Households</b>	<b>Poor Households</b>
<b>A. Urban</b>			
1) With MWSS Connection			
a) 18 to 24--hr service with moderate to high water pressure	--	--	--
b) less than 18 hours service with moderate to high water pressure	--	--	--
c) less than 18 hours service with intermittent to low water pressure	--	--	--
2) Without MWSS Connection			
a) Private waterworks	--	--	--
b) Others (vendors, deep wells, etc.)	--	--	--
<b>B. Rural</b>			
Other sources (private/ public shallow wells, motorized/manual)		--	--

**Table 10. Distribution of Sample Households According to Water Source,  
Ownership, Income Class, and Location, 1998**  
(%)

	<b>Metro Manila</b>	<b>Pangasinan</b>
<b>Source of Water</b>		
MWSS	42	--
Private Waterworks	6	--
Public/Cooperative	10	28
Private Wells		
with motor	16	3
without motor	1	48
Water Vendor	4	--
Combinations	21	23
	----	----
<b>Total</b>	<b>100</b>	<b>100</b>
<b>Ownership</b>		
Owned	60	53
Shared	13	35
Common	23	10
Others*	4	3
	----	----
<b>Total</b>	<b>100</b>	<b>100</b>
<b>Income Class</b>		
Poor	18	57.5
Middle	71	42.5
Rich	11	--
	----	----
<b>Total</b>	<b>100</b>	<b>100</b>

\* "Others" include water sources owned by neighbors, non-relatives or non-neighbors.



**Table 11. Distribution of Sample Households by Water Source and Income Class  
Metro Manila and Pangasinan, 1998  
(%)**

Water Source	Income Class		
	Poor <sup>a</sup>	Middle <sup>b</sup>	Rich <sup>c</sup>
<b><u>Metro Manila</u></b>			
MWSS	38	46	18
Private Waterworks	11	6	--
Public/Cooperative	22	8	--
Private Wells (deep and shallow)			
with motor	11	20	--
without motor	--	1	--
Water Vendor	11	3	--
Combination	6	15	82
	----	----	----
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b><u>Pangasinan</u></b>			
Public/Cooperative	39	12	--
Deep wells			
with motor	4	--	--
without motor	26	76	--
Combination	30	12	--
	----	----	----
<b>Total</b>	<b>100</b>	<b>100</b>	

**Table 12. Distribution of Sample Households by House and Lot Ownership,  
and Sanitation Practices, Metro Manila and Pangasinan, 1998**

(%)

Description	Metro Manila	Pangasinan	Total
<b>Lot Ownership</b>			
Owned or Amortizing	65	42	58.7
Occupying for Free with Owner's Consent	8	58	22.5
Occupying for Free without Owner's Consent	5	--	3.6
Pay Rent	21	--	15.2
	----	----	----
<b>Total</b>	100	100	100
<b>House Ownership</b>			
Owned or Amortizing	78	78	77.9
Occupying for Free with Owner's Consent	6	22	10.7
Occupying for Free without Owner's Consent	8	--	5.7
Pay Rent	8	--	5.7
	----	----	----
<b>Total</b>	100	100	100
<b>Sanitation</b>			
Flush Toilet for Exclusive Use	43	--	32.9
Pour Flush Toilet for Exclusive Use	55	92.5	63.6
Shared Toilet	2	7.5	3.6
	----	----	----
<b>Total</b>	100	100	100

**Table 13. Distribution of Sample by Sanitation Practices  
Metro Manila and Pangasinan, 1998  
(%)**

<b>Practice</b>	<b>Poor</b>	<b>Middle</b>	<b>Rich</b>
<b><u>Metro Manila</u></b>			
Flush Toilet for Exclusive Use	28	41	82
Pour Flush Toilet for Exclusive Use	67	58	18
Shared Toilet	6	1	--
	----	----	----
<b>Total</b>	100	100	100
<b><u>Pangasinan</u></b>			
Flush Toilet for Exclusive Use	--	--	--
Pour Flush Toilet for Exclusive Use	87	100	--
Shared Toilet	13	--	--
	----	----	
<b>Total</b>	100	100	

**Table 14. Descriptive Statistics of Key Variables**  
**Metro Manila and Pangasinan, 1998**

Variable	Unit	Mean	Minimum	Maximum	Standard Deviation
<hr/>					
<b><u>Water Consumption</u></b>	liters/capita/day				
<u>Metro Manila</u>					
Poor		48	23	119	28
Middle		58	27	233	33
Rich		108	36	171	46
<u>Pangasinan</u>					
Poor		125	26	356	861
Middle		96	48	255	52
<b><u>Monthly Per Capita Income</u></b>	P/month				
<u>Metro Manila</u>					
Poor		911	277	2,367	4,813
Middle		6,238	950	27,778	5,364
Rich		38,409	12,000	144,444	46,222
<u>Pangasinan</u>					
Poor		737	150	1,722	392
Middle		3,074	758	7,500	2,193
<b><u>HH Size</u></b>					
Metro Manila		6.38	1.00	18.00	2.51
Pangasinan		5.48	1.00	13.00	2.36
<b><u>Floor Area</u></b>	m <sup>2</sup>				
<u>Metro Manila</u>					
Poor		43.67	2.00	200.00	47.38
Middle		113.03	2.00	600.00	114.41
Rich		230.91	20.00	410.00	113.76
<u>Pangasinan</u>					
Poor		108.13	2.00	480.00	132.75
Middle		236.76	20.00	600.00	223.71
<b><u>Lot Area</u></b>					
<u>Metro Manila</u>					
Poor		64.29	2.00	288.00	76.84
Middle		165.00	2.00	990.00	74.46
Rich		330.64	40.00	560.00	74.76
<u>Pangasinan</u>					
Poor		407.91	25.00	1700.00	411.05
Middle		605.29	50.00	1700.00	503.99
<b><u>Prices</u></b>					
MWSS	P/1000 li	3.17	1.70	7.20	1.38
PWW		3.73	3.50	4.10	0.23
Public/Cooperative		16.57	0.00	55.10	25.12
Private Wells					
with motor		--	--	--	--
without motor		--	--	--	--
Water Vendor		84.79	1.60	337.00	94.05

**Table 15. Perceived Percentage Reduction in Water Consumption due to El Niño  
by Source of Water, Metro Manila and Pangasinan, 1998**

<b>Percentage Reduction</b>	<b>MWSS n= 42</b>	<b>Private Waterworks n= 6</b>	<b>Public/ Cooperative n= 21</b>	<b>Private Wells n= 37</b>	<b>Water Vendor n= 4</b>	<b>Combined Sources n= 30</b>
0	29	100	71	70	100	77
10	5	0	14	11	0	13
25	26	0	10	8	0	7
33	12	0	0	0	0	0
50	12	0	5	8	0	3
70	14	0	0	3	0	0
80	2	0	0	0	0	0
<b>Total</b>	100	100	100	100	100	100

**Table 16. Perceived Percentage Reduction in Water Consumption due to El Niño  
by Income Class, Metro Manila and Pangasinan, 1998  
(%)**

<b>Percentage Reduction</b>	<b>Poor n= 24</b>	<b>Middle n= 105</b>	<b>Rich n= 11</b>
0	71	57	82
10	13	10	--
25	13	13	9
33	0	5	--
50	4	8	9
70	--	7	--
80	--	1	--
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

**Table 17. Perceived Percentage Reduction in Water Consumption  
by Location, Metro Manila and Pangasinan, 1998, (%)**

<b>Percentage Reduction</b>	<b>Urban n= 100</b>	<b>Rural n= 40</b>
0	63	58
10	6	18
25	12	15
33	5	0
50	6	10
70	7	0
80	1	0
<b>Total</b>	<b>100</b>	<b>100</b>

**Table 18. Estimates of Basic Water Requirements**

Activity	NASA		GLEICK (1996)	
	estimated minimum req't. (l/c/d)	% of sample within minimum	proposed minimum req't. (l/c/d)	% of sample within minimum
Drinking	1.6	97.9	5.0	100.0
Personal Hygiene				
Shower/bathing	2.7	0.0	15.0	34.3
Hand/face washing	4.1	86.4	-	-
Sanitation				
Urinal/toilet flushing	0.5	0.0	20.0	94.3
Cooking & Kitchen				
Food Preparation	0.8	10.0	10.0	96.4
Dish washing	5.5	82.1	- <sup>a</sup>	-
Laundry	12.5	71.9	-	-
<b>Total</b>	<b>27.7<sup>b</sup></b>		<b>50.0</b>	

Notes:

<sup>a</sup> While Gleick did not include this activity, he indicated that in a study done of the water provided for 1.2 million people in Northern California, an average of 15 liters/capita/day was used for dish washing.

<sup>b</sup> Available estimate at NASA totals less than 30 liters/capita/day, but in the NASA space settlement design, 35 liters/capita/day was assumed as the more likely and conservative estimate.

Sources:

NASA (Internet download, 1998).

Gleick (1996).

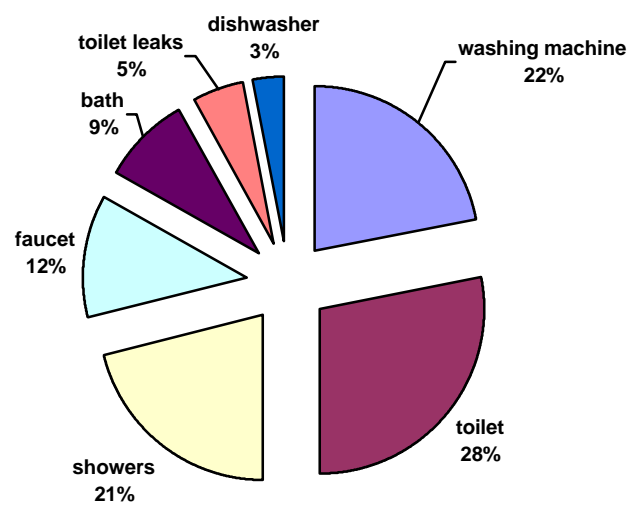


**Table 19. Estimated Basic Water Requirements  
Metro Manila and Pangasinan, 1998  
(l/c/d)**

<b>Activity</b>	<b>Mean</b>	<b>Minimum</b>	<b>Maximum</b>
Drinking	0.58	0.30	1.60
Personal Hygiene			
Showering/bathing	19.00	5.70	105.85
Hand/face washing	2.97	0.93	23.10
Brushing of Teeth	1.07	0.40	4.79
Sanitation Services			
Urinal/toilet flushing	7.63	2.38	62.04
Toilet cleaning	1.71	0.50	25.20
House cleaning	1.35	0.27	12.36
Cooking and Kitchen			
Food Preparation	1.87	1.43	2.01
Dish washing	1.96	1.73	2.39
Laundry	4.72	1.90	7.44
<b>Total</b>	<b>42.86</b>	<b>15.54</b>	<b>246.78</b>

**Table 20. Proposed Basic Water Requirements  
Metro Manila and Pangasinan, 1998  
(l/c/d)**

<b>Activity</b>	<b>Proposed Requirement</b>
Drinking	2
Personal Hygiene	23
Showering/bathing	
Hand/face washing	
Brushing of Teeth	
Sanitation Services	20
Urinal/toilet flushing	
Toilet cleaning	
House cleaning	
Cooking and Kitchen	4
Food Preparation	
Dish washing	
Laundry	5
<b>Total</b>	<b>54</b>
<b>Basic monthly water requirement for a household of 6 members (cu.m.)</b>	<b>9.7</b>



**Figure 1. Percentage Residential Water Use  
San Miguel County, USA, 1996**

Source: Hughes, Jim. 1996. "Are you a Water Hog?"

**Appendix Table 1. Distribution of Sample Households by Barangay, Metro Manila and Pangasinan, 1998**

Name of Barangay	Number of Households
<b>URBAN</b>	
Bagong Ilog, Pasig	10
BF Homes, Parañaque	10
Bgy. 119, Grace Park, Caloocan	10
Bgy.141, Pasay	10
Bgy. 655, Intramuros, Manila	10
Bgy. Tugatog, Malabon	10
Greenwoods, Cainta, Rizal	10
Commonwealth, Quezon City	10
San Antonio, Makati	10
Talon III, Las Piñas	10
<b>RURAL</b>	
Lelemaan, Manaoag, Pangasinan	10
Paseleng Norte, Binalonan, Pangasinan	10
Paseleng Sur, Binalonan, Pangasinan	10
San Ramon, Manaoag, Pangasinan	10
<b>Total</b>	<b>140</b>

**Appendix Table 2. Distribution of Households with Combined Sources  
Metro Manila and Pangasinan, 1998**

<b>Sources</b>	<b>Metro Manila</b>	<b>Pangasinan</b>
MWSS & Deep well with motor	1	--
MWSS & Shallow well	2	--
Private waterworks & Water Vendor	6	--
MWSS & Others	3	--
Public/Cooperative & Deep well w/o motor	--	3
Public Cooperative & Others	--	5
Vendors & Others	1	--
Private waterworks, Deep well with motor & Water Vendor	6	--
Private waterworks, Water Vendor & Others	2	--
Public/Cooperative, Deep well with motor, & Others	--	1
<b>Total</b>	<b>21</b>	<b>9</b>

**Appendix Table 3. ITSUR Coefficients Used in Estimating  
Drinking Water Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
BGY	-0.3299 (-3.51)	Dummy Variable Location of Barangay
SOURCE	-0.1065 (-1.36)	Dummy Variable Source of Water Supply
HHINC	-0.0351 (-0.28)	Dummy Variable Household Income in '000 pesos
FAREA	-0.0182 (-0.06)	Dummy Variable Floor Area in Square Meters
LAREA	0.0686 (0.23)	Dummy Variable Lot Area in Square Meters
TEN_HSE	-0.2230 (-0.94)	Dummy Variable Type of House Tenure
TEN_LOT	-0.0225 (-0.08)	Dummy Variable Type of Lot Tenure
Constant	1.1591 (1.40)	
Adjusted R <sup>2</sup>	0.8353	

**Appendix Table 4. ITSUR Coefficients Used in Estimating  
Cooking Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
L_AVLHRS	-0.238 (-2.35)	Continuous Variable Number of Hours of Water Availability
FAREA	-0.4748 (-1.59)	Dummy Variable Floor Area in Square Meters
LAREA	0.5543 (1.70)	Dummy Variable Lot Area in Square Meters
Constant	0.6424 (1.44)	
Adjusted R <sup>2</sup>	0.547	

**Appendix Table 5. ITSUR Coefficients Used in Estimating  
Dishwashing Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
BGY	0.0460 -0.50	Dummy Variable Location of Barangay
SOURCE	0.1422 -1.85	Dummy Variable Source of Water Supply
HHINC	-0.0590 (-0.48)	Dummy Variable Household Income in '000 pesos
FAREA	-0.2710 (-0.96)	Dummy Variable Floor Area in square meters
LAREA	0.3049 -1.04	Dummy Variable Lot Area in square meters
TEN_HSE	-0.2014 (-0.87)	Dummy Variable Type of House Tenure
TEN_LOT	-0.1042 (-0.40)	Dummy Variable Type of Lot Tenure
Constant	0.7158 (0.89)	
Adjusted R <sup>2</sup>	0.79	



**Appendix Table 6. ITSUR Coefficients Used in Estimating  
Bathing Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
HHINC	0.2740 (2.08)	Dummy Variable Household Income in '000 pesos
FAREA	0.3644 (0.93)	Dummy Variable Floor Area in Square Meters
LAREA	-0.1703 (-0.42)	Dummy Variable Lot Area in Square Meters
TEN_HSE	0.2667 (0.92)	Dummy Variable Type of House Tenure
TEN_LOT	-0.209 (-0.67)	Dummy Variable Type of Lot Tenure
Constant	1.2134 (1.19)	
Adjusted R <sup>2</sup>	0.5313	

**Appendix Table 7. ITSUR Coefficients Used in Estimating  
House Cleaning Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
HHINC	0.3849 (2.35)	Dummy Variable Household Income in '000 pesos
FAREA	0.3746 (0.86)	Dummy Variable Floor Area in Square Meters
LAREA	-0.1488 (-0.31)	Dummy Variable Lot Area in Square Meters
TEN_HSE	-0.1023 (-0.28)	Dummy Variable Type of House Tenure
TEN_LOT	-0.1856 (0.48)	Dummy Variable Type of Lot Tenure
Constant	-2.0326 (-1.61)	
Adjusted R <sup>2</sup>	0.3869	

**Appendix Table 8. ITSUR Coefficients Used in Estimating  
Toilet Flushing Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
BGY	0.1449 (2.42)	Dummy Variable Location of Barangay
HHINC	0.1423 (1.41)	Dummy Variable Household Income in '000 pesos
FAREA	0.3692 (1.58)	Dummy Variable Floor Area in Square Meters
LAREA	-0.2117 (-0.84)	Dummy Variable Lot Area in Square Meters
TEN_HSE	-0.0028 (-0.01)	Dummy Variable Type of House Tenure
TEN_LOT	0.1168 (0.54)	Dummy Variable Type of Lot Tenure
Constant	0.3255 (0.46)	
Adjusted R <sup>2</sup>	0.5636	

**Appendix Table 9. ITSUR Coefficients Used in Estimating  
Toilet Cleaning Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
BGY	-0.1407 (-1.47)	Dummy Variable Location of Barangay
HHINC	0.4231 (2.62)	Dummy Variable Household Income in "000 pesos
FAREA	-0.3292 (-0.88)	Dummy Variable Floor Area in Square Meters
LAREA	-0.2738 (-0.68)	Dummy Variable Lot Area in Square Meters
TEN_HSE	0.0487 (0.16)	Dummy Variable Type of House Tenure
TEN_LOT	-0.0707 (0.21)	Dummy Variable Type of Lot Tenure
Constant	1.3591 (1.21)	
Adjusted R <sup>2</sup>	0.3859	

**Appendix Table 10. ITSUR Coefficients Used in Estimating  
Hand Washing Requirements**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
HHINC	-0.3127 (-1.95)	Dummy Variable Household Income in '000 pesos
FAREA	0.7665 (1.76)	Dummy Variable Floor Area in Square Meters
LAREA	-0.6195 (-1.31)	Dummy Variable Lot Area in Square Meters
TEN_HSE	-0.0037 (-0.01)	Dummy Variable Type of House Tenure
L_LOT	-0.4000 (-0.40)	Dummy Variable Type of Lot Tenure
Constant	0.7092 (0.57)	
Adjusted R <sup>2</sup>	0.218	

**Appendix Table 11. ITSUR Coefficients Used in Estimating  
Requirements for Brushing of Teeth**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
BGY	-0.2948 (-3.58)	Dummy Variable Name of Barangay
SOURCE	-0.0403 (-0.29)	Dummy Variable Source of Water Supply
HHINC	-0.0351 (-0.20)	Dummy Variable Household Income in '000 pesos
FAREA	-0.0647 (-0.19)	Dummy Variable Floor Area in Square Meters
LAREA	0.0653 (0.55)	Dummy Variable Lot Area in Square Meters
TEN_HSE	-0.1463 (-1.04)	Dummy Variable Type of House Tenure
TEN_LOT	-0.3065 (-___)	Dummy Variable Type of Lot Tenure
Constant	2.4544 (2.54)	
Adjusted R <sup>2</sup>	0.7728	

**Appendix Table 12. ITSUR Coefficients Used in Estimating  
Requirements for Laundry**

<b>Explanatory Variable</b>	<b>Estimated Coefficient (t-variable)</b>	<b>Variable Specification/Measure</b>
DISTANCE	-0.0836 (-1.93)	Dummy Variable Distance travelled to fetch water in meters
NINO_EFF	-0.0109 (-1.51)	Dummy Variable Reduction of Water Due to El Niño
SOURCE	-0.0553 (-0.52)	Dummy Variable Source of Water Supply
HHINC	0.2662 (1.42)	Dummy Variable Household Income in '000 pesos
FAREA	0.633 (1.65)	Dummy Variable Floor Area in Square Meters
LAREA	-0.7194 (-1.73)	Dummy Variable Lot Area in Square Meters
TEN_HSE	-0.1922 (-0.60)	Dummy Variable Type of House Tenure
TEN_LOT	0.0933 (0.29)	Dummy Variable Type of Lot Tenure
Constant	1.8954 (1.74)	
Adjusted R <sup>2</sup>	0.4139	

**Appendix Table 13. Tariff Structure of Binalonan Water District Effective November, 1993**

<b>Consumption in cubic meters</b>	<b>Pesos per cu.m. (minimum charge)</b>	<b>Pesos per cu.m. (proposed rates)</b>
First 10 cu.m.	8.0 <sup>a</sup>	10.0 <sup>a</sup>
11 to 20	8.5	11.0
21 to 30	9.0	11.5
31 to 40	9.5	12.0
over 40	10.0	12.5

Notes:

Number of Concessionnaires - 780 as of 1997.

Average monthly consumption/service connection - 16 cu.m. -- which is equivalent to 88.88 liters/capita/day assuming a household size of 6.

Total bill for all households is ₱159,000 (December 1997).



**Appendix Table 14. Tariff Structure of Manaoag Water District Effective  
November 1997**

<b>Consumption Value in cu.meters</b>	<b>Price per cu.m. in PhP</b>
First 10 cu.m.	10.50 <sup>a</sup>
11 to 20	11.55
21 to 30	13.65
31 to 40	15.75
over 40	15.75

Number of Concessionaires - 1,898 as of 1997

Average Monthly Consumption/service connection - 22 cu.m. as of date which is equivalent to  
122.22 liters/capita/day assuming a household of 6

Total Bill for all households - P 496,000 (December 1997)

<sup>a</sup> Minimum Charge

**Appendix Table 15. Tariff Structures of the Old MWSS, Manila Water Company  
and Maynilad Water Services, Inc. (P/cu. m.)**

<b>Cons vol/mo.</b>	<b>Old MWSS</b>	<b>MWC</b>	<b>Maynilad</b>
<b>Residential</b>			
first 10 cu.m.	2.95	0.78	1.67
next 10	3.60	0.95	2.03
next 20	6.85	1.81	3.47
next 20	9.00	2.37	5.09
next 20	10.50	2.77	5.94
next 20	11.00	2.90	6.22
next 50	11.50	3.03	6.50
next 50	12.00	3.16	6.79
next 200	12.50	3.30	7.07
<b>Semi-Business</b>			
first 10 cu.m.	4.95	1.31	2.80
next 10	6.05	1.59	3.42
next 20	7.45	1.97	4.21
next 20	9.45	2.49	5.34
next 20	11.00	2.90	6.22
next 20	11.50	3.03	6.50
next 50	12.00	3.16	6.79
next 50	12.50	3.29	7.07
next 200	13.00	3.43	7.35

**Appendix Table 16. Tariff Structure of Metro Cebu Water District**

<b>Bracket</b>	<b>Without Discount</b>	<b>With Discount</b>
First 10 cu.m.		
Meter Size		
1/2	90.64	86.11
3/4	147.00	139.65
1	287.87	273.48
1 - 1/2	735.00	698.00
2	1,825.00	1,733.00
3	3,283.00	3,118.00
4	6,566.00	6,237.00
6	9,842.00	9,350.00
11 - 20 cu.m.	10.00	9.50
21 - 30 cu.m.	11.76	11.17
Over 30 cu.m.	32.25	30.65

**Appendix Table 17. Recommended Dietary Allowances for Filipinos for Energy  
Average Per Day, (1989)**

Age in years	Weight (kg)	Energy (kcal)
Infants		
3 - < 6 mo	6	620
6 - < 12 mo	9	880
Children		
1 - 3	13	1,350
4 - 6	18	1,600
7 - 9	24	1,740
Males		
10 - 11	32	2,090
13 - 15	44	2,340
16 - 19	55	2,580
20 - 39	56	2,570
40 - 49	56	2,440
50 - 59	56	2,320
60 - 69	56	2,090
70 - +	56	1,880
Females		
10 - 11	35	1,910
13 - 15	44	2,010
16 - 19	48	2,020
20 - 39	49	1,900
40 - 49	49	1,800
50 - 59	49	1,720
60 - 69	49	1,540
70 - +	49	1,390
Pregnancy		
1st trimester		+ 000
2nd trimester		-
3rd trimester		+ 300
Lactation		
1st 6 months		+ 500
2nd 6 months		-
<b>Average</b>		<b>1,993</b>

Source: FNRI. 1993. Food Demand and Nutritional Needs.