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9. ABSTRACT
This paper analyzes and evaluates the impacts of the proposed expansion of the water and sewerage systems on the population of Amman, Jordan. Special emphasis is placed on the needs of the urban poor and on the expected health, social, and economic implications for the residents of the city. About 35% of the population of Jordan lives within the boundaries of Amman. The city is partially served by water distribution and sewarage networks, but rapid growth and expansion of the city have left many portions unserved by the existing system. The report discusses the effectiveness of the present system, the socioeconomic setting, access and utilization, and existing systems. An effort should be made to regulate the prices being charged by water and sanitation tankers and private well owners. Consideration should be given to allowing payment of connection costs in monthly installments over a period of 12-18 months to be collected with the quarterly water bills. The possibility of increasing the number of sewer connections in the Nadif and Mahatta areas should be reviewed. Educational programs should be conducted in the schools, and the mass media should emphasize the goals of conservation and the judicious use of water. These programs should stress the water is a valuable and scarce resource and that a certain amount of it is necessary for clean and healthy living. The use of water conserving fixtures should be encouraged. The program for detecting and repairing or replacing leaky pipes should be strengthened. It is imperative that strict quality control and continuous testing of the water leaving King Talal Dam, flowing into it, and flowing at selected points along the Seil Zarqa be conducted. The question of water pollution in the Seil Zarqa should also be addressed.

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# A SOCIAL SOUNDNESS ANALYSIS OF THE AMMAN WATER AND SEWERAGE SYSTEMS

by

Jarir S. Dajani
Associate Professor of Civil Engineering
Stanford University
Stanford, California 94305

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## 1. Introduction

The city of Amman is the largest city and the capital of the Hasemite Kingdom of Jordan. About 35% of the country's population of two million reside within the municipal boundaries of Amman.

The city is partially served by water distribution and sewerage networks. Rapid growth and expansion of the city have left many portions of it unserved by the existing system. Even areas which are connected to the water network suffer from the lack of water, due to a general water shortage. This had lead to the development of plans for importing water from the King Talal Dam and expanding the water and sewerage systems. Figure 1 shows the urbanized regions of Jordan and the locations of Amman and the King Talal Dam in a regional context. The statistics of the urban portions of the proposed improvements are given in Table I.

It is the purpose of this paper to analyze and evaluate the impacts of the proposed system improvements on the population of Amman. Special emphasis will be placed on the needs of the urban poor, and on the expected health, social and economic implications for the residents of the city.

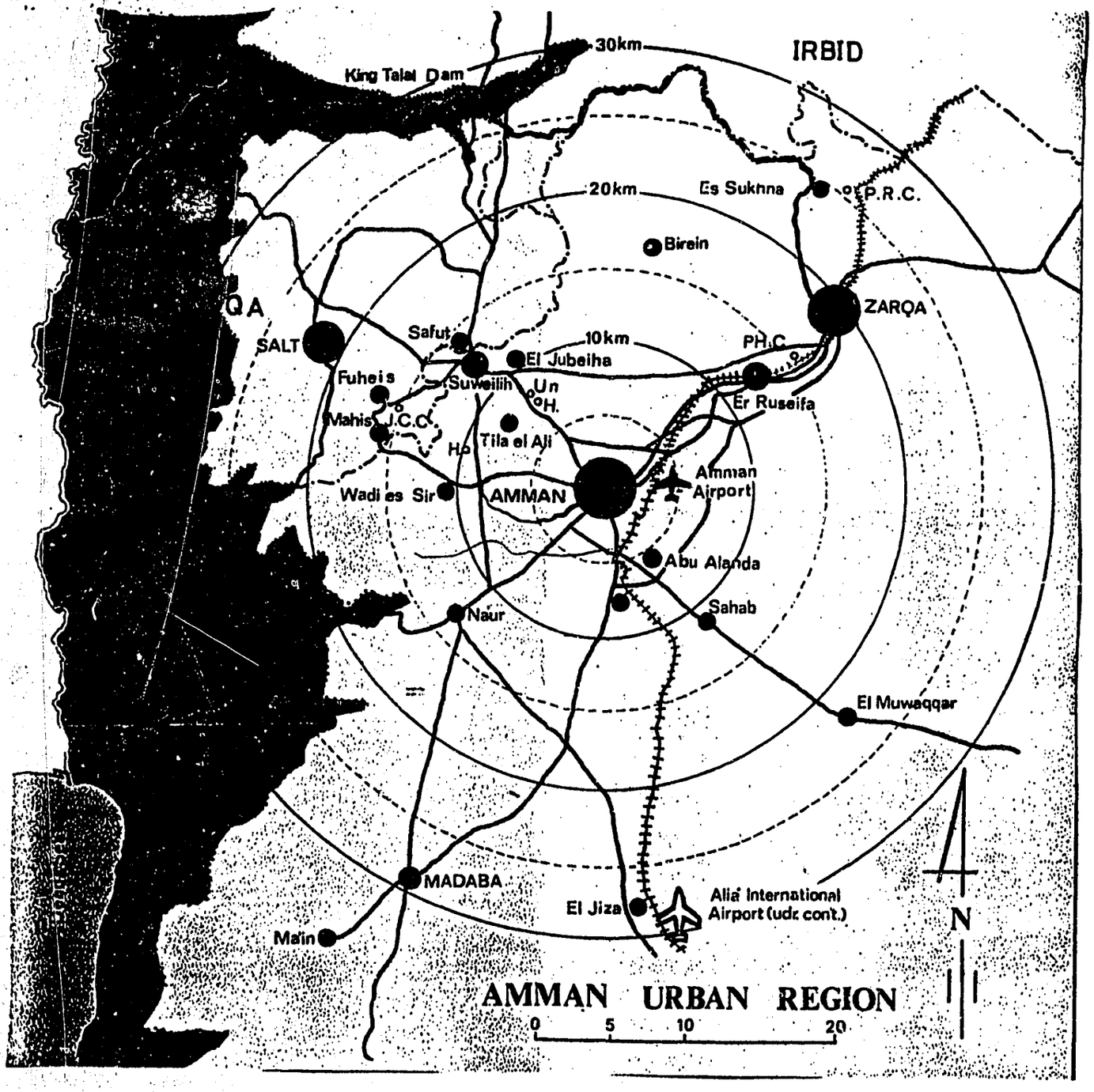



FIGURE 1

AMMAN IN A REGIONAL CONTEXT

Source: Amman Urban Region Planning Project

TABLE I

EXISTING AND PROPOSED WATER AND SEWER SYSTEMS STATISTICS

| | Water | | | Sewers | | |
|---|---|---|---|---|---|---|
| | 1977 | 1981 | 1990 | 1977 | 1981 | 1990 |
| Population ('000) | 700 | 780 | 1129 | 700 | 780 | 1129 |
| Length of laterals in km. | 320 | 477 | -- | 207 | 411 | 811 |
| No. of connections ('000) | 43 | 52 | 77 | 8 | 20.0 | 38.0 |
| Population served ('000) | 500 | 624 | 1129 | 150 | 440 | 925 |
| % of population served | 71% | 82% | 100% | 21% | 56% | 82% |
| Per capita water consumption (lpcd) | 40-50 | 50-60 | 90-100 | -- | -- | -- |

Source: Figures are derived from VBB and IBRD studies.

## 2. The Effectiveness of Water and Sewerage Systems

The ultimate objectives of water and sewage system improvements are to improve the health and social and economic well being of the population being served. The full extent of these benefits is achieved when a plentiful supply of uncontaminated water is available at the house, and when unwanted waste water can be disposed of with no risk of contaminating the water supply. Direct causal and quantifiable relationships between system improvements and the different aspects of community well being are difficult, if not impossible, to obtain. It is, therefore, necessary to identify some measurable entities which may be highly correlated with the intended outcomes of the system improvements and to use those entities as surrogates for the expected benefits of these improvements.

Figure 2 provides a conceptual framework describing the relevant factors in system evaluation. The characteristics of the water and sewerage system combine with those of the socio-economic setting to determine the residents' access to these systems. Access is defined in terms of the following components:

(1) Physical access, which includes such factors as distance to a public tap or latrine, availability of a main or lateral pipe in close proximity to the property, availability of indoor plumbing and fixtures, availability of adequate pressure to service the location in question.

(2) Economic access, which includes the ability of the residents to pay the out-of-pocket and in-kind costs to be incurred in order to benefit from system improvements. These costs include initial fees, connection and plumbing costs, as well as the costs of consumption and service utilization on an ongoing basis.

(3) Temporal access, which describes the extent to which the residents are able to benefit from the systems at all times, and thus is measured by the temporal reliability of the system.

System accessibility, in turn, determines the extent to which residents will utilize it. This is manifested in actual water use, and in the actual number of sewer connections made. It is also manifested in the actual end-uses to which water is put. The level of system utilization is influenced by the willingness to pay of potential subscribers, as well as by their level of awareness with respect to personal and family hygiene. It is only when the system is utilized, that the health and socio-economic benefits can begin to materialize. Institutional and managerial actions are frequently necessary in order to influence the linkages between access and utilization, on the one hand, and between utilization and the achievement of benefits, on the other.

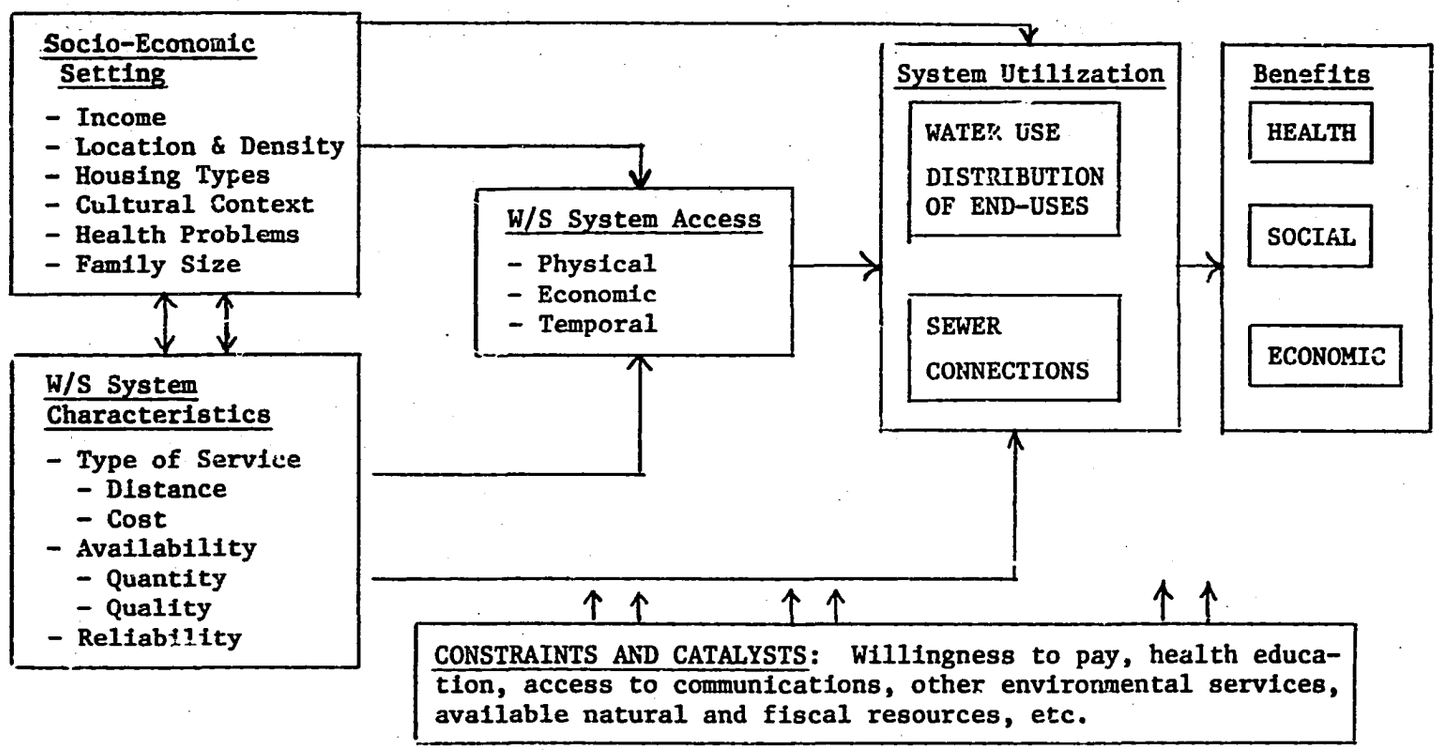



FIGURE 2

A CONCEPTUAL FRAMEWORK

Health education, for example, will allow a higher benefit to result from a given level of system utilization. This activity could be significantly assisted if the residents have good access to electronic and printed communication media. An unwillingness to pay for the services will not result in improved utilization, in spite of the fact that access to the system may have been improved. The lack of proper environmental services such as refuse disposal or rodent control may render the attainment of the expected health benefits of a water and sewerage system more difficult.

The following two sections of this paper will describe the present socio-economic setting in Amman, as well as present sources of domestic water supply and methods of wastewater disposal. We will then assess changes in system accessibility which can be expected to result from the proposed system extensions and evaluate changes in system utilization and in the accrual of benefits to different neighbourhoods in Amman. Throughout the paper, an assessment of both the constraints on benefit attainment and the catalysts needed to magnify these benefits will be undertaken, and conclusions and recommendations will be made.

It should be noted, however, that the necessary data for conducting these analyses, are not readily available. Most data are available, if at all, on an aggregate basis, for the Amman Governorate or for the nation as a whole. Almost no information exists on a disaggregate basis for the various zones within the city of Amman. The following analysis draws heavily on data which are obtained from reports prepared by VBB Fawzi & Associates (1), the World Bank (2), and the Jordanian Department of Statistics (3). These data were supplemented by field interviews and by a questionnaire which was designed specifically for this study. Both questionnaires and interviews addressed questions of housing, income, household size, water supply, and sewage disposal. The sample was not scientifically selected, and is not statistically sound, but it is felt that the results are indicative of situations in different parts of the city and can provide an additional input to these analyses in areas where no information is otherwise readily available.

Under the circumstances, and in view to absence of usable data, the shortage of time and the lack of resources, an approximate and indicative approach was taken to assess the social soundness of the proposed investments and their impacts on the different socio-economic groups in Amman. The methodology is based on first gleaning as many insights as possible into the present socio-economic structure, housing characteristics, income, water use, and wastewater disposal patterns and costs, from a small sample of randomly selected home interviews, mostly in low income areas. The sample was then expanded by the use of less time consuming questionnaires and interviews. Questionnaires were used to obtain the same information for better educated upper middle-class households. Interviews were conducted with heads of households of lower income households. In both cases, the sample was selected from salaried employees, who represent the lowest spectrum of incomes in each category. The data obtained are given in Appendices A and B. Each Appendix includes three Tables: one for the high income Jabal Amman area, one for selected low income areas, and one for selected middle income areas. The number of households sampled in each area is 15, 29 and 20, respectively.

The insights obtained from these interviews and questionnaires were then used to piece together composite profiles of prototypical households in each category and the impacts of system changes on each type of household were assessed. Fortunately, variations among households in Amman were found to be significant. These variations were readily reflected in both the home and office interviews and the questionnaires. The data thus provided enough information to map the before and after system improvement picture, without having to make too many unsupported assumptions.

## 3. The Socio-Economic Setting

The city of Amman has a total population of about 700,000. They are distributed in more than 20 relatively distinct areas in a very hilly terrain. See Figure 3. Many of those areas are separate mountains (Jabals), with very steep slopes on which housing is constructed. Since no population census has been conducted since 1961, all population figures should be considered as rough estimates only. Table II, which is based on the VBB report, lists those areas, together with their 1977, 1981, and 1990 populations.

In order to be able to determine the extent of poverty in a given area, the analyst needs population and income distribution data, as well as a determination of the poverty line. None of these three inputs is readily available in Jordan. The problem is exacerbated by the fact that residential segregation is frequently not based on economic criteria alo and that wide variations in income and life-style may exist side by side. nbers of extended families, clans or tribes and people who share the sa e background will frequently reside next to each other, in spite of wide variations in income. It is thus frequently the case that household income is not necessarily reflected by the type and cost of housing. Mass population movements in the recent past have also had a significant impact on the evolving pattern of intra-urban population distribution. The economic boom in the adjacent oil-producing countries has attracted large numbers of skilled and unskilled workers to those countries, where they obtain high incomes, a good proportion of which is funnelled back to Jordan to support families and relatives. This has created labor shortages which in turn attracted about 70,000 foreign workers to Jordan. High rates of inflation, especially in the past three years, coupled with the recent inflow of refugees from Lebanon, high birth rates, and high rates of family formation have resulted in extremely high land values and rents. This has led to government intervention which fixed the rent of occupied units, while leaving that of unoccupied units to soar. This, in turn, resulted in increased occupancy and crowding of existing dwelling units, and in a reluctance to change a residence, even when the resident's economic status improves. Rising land values encouraged land speculation, and forced middle income home seekers to purchase remote sites, although a large percentage of the land within the city boundaries remains undeveloped. High land and housing costs have encouraged the creation of a variety of middle-class and professional housing cooperatives which sought, bought and developed remote sites which are difficult and expensive to service.

Considering that 50% of the population of Jordan is between the ages of 5 and 15, and that many of those will be in the family formation stage during the coming ten years, both the demand for housing and the overcrowding of housing units occupied by extended families can be expected to continue. Extreme variations in rents have thus resulted. It is not unusual to find that a 4-room apartment in the desirable high income Jabal Amman area which has complete internal plumbing, rents for JD 30 while a single room with one faucet in the low income area of Jabal Tadj rents for JD 25. Neither is it unusual to find a dwelling unit which rents for five times what an adjacent and equal unit may rent for, or to find a luxury house adjacent to a simple 1 or 2 room house with almost no internal plumbing.

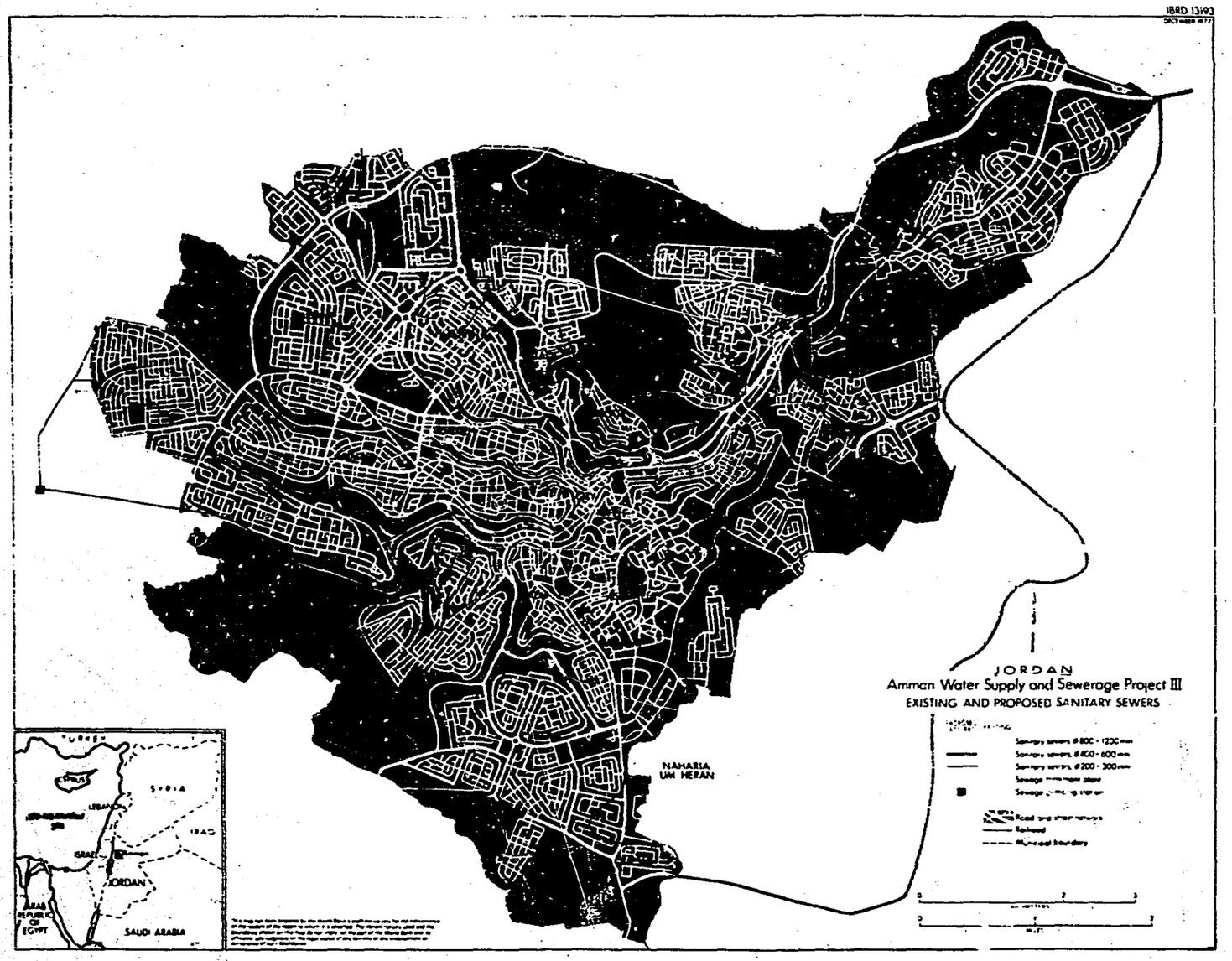



**Figure 3**

**Amman Neighbourhoods**
**(Map Prepared by the World Bank Staff)**

TABLE II

DISTRIBUTION OF POPULATION AND URBAN POOR IN AREAS TO BE SERVED BY PROPOSED PROJECTS[1]

| Area | Population 1977 | 1981 | 1990 | Urban Poor[2] |
|---|---|---|---|---|
| 1. Jabal Amman** | 47 | 58 | 82 | insignificant |
| 2. Sport City | 3 | 4 | 10 | |
| 3. Jabal Hussein | 40 | 50 | 80 | low |
| 4. Wadi Haddada | 12 | 13 | 20 | very high |
| 5. Nazzal | 40 | 42 | 75 | high |
| 6. Nadif* | 30 | 40 | 54 | high |
| 7. Ashrafiya | 39 | 45 | 85 | very high |
| 8. Aussour | 15 | 18 | 30 | medium |
| 9. Hashemi | 24 | 31 | 60 | medium |
| 10. Shamsani** | 2 | 3 | 16 | none |
| 11. Abdoun** | 6 | 8 | 18 | none |
| 12. Smissani | 7 | 10 | 20 | none |
| 13. Marka | 40 | 50 | 65 | medium |
| 14. Nuzha | 24 | 29 | 40 | medium |
| 15. Sha'lieh* | 10 | 15 | 23 | very high |
| 16. Zuhour | 3 | 4 | 6 | low |
| 17. Tadj* | 45 | 48 | 64 | medium |
| 18. Mahatta* | 13 | 13 | 13 | medium |
| 19. Jofeh* | 37 | 40 | 45 | high |
| 20. Qala* | 12 | 13 | 15 | medium |
| 21. Nasr* | 40 | 48 | 50 | high |
| 22. Webdeh | 23 | 25 | 30 | low |
| 23. Refugee Camps (Wahdat & Hussein) | 165 | 180 | 170 | medium |

[1] Data is based on VBB report and IBRD estimates. All figures should be considered to be rough estimates.

[2] Insignificant: less than 5 percent; low: 5-15 percent, medium: 15-25 percent; high: 25-35 percent; very high: more than 35%.

* Areas to be served by sewerage in Contract 1S.

** Areas to be served by water and sewerage in Contract 5WS.

Not only do rents vary, but so do household sizes and incomes. A recent survey by the Jordan Department of Statistics has indicated that the overall average number of persons employed per household in urban Jordan is 1.27 (4). The figures, given in Table III, show that this number does not vary much by household size, that the largest single group of households has more than 10 persons, and that there is an almost equal distribution of households having 4-9 members. They also show that the average wage earner may support between one and more than six dependents.

Household income depends on the number of workers in the household and on their type of employment. Wages are frequently supplemented by disbursements from relatives abroad, receipt of rent on property, receipt of food rations distributed to refugees by the United Nations Relief and Work Agency (UNRWA), additional income from second jobs and private enterprise or rent-free housing in the refugee camps. Since most housing units are not financed by long-term mortgage arrangements, but are rather paid for during or soon after construction, owner-occupants enjoy a significant advantage with respect to their disposable income since renters in Jordan pay, on the average, between 28 and 35% of their incomes for rent. There is, however, no information on the percentage of owner-occupied housing, although it is probably less than 50 percent, and is probably higher in low and upper income areas than it is in middle income areas.

Jordan presently enjoys full employment. The Employment Survey of 1976 lists figures for those employed in establishments with five or more employees in the city of Amman (5). The survey provides these figures by sector, and provides average salaries in each sector. These are given in Table IV, together with the percentage of salaried employees in each sector. These percentages are indicative of extent to which these average salaries are representative of employment in a particular sector, since it is highly likely that those who are self-employed or family-employed work in smaller establishments employing less than five persons. This is indeed the case, since, as shown in Table IV, 83.4% of all those employed are represented in the survey. These figures show that the average annual salary is JD 816. Considering that minimum wages for government employees run at about JD 500, and considering the high cost of living in Amman, it is reasonable to draw the poverty line at about JD 800 per worker. With an average of 1.27 workers per household, this line can be drawn at about JD 1000 ($3000) per household or JD 166 ($500) per capita for an average family of six. Home interviews with a number of poor households have confirmed, albeit subjectively, that households living on this per capita income do indeed represent that sector of the population which finds it hardest to live in Amman. It should be emphasized that this definition of the poverty line should be considered as a crude and rough estimate only, since there are no hard data to support it.

The poorest of the poor in Amman are represented by a typical squatter household living in a one-room mud house with a corrugated metal roof held in place by rubble, or in natural caves with some mud or brick improvements. The area of the room is about 15m$^2$ and the average household size is about 10. These one-room units are built at a density of about 40 per 1000 m$^2$ resulting in a population density in excess of 400 persons/1000 m$^2$ (1750 persons/acre). An example of such an area is the Mukhayyam Al-Jofeh, an

TABLE III

SIZE OF URBAN JORDANIAN HOUSEHOLDS AND NUMBER OF EMPLOYED PERSONS PER HOUSEHOLD

| Persons in Household | Total No. of wage Earners in Sample | Total Population in Sample | % of Population in Household Category | Persons Employed per Household | Persons Supported per Wage Earner |
|---|---|---|---|---|---|
| 1 | 62 | 282 | 1.9 | .20 | 1.0 |
| 2 | 602 | 1840 | 6.4 | .64 | - |
| 3 | 1070 | 3117 | 7.2 | 1.031 | 2.9 |
| 4 | 1500 | 5160 | 12.0 | 1.16 | 3.4 |
| 5 | 1902 | 7700 | 10.7 | 1.23 | 4.1 |
| 6 | 2248 | 10488 | 12.2 | 1.28 | 4.7 |
| 7 | 2247 | 11788 | 11.7 | 1.33 | 5.3 |
| 8 | 2243 | 12376 | 10.8 | 1.44 | 5.6 |
| 9 | 1949 | 11898 | 9.2 | 1.40 | 6.4 |
| 10 or more | 3964 | 24776 | 17.3 | 1.59 | 6.3+ |

Source: Department of Statistics, The Multi-purpose Household Survey, Jan. - Apr., 1976, Amman, June 1977.

TABLE IV

CITY OF AMMAN. PERSONS EMPLOYED, BY CATEGORY OF EMPLOYMENT, AND AVERAGE SALARY[1]

| Type of Employment | No. Persons | % Persons | Average Annual[2] Salary (JDs) | % salaried in sector[3] |
|---|---|---|---|---|
| Mining | 3486 | 4.1 | 1305 | 95.6 |
| Manufacturing | 10099 | 12.1 | 846 | 67.9 |
| Electricity | 1071 | 1.2 | 1210 | 93.9 |
| Construction | 4373 | 5.2 | 980 | 80.8 |
| Commerce | 4616 | 5.5 | 818 | 32.4 |
| Transport | 4035 | 4.8 | 700 | 75.9 |
| Financial Services | 3391 | 4.0 | 1299 | 85.0 |
| Comunity Services, Public Administration | 52648 | 62.8 | 740 | 91.2 |
| TOTALS | 83719 | 99.7 | 816 | 83.4 |

[1]These percentages and numbers are taken from the Employment Survey for Establishments Engaging More than (5) Persons, Dept. of Statistics, December 1976, and represent people employed in establishments of five of more persons. However, the similarity to figures quoted in the Multiple Purpose Survey, listing employment only for the Governorate of Amman, is striking. Nevertheless, the figures must be understood to be approximate only.

[2]Average annual salaries are derived from a sample survey conducted by the Ministry of Labor for the Kingdom of Jordan as a whole. All figures were upgraded by 25%, as private communication from the World Bank indicated this inflation factor between 1976 and 1977.

[3]These figures are extracted from the Multiple Purpose Household Survey, 1976.

unofficial squatter refugee camp. The typical household has one wage earner, who is most likely an unskilled laborer employed in the public sector and earning JD 600 ($1800) per year. Assuming an average household size of 10, this leads to a per capita annual income of JD 60 ($200). It is difficult to estimate the number of persons living at this subsistence level, but it is probably between 2 and 4 percent of the population of Amman. Households at the poverty level in Amman are thus defined as those having an annual income of between JD 600 and JD 1000 ($1800 - $3000), or an annual per capita income of between JD 60 and JD 166, ($200 - $500).

The location of the urban poor within the boundaries of the city of Amman, and among the different areas described above, has been determined by (i) actual windshield surveys and home interviews, (ii) guidelines from IBRD data, and (iii) through the use of other available indicators of low income. One such indicator is population density, which seems to be correlated with poverty. Another is the average assessed annual rental on which property taxes in Amman are based. These two indicators, together with the IBRD estimates are given in Table V for some selected areas including those to be served by contracts 1S and 5WS. A combined subjective estimate of the extent of poverty in each area of the city is shown in Table II. It is clear that the worst situations exist in Wadi Haddada, Ashrafiya, Sha'lieh, Nasr, Nazzal, Nadif and Jofeh. Other areas with somewhat less, but still significant poverty, are Qussour, Hashemi, Marka, Nuzha, Tadj, Mahatta, Qualah, and the UNRWA refugee camps of Wahdat and Hussein.

Jordan enjoys one of the highest literacy rates in the Middle East, and maintains an educational system in which almost 30% of the total population of the country is enrolled. The extensiveness of the educational system, together with the fact that all households in Amman have access to both radio and television, have both contributed to a relatively high level of awareness of the basics of personal and family hygiene. Both printed and electronic communication media are readily accessible to all the residents of Amman.

TABLE V

SOME POVERTY INDICATORS IN SELECTED AREAS IN AMMAN

| | IBRD Estimate % poor | Planned Density in Persons/ 1000 $m^2$ | Estimated Assessed Annual Rental (JD) |
|---|---|---|---|
| Ashrafiyah | 30 | 60 | 200 |
| J. Abdoun | 0 | 35 | 1560 |
| J. Amman | 2 | 35 | 1200 |
| Jofeh | 20 | 60 | 200 |
| Mahatta | 20 | 60 | 180 |
| Nadif | 25 | 60 | 160 |
| Nasr | 30 | 60 | 160 |
| Nazzal | 25 | 60 | 320 |
| Nuzha | 25 | 60 | 100 |
| Qala'ah | 20 | 60 | 360 |
| Sha'lieh | 25 | 60 | 360 |
| Shamsani | 0 | 40 | 800 |
| Smissani | 0 | 35 | 1040 |
| Tadj | 20 | 60 | 260 |

## 4. Existing Systems

The city of Amman is presently served by a water system which serves a total of 500,000 persons, and a sewerage system which serves 150,000 persons. These figures represent about 71% and 21% of the population, respectively. Water is presently being obtained from two aquifers, through 28 producing wells. The total amount of water produced in 1977 is 17.5 million cubic meters ($Mm^3$) (68 liters per capita per day), of which only 10.85 $Mm^3$ are actually sold (42 lpcd). The apparent unaccounted for difference is mainly due to inaccurate water metering and to system leakage. The city is located in a semi-arid region with an annual rainfall of 400 mm (16 inches). The country is generally short of water, and prolonged periods of drought have been known to occur in the Amman region.

The water system does not, however, provide a continuous flow of water to areas which are connected to it. Water is allocated to different neighbourhoods on a once or twice a week basis, for durations which vary with the elevation of a particular subscriber. Pressures are generally inadequate, with resulting water shortages in some high-rise buildings or in locations at high elevations. During the summers of dry years some subscribers have been known to go without water for weeks.

The intermittent operation of the system has some drawbacks, not the least of which is increasing the risks of contaminating the piped water supply. The intermittent flow creates a back-siphoning effect when taps are opened, causing contaminants from the sewage-saturated soil to seep into the pipes. Intermittent flow has caused subscribers to install roof tanks, usually galvanized steel with a capacity of 1-3 cubic meters. In some cases, especially where the pressure is inadequate, ground tanks are also installed, and the water is then pumped to the roof tanks from which it flows by gravity through the residence's internal plumbing. Old, rusty and leaky pipes also contribute to increasing leakages and to reducing the quality of delivered water.

About 80% of the residents depend on cesspools and septic tanks for their wastewater disposal. The large number of cesspools has contributed to both the pollution of piped water and the pollution of the supplying aquifers. It is estimated that 35% of the total water consumed in Amman from the aquifer system is replenished by cesspool effluents (6). This percentage is down from 50% in 1961, prior to the construction of the existing sewerage system. As new sewer connections are made, the use of septic tanks and cesspools decreases, and so does aquifer pollution. An increasingly important source of aquifer pollution is the percolation of industrial wastes in the Amman-Zerka area. Industrial production in this region has almost doubled in the last decade, with little effort to control the effluent in order to preserve the quality of both surface and ground water.

The piped water supply in Amman suffers from intermittent occurances of objectionable physical characteristics of turbidity, color, odor and taste. The average concentration of total dissolved solids (T.D.S.) in water has been found to be close to WHO permissible limit of 500 ppm. Some shallow

wells have been found to have TDS values of up to 6500 ppm.* Another significant characteristic of the Amman water is its large quantities of nitrates. Values in excess of 100 ppm have been found to exist in the water, far in excess of the WHO permissible standard of 45 ppm. Excessive nitrates quantities in drinking water is a causal agent for infantile metahemoglobinemia. This high level of pollution of domestic and industrial wastes can also be attributed to excessive ground dumping of domestic and industrial wastes.

The Ministry of Health reports that bacteriological testing of the Amman water sources in 1976 has indicated that the percentage of unsafe samples containing any amount of coliform bacteria (MPN) has been about 8.5% for the period between 1972-1976. The percentage in refugee camp distribution systems during the same period stands at about 10%. Both of these percentages are the lowest found among all cities in Jordan. The Ministry also reports that in August 1975, fecal bacteria were found in 37 percent of all wells in the Amman-Zerqa area, and in 100 percent of Amman's shallow aquifer wells (7). This bacteriological pollution is responsible for enteric and diarrheal diseases such as cholera and typhoid, as well as other intestinal disorders and worm infestations. An outbreak of gastroenteritis, typhoid and infectious hepatitis "A" in the neighboring city of Salt in the winter of 1976 has affected more than 15% of the population of that town. Enteric and diarreal diseases represent the second highest cause of death in children less than five years of age in Jordan. Bacteriological pollution can also be traced to fecal contamination from cesspools.

All housing units in Amman have either an indoor or an outdoor toilet, and are either connected to the sewerage system or a cesspool. Available solutions with respect to water supply, however, are more varied. They include the following

(a) Piped water, roof tank (galvanized steel or barrels), with or without ground level water storage.

(b) Piped water, roof tank (galvanized steel or barrels), with or without ground level water storage, supplemented with cistern for the collection of rainwater (very rare).

(c) Piped water, roof tank (galvanized steel or barrels), with or without ground-level water storage, supplemented with water purchase by tanker.

(d) No piped water, roof tanks, water purchase by tankers or from neighbors connected to the system.

(e) No piped water, ground-level storage in concrete, galvanized steel tanks or 240 liter barrels, water purchase by tankers or from neighbors connected to the system.

(f) No piped water, ground-level storage in 240 liter barrels, and/or 20 liter containers, water carried from public taps (very rare).

---

*Tests were conducted in 1974 by the Natural Resources Authority and reported in Gedeon, Shalbak and Shehabi (1978).

Solutions (a) through (d) require some level of home plumbing. This may vary from the most modern and elaborate, to simple systems with one or two pipes and faucents. Solutions (e) and (f) do not use any plumbing, since water is obtained by dipping into storage tanks or barrels. This practice, of course, results in a high risk of contamination of both the stored and used water.

In order to supplement the water supply system, the Amman Water and Sewer Authority (AWSA) is selling water by tankers. They own 52 tankers. A waiting list of purchasers has frequently developed prior to the recent addition of 21 tankers to the fleet, but it is not clear that the new fleet will completely serve the market when a dry period occurs. Some other governmental and private entities provide water in tankers for the convenience of their employees. The facts that people cannot wait for water, and that they have small storage tanks which need to be filled frequently, have led private entrepreneurs to fill the gap. Private operators also sell water in tankers. These are regulated with respect to their allowable sources of water, are painted in an identifiable green color and are marked with the words "potable water". While purchases from AWSA tankers have a fixed price of JD 0.250 per cubic meter, private operators charge much higher prices, and in water-short seasons when the demand for their services soars, they can obtain almost any price they ask for. There is generally a five-tier water pricing system presently in operation in Amman, depending on the source. These five price levels are:

(1) Subscribers to Amman Water System: Effective April 1, 1978, these subscribers will pay for water in accordance with the following progressive rate structure:

| | |
|---|---|
| 0-10 $m^3$ | 600 fils/$m^3$ |
| 11-20 $m^3$ | 60 fils/$m^3$ |
| 21-40 $m^3$ | 80 fils/$m^3$ |
| 41-100 $m^3$ | 180 fils/$m^3$ |
| 101 $m^3$ or more | 260 fils/$m^3$ |

(2) Purchasers from AWSA tankers:

| | |
|---|---|
| 4 $m^3$ tanker | JD 1.000 |
| 7 $m^3$ tanker | JD 1.500 |
| 11 $m^3$ tanker | JD 2.500 |

For most residential users not purchasing large quantities the cost is 250 fils/$m^3$.

(3) Purchasers from private tanker operators: Prices vary appreciably, but they are generally between JD 0.750 and JD 1.250 per cubic meter.

(4) Purchasers from neighbors: There is no set price in this category, but interviews have indicated that the price is between 10 and 15 fils per 20 liter container or between JD 0.500 and JD 0.750 per cubic meter. Water is carried in 20 liter containers or by hose. This is the most common method in some of the poorest neighborhoods.

(5) Carriers from public taps; free.

It should be noted, however, that complete dependence on public taps, is almost nonexistent, although these taps are used to supplement the water supplies of a very small number of people during the dry summer months. There are a few public water taps in the city. The largest concentration of these taps is in the refugee camps. United Nations Relief and Works Agency (UNRWA) statistics indicate that while there are 144 taps in 21 locations in the Amman New Camp (Wahdat), and 101 taps at 11 locations in the Jabal El-Hussein Camp, they provide no more than 2.8 and 2.3 liters/capita/day, respectively, to each registered resident in these camps. These quantities are probably used for drinking and washing by passers-by, rather than carried to the homes as a main source of water. It is interesting to note that these UNRWA statistics also show that all dwelling units in these camps have private latrines, and that there are only 14 public latrines in both camps. These are located in markets and public areas.

## 5. Access and Utilization

This section will address the questions of changes in access to water and sewerage service and in the utilization of these services, which can be expected to result from the proposed system improvements and extensions. Changes in physical access will be discussed first, followed by an analysis of economic and temporal accessibility, and changes in the quantity of water used.

### 5.1 Physical Access

Table VI shows the percentages of the population in each of the areas of the city which are expected to be connected to the water and sewerage networks by 1981 and 1990. Figures 4, 5, and 6 show these percentages relative to the estimated annual rental in each of these areas. These assessments provide some indication of the incomes of the residents and are given in Table V. The differences in the percentages given in Figures 5 and 6 indicate additional sewer connections to be implemented in the following phases of the project. It is expected that all the residents of Amman will have water connections by 1990. It is clear from Figures 4 and 5 that areas with the highest income have been provided with the best service with respect to both water and sewerage. Some of the low income areas such as Nuzha, Qussour, Hashemi, Nazzal and Sha'lieh will be provided with relatively good water coverage in 1980. Hashemi will have good sewerage connections as well. Many other low income areas will receive a low priority during the first phase of the proposed system improvements. The level of service with respect to sewerage will improve appreciably in most areas by 1990. It should be noted, however, that it will deteriorate significantly in Wadi Haddada as a result of both population increases and inadequate system improvements. The only areas which will continue to have less than 60 percent of the population connected to the sewerage system in 1990 are Jofeh, Qala'ah, Nadif, Qussour, and Wadi Haddada: all low income areas. While it is expected that all areas will have water connections by 1990, the low income areas of Ashrafiyah, Jofeh, Mahatta, Marka, Nasr, Qala'ah and Wadi Haddada will still have 30% or more of their population unconnected to the system by the end of the present phase (1981).

### 5.2 Economic Access

Once a water or sewer lateral is constructed, residents in the immediate vicinity are expected to connect to it. The owner is required to make the connection and to pay for it, while the renter pays for the services he receives and for which he is billed quarterly. The following paragraphs will discuss both connection and service costs, and the impacts which they are expected to have on different classes of residents in Amman.

Water connections are generally less costly than sewer connections, and their benefits are so obvious that most owners will have no problem with connecting to the system as soon as laterals are installed. Renters are frequently willing to pay connection costs if owners fail to do so. Sewer connections, on the other hand, are more costly and their benefits are not immediately obvious to some owners, who might thus be reluctant to connect.

TABLE VI

PROJECTED WATER AND SEWER SERVICE IN DIFFERENT AMMAN NEIGHBOURHOODS

| Area | % Sewered | | % Water | |
|---|---|---|---|---|
| | 1981 | 1990 | 1991 | 1990 |
| Abdoun | 32.5 | 93.9 | 75.0 | 100.00 |
| Ashrafiyah | 30.5 | 60.0 | 66.6 | 100.00 |
| Hashemi | 7.10 | 69.0 | 80.6 | 100.00 |
| J. Amman | 58.4 | 92.5 | 94.8 | 100.00 |
| J. Hussein | 53.0 | 72.9 | 90.0 | 100.00 |
| Jofeh | 47.0 | 55.7 | 45.0 | 100.00 |
| Mahatta | 26.0 | 67.2 | 45.0 | 100.00 |
| Marka | 20.4 | 80.8 | 60.0 | 100.00 |
| Nadif | 41.0 | 51.5 | 50.0 | 100.00 |
| Nasr | 30.4 | 86.9 | 50.0 | 100.00 |
| Nazzal | 32.8 | 74.9 | 80.9 | 100.00 |
| Nuzha | 38.9 | 78.9 | 82.7 | 100.00 |
| Qala'ah | 45.4 | 53.8 | 45.0 | 100.00 |
| Qussour | 43.3 | 43.0 | 83.3 | 100.00 |
| Refugee Camps | 42.2 | 70.5 | 94.0 | 100.00 |
| Sha'alieh | 53.3 | 74.1 | 80.0 | 100.00 |
| Shamsani | 73.3 | 75.0 | 73.3 | 100.00 |
| Smissani | 90.0 | 90.0 | 100.0 | 100.00 |
| Tadj | 51.8 | 62.0 | 75.0 | 100.00 |
| Wadi Haddada | 46.1 | 21.4 | 53.8 | 100.00 |
| Zuhour | 50.0 | 81.0 | 75.0 | 100.00 |

Sources: VBB reports and IBRD estimates

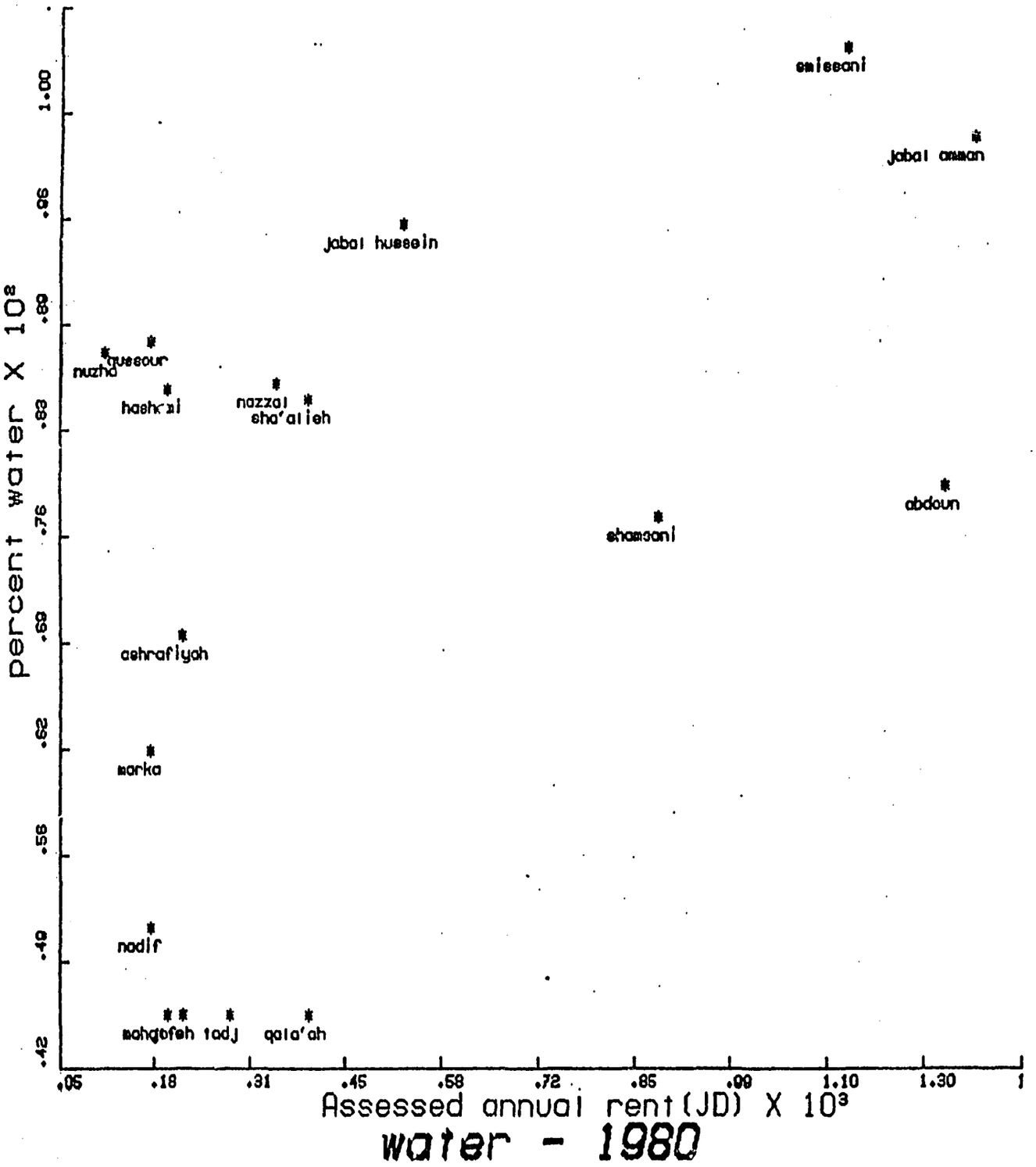
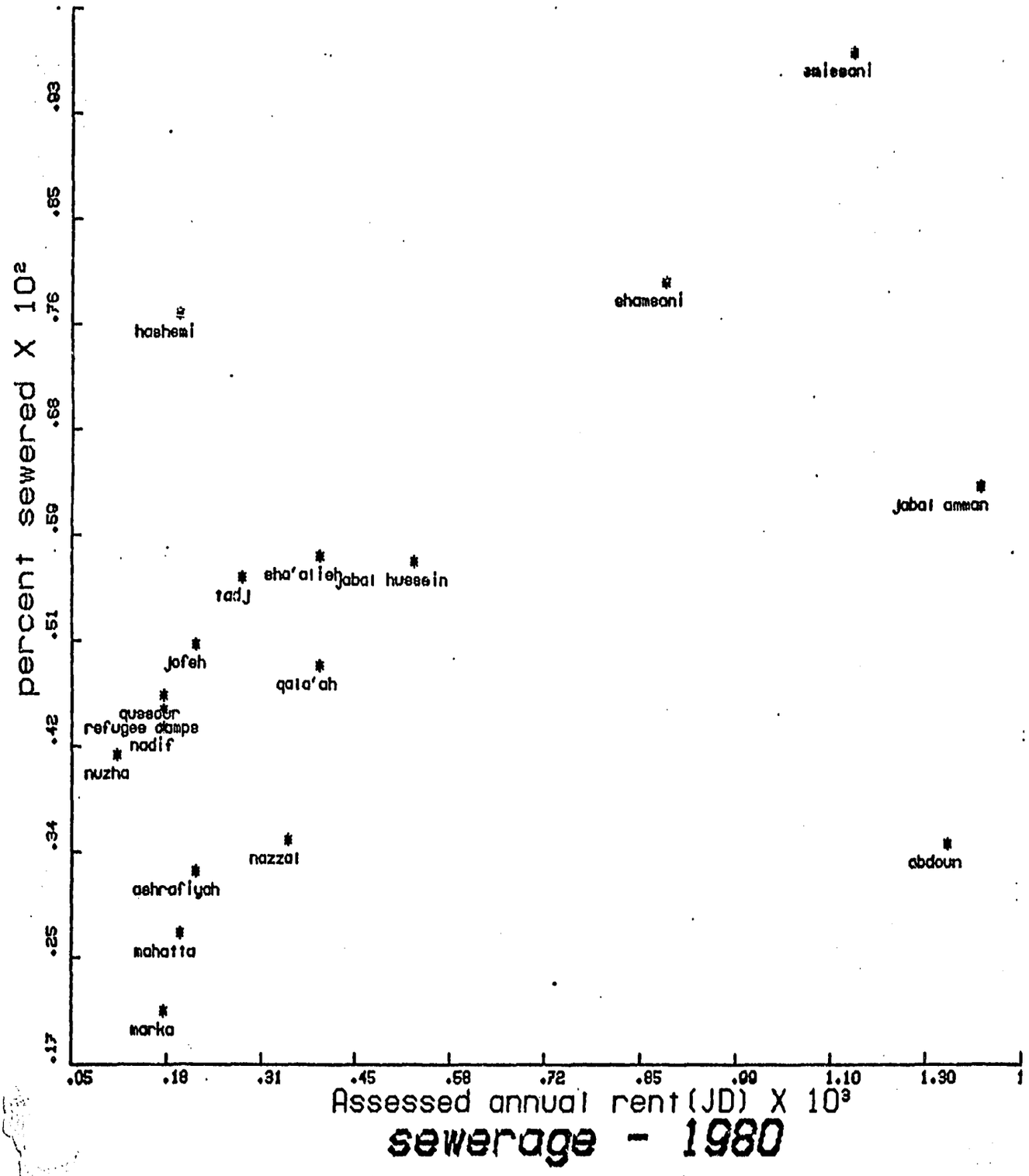
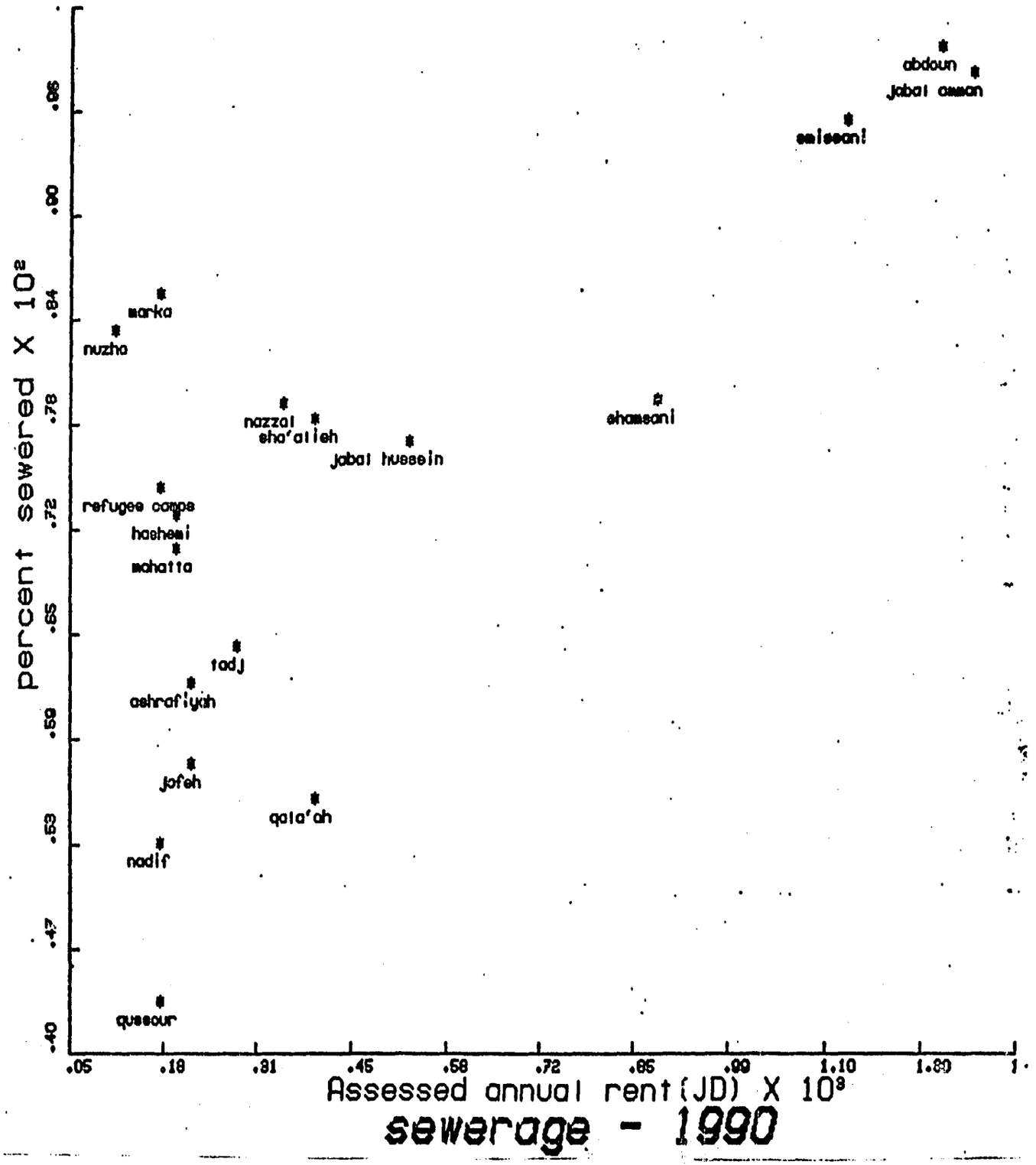

percent water X 10²
1.00
.96
.89
.83
.76
.69
.62
.56
.49
.42
.05
.18
.31
.45
.58
.72
.85
.99
1.10
1.30
1
Assessed annual rent(JD) X 10³
water - 1980
emiseani
jabal amman
jabal hussein
nuzha
qusseour
hashmi
nazzal
sha'alieh
abdoun
shamsani
ashrafiyah
marka
nadif
mahgbeh
tadj
qala'ah

FIGURE 4




sewerage - 1980

FIGURE 5




sewerage - 1990

FIGURE 6

The law, with respect to sewer connections, however, is clear. Upon announcing that an area has been served by laterals, the Amman Water and Sewerage Authority (AWSA), expects the owner to pay his connection fees, and make the necessary arrangements for selecting a contractor, from an approved list, to construct the connection. The owner also has the option to construct the connection himself, under AWSA supervision. Should the owner fail to respond within three months of the announcement, AWSA will construct the connection and bill the owner at cost plus 20 percent. The cost of connection has apparently deterred some from connecting, as indicated by the fact that the number of sewer connections in the past few years has been less than expected. Voluntary compliance with the connection requirement is particularly difficult when the owner does not occupy the structure. Rent control which has been in effect for six years has resulted in low rents, and thus no incentive for the owner to undertake any improvements.

The fee for a new water connection is made up of a connection fee of JD 1.275, a plan preparation and survey fee of JD 2.000, and a hook-up fee of between JD 15.00 and JD 33.000, depending on the size of lateral to which the connection is made. The total fee is thus between JD 18.275 and JD 36.275. The owner will also have to pay the cost of the house connection from the lateral to the water-meter which is installed inside his lot as well as the cost of the water meter, valves and valve chambers. These costs will depend on the distance to the lateral and will cost JD 5.00 for each water meter, JD 2.00 for the valve chamber, and about JD 25.000 for connecting the lateral through the meter to the roof tank. If the building has no roof tank and no internal plumbing, an additional amount of JD 40 will be needed for these items. The total connection cost for a single-unit residential structure will thus be in the order of JD 50-55 without the tank and plumbing and JD 90-95, if these need to be purchased. Since there is neither a legal requirement nor a financial incentive for the owner of a low-rent dwelling unit to connect to the water, it is often the case that the renters will pay the connection costs themselves. They will probably get by with minimum expenditures which would cover the cost of a single tap from which they will fill their barrels whenever water is pumped through the system. Such a minimal arrangement may cost about JD 40. The renter must pay a deposit of JD 15 for Class A residential building, JD 10 for Classes B, C, and D. The renter will then pay the quarterly bills in accordance with the fee schedule given in section 4 above.

The fee structure for sewer connections is more directly pegged to the subscriber's ability to pay than that of water. It is made up of an application fee and a connection fee. The application fee also varies with the type of building and is collected at the rate of JD 10 for Class A residential buildings, JD 5 for Class B residential buildings, JD 3 for Class C residential buildings and JD 25 for commercial buildings. Classes A and B are typical of the higher income areas. The connection fee is determined at 25% of the assessed annual rent of the structure. These fees are of the order of less than JD 100 for the low income areas, between JD 100-200 for the middle income areas, and in excess of JD 200 for the high income areas. Once an owner is connected to the sewerage system, he will have to continue to pay an annual property tax surcharge of 4% of the assessed rental (8).

This will increase his total tax from 17% to 21% of the assessed rental.* He will also have to pay the cost of the house connection itself, which amounts to between JD 18-25 per meter-run of the connection. These average about 3.25 meters in the low income areas and 4.50 meters in the high income areas.

Connection to the sewer system will also result in quarterly surcharge to the water bill, which is paid by the occupant. The present surcharge is 30 fils/$m^3$ and an increase to 35 fils/$m^3$ is being considered. For a family of six using 60 lcpd, this amounts to JD 4.590 per year. The cost to a similar-size family using three times the quantity of water is JD 13.700 per year.

In order to assess the impacts of these costs on households of different income levels in Amman, we will assume six prototypical households in each of the low income and the middle income categories, assume the characteristics of the households on the basis of the information obtained from questionnaires and interviews which is given in Appendices A and B, and calculate the impacts of water and sewer connections on their expenditures for these services. Table VII describes the 12 typical households to be considered. It should be noted that, as is evident from the tabulations in Appendices A and B, the variations among households in Amman are significant. It is felt, however, that the judgmental and subjective selection of these typical households will serve to demonstrate the fiscal impacts of system extensions and improvements. The selection represents some of the worst situations in each category.

Table VII shows the connection costs and the recurring annual, costs to each of these 12 types of households after the change in the service. The figures assume that the improved system will drastically reduce the dependence on tanker water purchases, and that such purchases will only be needed in situations of extreme and extended droughts. Estimates are based on the new tariff which came into effect on April 1, 1978. All other assumptions are given in the footnotes to the Table.

It is clear from this analysis that all of these typical low and middle income households will be better off with respect to their combined water and sewerage recurring annual costs. Low income renters will save an annual amount of JD 41, 63.5 and 40.5, depending on whether they will obtain water, water and sewerage, or sewerage only. Middle income renters in these three categories will save JD 29, 48.5 and 25.5, respectively. If the owners pay the connection and installation costs, then these renters will have to invest in the water deposit only, which is well within their financial ability. The rent situation in Amman may cause the owners to be reluctant to make the initial investment, thus leading the renters to invest in a minimum-cost solution. People's appreciation for the need for water, and the fact that they are paying a high cost for it and perceive the savings which could accrue to them from connecting to the system, have resulted in almost universal connection, irrespective of who pays.

---

*Property taxes in Amman are composed of a 17% property tax and 4% sewerage tax, to be paid by the owners, and a 3% education tax to be paid by the renter, if other than the owner. Percentages are applied to the assessed annual rental.

TABLE VII

THE IMPACT OF SYSTEM IMPROVEMENTS ON TYPICAL HOUSEHOLDS

| House-Hold No. | Rent[1] or Own | Present[2] Service | Future Service | Income | Connection Costs | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Water[3] | Sewerage | Total | % of Income |
| 1. | R | none | W | 600 | 50 | -- | 50 | 8.3 |
| 2. | R | none | W/S | 600 | 50 | -- | 50 | 8.3 |
| 3. | R | W | S | 600 | -- | -- | -- | -- |
| 4. | O | none | W | 600 | 100 | -- | 100 | 16.6 |
| 5. | O | none | W/S | 600 | 100 | 80 | 180 | 30.0 |
| 6. | O | W | S | 600 | -- | 80 | 80 | 13.3 |
| 7. | R | none | W/S | 2400 | 65 | -- | 65 | 2.7 |
| 8. | R | none | W/S | 2400 | 65 | -- | 65 | 2.7 |
| 9. | R | W | S | 2400 | -- | -- | -- | -- |
| 10. | O | none | W | 2400 | 110 | -- | 110 | 4.6 |
| 11. | O | none | W/S | 2400 | 110 | 115 | 225 | 9.4 |
| 12. | O | W | S | 2400 | -- | 115 | 115 | 4.4 |

[1] Rent = R; Own = O

[2] Water = W; Sewerage = S; Water and Sewerage = W/S

[3] Water costs are based on the assumption that low income renters will pay the costs of the connection with a minimal cost system, while owners will invest in a roof tank and a few more faucets. Sewerage connection costs will be paid by owners.

TABLE VII (continued)

| House-Hold No. | Before Improvements | | | | After Improvements | | | | Change in | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Water[4] Cost/Yr. (JD) | Sewerage[5] Cost/Yr. (JD) | Total Cost/Yr. (JD) | % of Income | Water[6] Cost/Yr. (JD) | Sewerage[7] Cost/Yr. (JD) | Total Cost/ Year | % of Income | Annual Costs (JD) | % of Income |
| 1. | 50 | 27 | 77 | 13.0 | 9 | 27 | 36 | 6.0 | -41 | - 7.0 |
| 2. | 50 | 27 | 77 | 13.0 | 9 | 4.5 | 13.5 | 2.3 | -63.5 | -10.7 |
| 3. | 27 | 27 | 54 | 9.0 | 9 | 27 | 36 | 6.0 | -41 | - 6.9 |
| 4. | 50 | 27 | 77 | 12.9 | 9 | 11 | 20 | 3.3 | -57 | - 9.6 |
| 5. | 50 | 27 | 77 | 12.9 | 9 | 11 | 20 | 3.3 | -34 | - 5.7 |
| 6. | 27 | 27 | 54 | 9.0 | 21 | 27 | 48 | 2.0 | -29 | - 1.2 |
| 7. | 50 | 27 | 77 | 3.2 | 21 | 7.5 | 28.5 | 1.2 | -48.5 | - 2.0 |
| 8. | 50 | 27 | 77 | 3.2 | 21 | 7.5 | 28.5 | 1.2 | -25.5 | - 1.0 |
| 9. | 27 | 27 | 54 | 2.3 | 21 | 27 | 48 | 2.0 | -29 | - 1.2 |
| 10. | 50 | 27 | 77 | 3.2 | 21 | 27 | 48 | 2.0 | -29 | - 1.2 |
| 11. | 50 | 27 | 77 | 3.2 | 21 | 27 | 48 | 2.0 | -29 | - 1.2 |
| 12. | 27 | 27 | 54 | 2.3 | 21 | 27 | 48 | 2.0 | - 6 | - 0.3 |

[4] Assumes that households without municipal water depend completely on tankers, that those with it supplement their supply with tanker purchases.

[5] Assumes that the cost of cleaning the cesspool is JD 4.500, has to be done very two months, and is paid by the occupant. This may be on the high side, since some occupants frequently find illegal means of emptying cesspools.

[6] Assumes that improved system eliminates the need for tanker purchases except in situations of extreme drought, and that water consumption is 60 lpcd for low income households and 100 lpcd for middle income households. Costs are estimated on the basis of the new tariff which is effective April 1, 1978.

[7] Sewerage costs are based on a new surcharge rate of 35 fils/$m^3$. For owner-occupied dwellings an additional tax of 4% of assessed rent is levied. This is calculated on the assumption that assessed rents are JD 160 for low income households and JD 480 for middle income households.

Owner-occupants will reap similar but somewhat smaller benefits. For low income owner occupants, the benefits derived from the three types of improvements are JD 41, 57, and 34, respectively. For middle income owners, the benefits are JD 29, 29, and 6. The differences are due to the fact that owner-occupants will have to pay a 4% sewerage tax surcharge. In order to achieve these benefits, however, owner-occupants will often have to make a sizable investment, ranging between 4.4 and 30 percent of their annual incomes. The hardest hit are low income owner-occupants with no present service, who will obtain both water and sewerage. Naturally, they might be reluctant to connect. Middle income owner-occupants who have water service, might also be reluctant to connect, since the benefits accruing to them are small.

One important caveat in this analysis is that extreme variations exist in cesspool emptying costs. While many low income households have their own private cesspool, many also share these costs with other households. The construction of an increasing number of apartment buildings in the affluent and middle income neighbourhoods will increase the number of shared cesspools, as will the expected increase in density in most low income neighbourhoods. Strong incentives exist for connecting to the sewerage system for newly constructed units, since the costs of connection are generally less than the cost of new cesspools. This is particularly true in the upper income neighbourhoods where significant savings could be obtained. The high cost of cesspool cleaning has resulted in illegal pumping and disposal of cesspool contents, especially during the rainy season and in low income areas. This is not only a health hazard, but it also reduces the perceived benefits of connecting to the sewer system. Differing soil conditions and cesspool sizes also contribute to the wide variation in present wastewater disposal costs.

### 5.3 Temporal Access

The Amman water system does not provide a continuous flow of water to all areas of the city. The health implications of the problems of back-siphoning through the pipes have been discussed earlier. Variations in the number of times in which service is provided to different buildings depends on the pressure zone in which it is located, its elevation and the number of stories. It also depends on the season of the year and the availability of the water. While a few areas might receive close to continuous service in the winter others might not get more than once or twice a week for a duration of 6-8 hours each. During the summer months, especially during dry years, some areas have not received water for three or more weeks. This results in a need to purchase expensive water, a tendency to save on the quantity of water used for basic hygenic purposes, and an excessive amount of pollution in the pipes of the distribution network.

The other aspect of the temporal access issue is that of distribution within the house. While 40 liters per capita per day may be adequate if provided continuously, it may not be when provided on an intermittent basis. This is especially true when no proper storage facilities are available, thus resulting in occasional shortages. Many dwelling units in the low income neighbourhoods in Amman depend on 240 liter barrels for storage, rather than overhead tanks.

Not only can frequent shortages be expected to occur, but the fact that these barrels may remain uncovered, and the practice of dipping into them, both create a potential source of contamination. This situation occurs in many dwelling units which are connected to the municipal system by minimal piping, having one tap to fill 2 or 3 barrels when the water is pumped through that portion of the network. The lack of continuity of flow, whether caused by intermittent pumping or by the lack of adequate storage, is a hazard for all the residents of Amman. This is particularly true in the low income areas where both conditions prevail.

### 5.4 Water Use

The limited data which were collected in different areas of Amman indicate that water consumption is of the order of 30-70 lpcd's for low and lower middle income households, 70-110 lpcd's for middle income households, and anywhere between 110 and 300 or more lpcd's for upper income households. It seems that most households consume more than 30 lpcd, and that only the poorest of the poor are consuming between 15 and 30 lpcd's. These are estimated at between 2 and 4 percent of the population, and are characterized by both low income and large household size.

Figure 7 shows per capita water consumption plotted against the percentage of per capita income spent on water supply and wastewater disposal. As expected, those who have to pay more, generally consume less water. Also, those paying the largest proportion of their incomes for water and sewerage, are those who have to purchase water from tankers, and to depend on tankers for emptying their cesspools. The figure shows that there is generally a pattern of increasing water consumption as the price decreases, although the very poorest households may not increase their consumption when they are connected to the lower-cost municipal system, but may rather spend the resulting savings for other purposes. The data also indicate that large households will tend to spend less water per capita per day than do smaller ones, and indeed all of the low lpcd's (less than 30) obtained in the interviews were found in households of 10 or more.

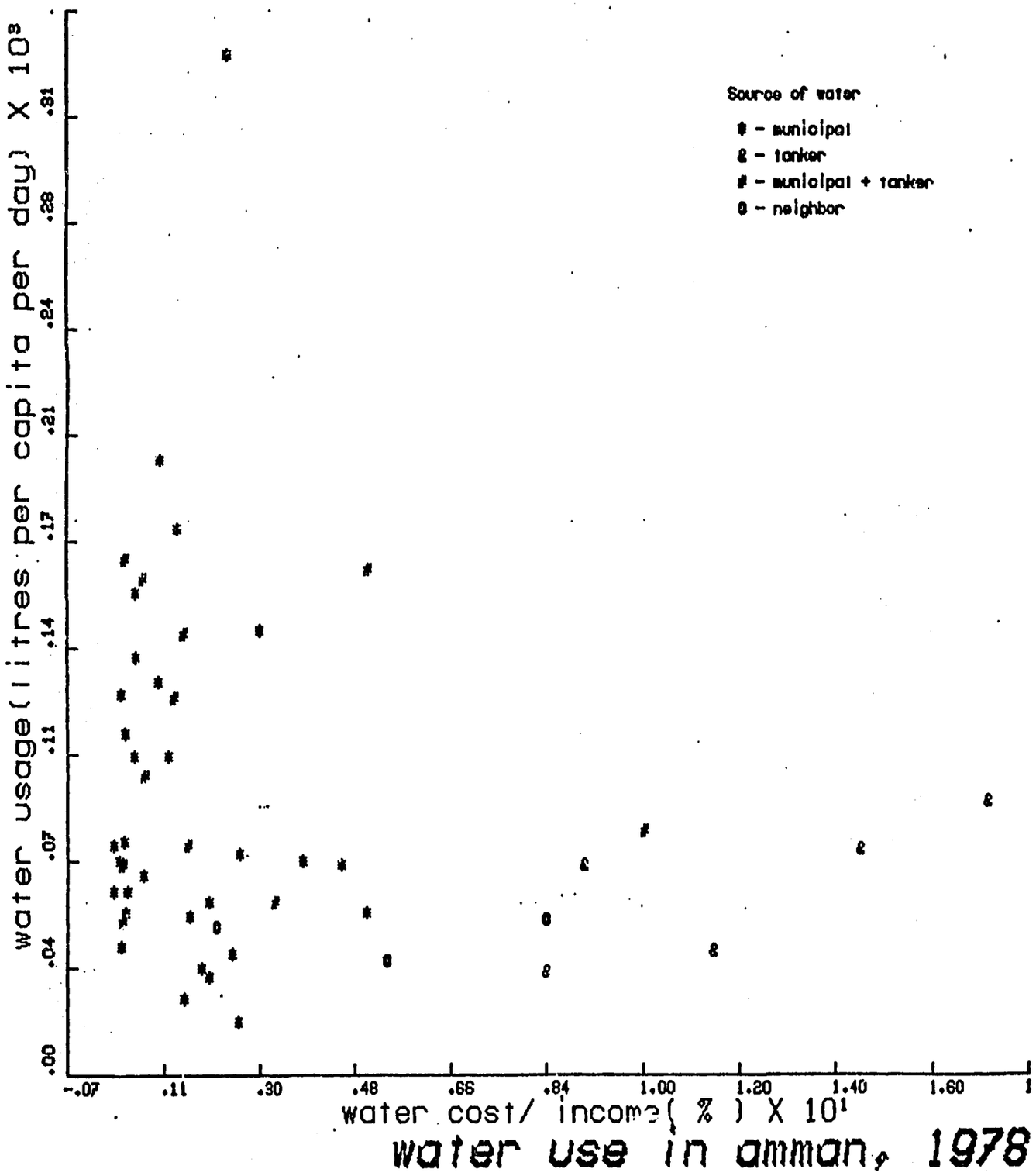

Source of water
* - municipal
& - tanker
# - municipal + tanker
0 - neighbor
water usage(litres per capita per day) X 10³
.00
.04
.07
.11
.14
.17
.21
.24
.28
.31
-.07
.11
.30
.48
.66
.84
1.00
1.20
1.40
1.60
water cost/ income( % ) X 10¹
water use in amman, 1978

FIGURE 7

## 6. Conclusions and Recommendations

There is no question that the proposed improvements and extensions to the Amman Water and Sewerage systems have the potential for providing all the people of Amman with significant benefits. Not least among these benefits are making potable water of good quality available in adequate quantities in the homes of a larger portion of the population, with a resulting decrease in the incidence of water-related diseases, and a reduction in the risks of major outbreaks of epidemics. The replacement of cesspools with a sewerage system will also reduce both aquifer and water pipe contamination, with further positive health impacts. The question is not whether such positive impacts will materialize, but to what extent. A variety of social, economic, environmental, and institutional factors will determine both the extent of the actual materialization of benefits and the distribution of these benefits among different population groups.

The following paragraphs will present some of the major findings of the study, together with recommendations which stem from them. It is believed that the benefits of the proposed investments can be appreciably increased, and that the distribution of these benefits among the beneficiaries can be made more equitable, as more attention is given to the problems discussed below.

### (1) Costs to Unconnected Households

The urban poor in Amman are paying a disproportionate share of their income for water and sewerage service. This is particularly true for those without piped services at the present time, since they have to pay exhorbitant prices for water and sanitation services provided by private entrepreneurs. These households may be paying in excess of 15% of their incomes for water and sewerage. Some of them will still have to pay about 6% of their annual incomes, if they are connected to water only. The high cost of these services has resulted in a black market for water purchased from neighbors. It has also resulted in many situations in which cesspools are drained or pumped illegally into the streets, causing a health hazard.

Recommendations: An effort should be made to regulate the prices being charged by water and sanitation tankers and private well owners, in order to hold them down at the lowest possible limit. Present AWSA charges of 250 fils per cubic meter for water and about 700 fils per cubic meter for sanitation tankers should be about the upper limits for such charges. While AWSA has recently increased the size of their tanker fleet, it is not clear that the present fleet is sufficiently large to accomodate demand during periods of prolonged water shortages. The situation should be carefully monitored, with respect to both water and sanitation tankers, especially since water tankers will be needed until 1990, and perhaps beyond that time on an emergency basis, while sanitation tankers will be definitely needed beyond that time.

### (2) Connection Costs

The cost of connecting to the water and/or sewerage system can be an undue burden on the poor. In spite of the fact that the poor will benefit from t

system through savings in annual water and sewerage costs sometimes reaching JD 60 per household per year, the one-time connection payment which may be as high as JD 200, may be a deterrent to connection. The lowest income groups have to also frequently contend with the minimum-cost water connection which includes a single tap at close to ground level. This will not provide them with the maximum potential benefits of the system, since water will not be continuously available in the tank, and since the usual barrel storage and dipping practices which accompany this minimal connection increase the risks of contamination.

Recommendations: Seriously consider a system allowing the payment of connection costs in monthly installments over a period of 12-18 months, to be collected with the quarterly water bills. Also consider a system of concessionary improvement loans, perhaps through the Housing Corporation, to encourage low income households to install roof tanks and an adequate plumbing system which reduces the risks of contamination and improves both physical and temporal access to water within the household. Consideration should also be given to forcing owners of rented units to provide a roof tank and a plumbing system with 3 or 4 faucets when water is connected to the dwelling unit, and to allow owners who make and pay for water and/or sewer connections to slightly raise old rents by a certain predetermined percentage.

(3) Differences in the level of service

Present plans call for the water system to completely cover the city of Amman by 1990. By 1980, however, coverage will be lowest in some of the poorest areas, at below 50 percent. Some of the lowest-income areas will have less than 30 percent sewerage connections by 1980, according to present plans. Upper and middle income areas are all covered at higher percentages. This is true in spite of the fact that the cost of serving the low income areas is appreciably less per connection (JD 135 per water connection in Qussour, JD 177 in Nazzal) than it is in the upper income areas (JD 247 per water connection in Jabal Amman, JD 291 in Abdoun.) This is due to the higher and increasing densities in these areas. The health benefits accruing to all the residents of Amman from a connection in the low areas, exceed those accruing from a connection in the high-income areas, since the risks of epidemics and water contamination are reduced significantly more by the former, and since appreciably more land per dwelling unit is available for cesspools in the latter. The income redistribution effects of connecting low income households are also significant, as discussed in the first conclusion above. It is, of course, realized that since the present sewerage connection fee structure provides a cross-subsidy between the high and low income areas, that fiscal considerations wil favor connections in high-income areas.

Recommendations: Review the possibility of increasing the number of sewer connections in the Nadif and Mahatta areas, which are included in the 1S contract (1978-81). Conduct a detailed social impact analysis to determine priorities and re-evaluate the allocation of sewerage services to be provided during the following phases of implementation (1981-1990).

(4) Water Conservation, and Tariffs

Amman is a water-short region. Wide variations in water use exist among different parts of the city. In high income areas water consumption is frequently in excess of 200 liters per capita per day, while it is in the 35-60 liters per capita per day in the low-income areas. In order to use present and expected water resources more judiciously, upper income households must be encouraged to conserve water, while lower income households must be educated as to the best mix of end-uses to which they can put the small quantities they can afford to buy. Many low income households using less than 40 liters per capita per day must also be encouraged to raise their consumption for end-uses related to family and personal hygiene. The proposed tariff penalizes excessive water consumption by high income households. It is highly unlikely that pricing alone will result in a significant reduction in water use, since most upper income households spend less than 0.5 percent of their incomes on water and sewers. The new tariff also slightly penalizes very poor and large families who are allowed to purchase only 20 $m^3$ of water per quarter at the lowest block rate of 60 fils/$m^3$. For a family of 10, consumption at this rate is limited to 22 liters per capita per day (lpcd). The previous rate allowed such a family to use 44 lpcd's at the lowest block rate.

Recommendations: Conduct educational programs in the schools and the mass media, which are directed toward the two pronged goals of conservation and judicious use of water. The effectiveness of such programs should be measured by both the reduction in total water consumption and the reduction in the gap in water use between high and low income areas. Educational programs should stress that water is a valuable and scarce water resource, but that a certain amount of it is necessary for clean and healthy living.

Carefully monitor and re-evaluate the impact of the new tariff structure on water consumption, with a view to redesigning this structure, should the results so indicate.

Encourage the use of water-conserving fixtures such as flushing equipment with smaller capacities and fordilla faucet valves.

Continue and strengthen the existing program for detecting and repairing or replacing leaky pipes.

Research the feasibility of more widespread use of cisterns for the collections of rain water from roof tops for single family units, multi-family dwellings and on a communal basis in low income areas.

(5) Urban Growth and Development

Rapid growth and high land values in Amman have resulted in wide-spread land speculation, and concomittant phenomena of leapfrogging and sprawled urban development. This, in turn, creates a situation where water and sewerage become more costly than necessary. This is especially true since no income is derived from land which is located in the vicinity of either network, but is not developed and has no assessed annual rental value.

Recommendation: The sewerage tax, and a similar water tax, should be levied from the owners of undeveloped land which is within the service areas of the networks, even though the land is not developed. If such a tax is made high enough, it will act as a deterrent to leapfrog development patterns and will help reduce the holdings of land speculators.

(6) Slum Clearance

Some of the poorest of the poor in Amman live in dilapidated substandard structures of a temporary nature. These probably represent 2-4% of the population. While serving those areas with a water and sewerage system would marginally improve their situation, their housing needs should be of major concern, especially since poor housing and environmental facilities both inside and outside the house will present a major constraint to their benefiting from water and sewerage networks.

Recommendations: A special effort must be made to identify the poorest of the poor in Amman, and to explore all possible means available for slum clearance and relocation of households residing in the most substandard structures in the city. While a study of the housing needs of the poor is called for, it is recommended that such a study include a pilot, or demonstration project, to rehouse some of the obvious targets of slum clearance. These may include the residents of the Jofeh Camp or the caves.

(7) Water Quality

The King Talal Dam project is projected to be both the source of Amman's potable water, and the ultimate sink for its treated wastes. Other wastes which are dumped into the Seil Zarqa, which flows into King Talal Dam, include those of the rapidly growing industrial areas of Ruseifa and the proposed municipal treatment plant in Zarqa. Not only do the industrial wastes feed into the new water source, but they are increasingly contributing in a significant way to the contamination of Amman's primary sources of water: the aquifers. This is a potentially hazardous situation. As the population of Amman and the industrial activities of the region grow, a positive feedback effect might take place, with a resulting deterioration in the quality of water.

Recommendations: It is imperative that strict quality control and continuous testing of the water leaving King Talal Dam, flowing into it, and flowing at selected points along the Seil Zarqa be conducted. Consideration should be given to the possibility of entrusting a separate agency, such as the Ministry of Health, with the quality control function. The separation of the water production function from that of quality control might provide an additional safeguard in this very important area.

It is also imperative that the question of water pollution in the Seil Zarqa be seriously addressed, and that planning and legislative action be taken to control the location, quantity and quality of effluents being disposed of into the stream.

(8) Environmental Factors

Any health improvements which might be achieved by an improved water and sewerage system, can be wiped out by the existence of other environmental hazards, or by the relaxation of on-going monitoring and control activities and the pursuant actions taken to remedy deteriorating conditions. The environmental balance in Amman is a particularly delicate one, as indicated by the recent sporadic outbreaks of cholera. Through a variety of preventive actions such as tougher enforcement of wastewater dumping laws, educational and media campaigns on water drinking and the disinfection of leafy vegetables and fruits, increased chlorination, and more frequent testing of city water at both the source and the taps, Amman has been able to contain cholera outbreaks and avoid a major disaster. Efforts are also continuing to improve solid waste collection, wastewater dumping practices, and rodent control activities, although open dumping remains the practice in some parts of the city, and rat bites have been reported. The rodent problem is a particularly serious one, since it could wipe out all the benefits obtained through the availability of more plentiful high-quality water, and the sanitary disposal of wastewaters.

Recommendations: Authorities should continue their efforts to enforce sewer connection laws. They should also continue and strengthen their activities in the areas of eliminating open dumps in the city, in rodent control, and in prohibiting the disposal of wastewater into the streets.

Authorities should continue and strengthen their efforts in monitoring the delicate environmental balance in Amman, and in using all possible preventive, educational and law enforcement means available to them for maintaining this balance.

## 7. References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## APPENDICES A AND B

These two Appendices include data obtained from home and office interviews conducted in March, 1978. A sample of 64 households in different parts of Amman was interviewed. It consists of 15 households in the Jabal Amman area, 20 in selected middle and upper income areas and 29 in lower income areas. The sample was not scientifically selected, and thus no claim is made for its statistical significance. It is felt, however, that it is somewhat representative of the socio-economic and water consumption patterns in Amman.

Due to the difficulty in obtaining income figures and the variety of income sources in Amman, incomes given in these tables must be considered as lower bounds. This is particularly true in the upper and middle income areas, where the sample consisted only of salaried employees, and thus excluded those who are self-employed, and who incomes are generally higher.

TABLE A-1

SURVEY DATA FOR RESIDENTS IN JABAL AMMAN

| House-Hold No. | No. of Rooms | No. of Faucets | No. of Residents | Rent[1] | Own[2] | No. of Workers | Total Annual Income (JD) | Source of Water[3] | Water Storage[4] | Waste-Water Disposal[5] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 4 | 13 | 3 | -- | X | 1 | 2220 | M + T | R | S |
| 2. | 5 | 1 | 4 | 100 | -- | 1 | -- | M | R | C |
| 3. | 8 | 8 | 6 | -- | X | 3 | -- | M | R | S |
| 4. | 3 | - | 2 | 25 | 1 | 1 | 1800 | M | R | S |
| 5. | 3 | - | 4 | -- | 150 | 1 | 420 | M | R | S |
| 6. | 4 | 5 | 5 | X | -- | 3 | 11500 | M + T | R | S |
| 7. | 6 | 4 | 7 | -- | X | 3 | 14760 | M | R | C |
| 8. | 2 | 4 | 1 | -- | X | 1 | 3240 | M | R | S |
| 9. | 4 | 8 | 8 | -- | 37 | 4 | 5940 | M | R | S |
| 10. | 4 | 5 | 6 | 10 | -- | 1 | 1340 | M | R | S |
| 11. | 5 | 5 | 12 | -- | X | 3 | 1440 | M | R | S |
| 12. | 2 | 5 | 6 | 11 | -- | 2 | 1800 | M | B + G | S |
| 13. | 4 | 4 | 4 | -- | 105 | 1 | 2760 | M | C | S |
| 14. | 4 | 5 | 4 | 72 | -- | 1 | 4800 | M + T | R | S |
| 15. | 6 | 6 | 8 | 200 | -- | 2 | 6600 | M + T | R | S |

[1]For renters, the monthly rent is given in Jordanian Dinars. An (X) indicates that the monthly rent has not been reported.

[2]For owners, the annual property tax is given in Jordanian Dinars. An (X) indicates that the annual property tax has not been reported.

[3]Sources of Water: M = Municipal; T = Tanker; N = Neighbors.

[4]Water Storage: R = Roof Tank; B = Barrels; G = Ground Tank.

[5]Wastewater Disposal: S = Sewerage; C = Cesspool.

TABLE A-2

SURVEY DATA FOR RESIDENTS OF LOW INCOME AREAS

| Household No. | Location | No. of Rooms | No. of Faucets | No. of Residents | Rent[1] | Own[2] | No. of Workers | Total Annual Income (JD) | Source of Water[3] | Water[4] Storage | Waste[5] water Disposal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Office Interviews | | | | | | | | | | |
| 1. | Alia Area | 2 | 1 | 8 | -- | X | 1 | 570 | T | G | C |
| 2. | Tadj | 1 | 1 | 1 | 25 | -- | 1 | 1260 | M | R | S |
| 3. | Nazzal | 3 | 5 | 3 | -- | 25 | 1 | 1260 | T | R | C |
| 4. | Nasr | 4 | 10 | 7 | -- | 58 | 1 | 1140 | M + T | G | C |
| 5. | Qala'ah | 2 | 4 | 5 | 12 | -- | 1 | 1020 | M | G | C |
| 6. | Ashrafiyah | 4 | 2 | 6 | -- | 38 | 1 | 1680 | M + T | R | S |
| 7. | Tadj | 2 | 4 | 14 | -- | 60 | 1 | 600 | M | G | S |
| 8. | Ashrafiyah | 2 | 2 | 12 | -- | X | 1 | 650 | M | G | S |
| 9. | Ashrafiyah | 3 | 2 | 1 | 16 | -- | 1 | 1900 | M | B | S |
| 10. | Nazzal | 1 | 1 | 1 | 15 | -- | 1 | 480 | M | B | C |
| 11. | Nuzha | 3 | 6 | 13 | -- | X | 5 | 5040 | M | R | C |
| 12. | Nazzal | 3 | 5 | 5 | 30 | -- | 1 | 4320 | M + T | R + G | C |
| 13. | Qala'ah | 2 | 2 | 6 | -- | 14 | 1 | 780 | M | R | S |
| 14. | Ashrafiyah | 5 | 4 | 6 | -- | 12 | 1 | 1320 | M | R | S |
| 15. | Wadi El-Sir | 10 | 10 | 8 | -- | X | 5 | 4500 | M | R | C |
| 16. | City Center | 4 | 4 | 8 | -- | 15 | 5 | 4520 | M | R | S |
| 17. | Nazzal | 9 | 4 | 9 | -- | 10 | 1 | 600 | T | R + G | C |
| 18. | Wahdat | 3 | 6 | 9 | -- | X | 1 | 600 | M + T | G | C |
| 19. | Hashimi | 3 | 6 | 10 | -- | 35 | 1 | 640 | M | R + G | C |
| | Home Interviews | | | | | | | | | | |
| 20. | Sha'lieh | 3 | 0 | 6 | -- | X | 0 | 970 | T | G | C |
| 21. | Sha'lieh | 3 | 0 | 7 | 25 | -- | 2 | 1100 | N | B | C |
| 22. | Sha'lieh | 1 | 0 | 2 | 6 | -- | 1 | 1050 | N | B | C |
| 23. | Wahdat | 4 | 3 | 12 | -- | X | 1 | 2000 | M | R + G | C |
| 24. | Wahdat | 5 | 3 | 23 | -- | X | 3 | 6000 | M + T | R + B | C |
| 25. | Wahdat | 2 | 0 | 8 | -- | X | 2 | 1200 | N | B | C |
| 26. | Qal'ah | 1 | 2 | 10 | 7.50 | -- | 1 | 600 | M | R + B | C |
| 27. | Jofeh | 2 | 2 | 4 | -- | X | 1 | 500 | M | R | C |
| 28. | Nazzal | 8 | 4 | 20 | -- | X | 2 | 1200 | T | G | C |
| 29. | Webdeh | 2 | 6 | 10 | -- | X | 1 | 1150 | M | R | S |

For footnotes see Table A-1

TABLE A-3

SURVEY DATA FOR RESIDENTS IN SELECTED MIDDLE AND UPPER INCOME AREAS

| Household No. | Location | No. of rooms | No. of faucets | No. of Residents | Rent[1] | Own[2] | No. of workers | Total Annual Income (JD) | Source of Water[3] | Water[4] Storage | Wastewater[5] Disposal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Hussein | 3 | 6 | 5 | X | -- | 1 | 3000 | M | R | S |
| 2. | " | 5 | 5 | 5 | 25 | -- | 2 | 1200 | M + N | R + B | S |
| 3. | " | 4 | 5 | 5 | 40 | -- | 1 | 7200 | M + T | R + G | S |
| 4. | " | 4 | -- | 4 | -- | 35 | 2 | 1500 | M | R | S |
| 5. | " | 4 | 5 | 7 | -- | X | 4 | 7400 | M | R + B | S |
| 6. | " | 3 | 4 | 3 | 11 | -- | 2 | 1920 | M | R | S |
| 7. | " | 2 | 4 | 5 | 13 | -- | 2 | 2400 | M + T | R | S |
| 8. | " | 3 | 1 | 7 | 25 | -- | 1 | 4800 | M + T | R | S |
| 9. | " | 3 | 4 | 5 | 25 | -- | 1 | 3600 | M | R | S |
| 10. | Shmeisani | 5 | 8 | 3 | 120 | -- | 1 | -- | M | B + G | C |
| 11. | " | 4 | 10 | 4 | 150 | -- | 2 | 4680 | M + T | R | C |
| 12. | " | 3 | 7 | 9 | -- | 90 | 4 | 1440 | M + T | G | C |
| 13. | " | 4 | 4 | 3 | 84 | -- | 1 | 4200 | M | R | S |
| 14. | Weibdeh | 3 | 5 | 1 | 85 | -- | 1 | 6000 | M | R | C |
| 15. | " | 3 | 5 | 6 | 12 | -- | 3 | 2004 | M | G | S |
| 16. | " | 6 | 3 | 4 | 35 | -- | 2 | 5900 | M | R | C |
| 17. | " | 1 | 1 | 8 | 8 | -- | 1 | 600 | M | B | C |
| 18. | " | 4 | -- | 6 | 25 | -- | 1 | 1800 | M | R | S |
| 19. | " | 2 | 3 | 4 | -- | 50 | 1 | 2400 | M | R | S |
| 20. | Hussein | 5 | 11 | 4 | 30 | -- | 2 | 4020 | M + T | B | S |

For footnotes see Table A-1

TABLE B-1

REDUCED DATA FOR RESIDENT OF JABAL AMMAN

| House-hold No. | Per Capita Income/ Year (JD) | Persons/ Room | Water Consumption (lpcd) | Cost of[1] Water/ Yr. (JD) | Cost of Sewerage/ Year (JD) | Total Cost/Year (JD) | Water + Sewerage Cost as percent of House-hold Income |
|---|---|---|---|---|---|---|---|
| 1. | 1073 | 0.75 | 145 | 18 | -- | 18 | 0.81 |
| 2. | -- | 0.80 | 230 | -- | -- | -- | -- |
| 3. | -- | 0.75 | -- | -- | -- | -- | -- |
| 4. | 900 | 0.60 | 122 | 8 | -- | 8 | 0.4 |
| 5. | 105 | 1.30 | 300 | 48 | -- | 48 | 11.4 |
| 6. | 2304 | 1.25 | 151 | 28 | -- | 28 | 0.2 |
| 7. | 2108 | 1.16 | 53 | 8 | -- | 8 | 0.0 |
| 8. | 3240 | 0.50 | 67 | 2 | -- | 2 | 0.0 |
| 9. | 742 | 2.00 | 93 | 24 | -- | 24 | 0.4 |
| 10. | 224 | 1.50 | 32 | 4 | -- | 4 | 0.3 |
| 11. | 36 | 2.40 | 51 | 22 | -- | 22 | 1.5 |
| 12. | 300 | 3.00 | 145 | 28 | -- | 28 | 1.5 |
| 13. | 690 | 1.00 | 92 | 12 | -- | 12 | 0.6 |
| 14. | 1200 | 1.00 | 139 | 18 | -- | 18 | 0.4 |
| 15. | 832 | 1.30 | 200 | 62 | -- | 182 | 2.7 |

[1] In cases where the residence is connected to the sewerage system, the cost of water given in this column includes the sewerage surcharge of 30 fils/$m^3$ (expected to increase to 35 fils/$m^3$)

TABLE B-2

REDUCED DATA FOR RESIDENTS OF POOR AREAS

| Household No. | Location | Per Capita Income/ Year (JD) | Persons/ Room | Water Consumption (lpcd) | Cost of[1] Water/ Yr. (JD) | Cost of Sewerage/ year (JD) | Total Cost/Year (JD) | Water + Sewerage Cost as percent of Household Income |
|---|---|---|---|---|---|---|---|---|
| | Office Interviews | | | | | | | |
| 1. | Alia Area | 70 | 4.00 | 36 | 58.5 | -- | 58.5 | 10.3 |
| 2. | Tadj | 1260 | 1.00 | 100 | 3.2 | -- | 3.2 | 0.5 |
| 3. | Nazzal | 420 | 1.00 | 66 | 90.0 | 72.0 | 162.0 | 12.8 |
| 4. | Nasr | 162 | 1.75 | -- | -- | -- | -- | -- |
| 5. | Qala'ah | 204 | 2.50 | 93 | 10.0 | -- | 10.0 | .8 |
| 6. | Ashrafiyah | 280 | 1.50 | 67 | -- | -- | 19.0 | 1.13 |
| 7. | Tadj | 42 | 7.00 | 28 | 10.0 | -- | 10.0 | 1.7 |
| 8. | Ashrafiyah | 54 | 6.00 | 22 | 8.0 | -- | 8.0 | 1.3 |
| 9. | Ashrafiyah | 1896 | 0.30 | 111 | 3.6 | -- | 3.6 | 0.18 |
| 10. | Nazzal | 480 | 1.00 | 180 | 4.0 | -- | 4.0 | 0.8 |
| 11. | Nuzha | 387 | 2.10 | 50 | 14.0 | 70.0 | 84.0 | 1.66 |
| 12. | Nazzal | 864 | 1.00 | 129 | 54.0 | -- | 54.0 | 1.2 |
| 13. | Qala'ah | 130 | 3.00 | 130 | 20.0 | -- | 20.0 | 2.6 |
| 14. | Ashrafiyah | 220 | 1.50 | 62 | 44.0 | -- | 44.0 | 0.3 |
| 15. | Wadi El-Sir | 562 | 0.80 | 115 | 20.0 | 16.0 | 36.0 | 0.8 |
| 16. | City Center | 615 | 2.00 | 47 | 12.0 | -- | 12.0 | 0.24 |
| 17. | Nazzal | 66 | 2.25 | 80 | 90.0 | -- | 90.0 | 15 |
| 18. | Wahdat | 66 | 1.50 | 71 | 27.0 | 28.0 | 55.0 | 9.16 |
| 19. | Hashimi | 63 | 1.60 | 64 | 14.0 | -- | 14.0 | 2.20 |
| | Home Interviews | | | | | | | |
| 21. | Sha'lieh | 162 | 2.00 | 61 | 72.0 | 7.0 | 79.0 | 8.1 |
| 21. | Sha'lieh | 159 | 2.30 | 33 | 46.0 | 7.0 | 53.0 | 4.2 |
| 22. | Sha'lieh | 525 | 2.00 | 43 | 15.0 | 4.0 | 19.0 | 1.8 |
| 23. | Wahdat | 166 | 3.00 | 31 | 7.0 | 24.0 | 31.0 | 1.5 |
| 24. | Wahdat | 264 | 4.60 | 50 | 100.0 | 72.0 | 172.0 | 8.6 |
| 25. | Wahdat | 150 | 4.00 | 45 | 90.0 | -- | 90.0 | 7.5 |
| 26. | Qala'ah | 55 | 10.00 | 15 | 12.0 | -- | 12.0 | 2.0 |
| 27. | Jofeh | 125 | 2.00 | 47 | 12.0 | 10.0 | 22.0 | 4.4 |
| 28. | Nazzal | 60 | 2.50 | 30 | 90.0 | -- | 90.0 | 7.5 |
| 29. | Webdeh | 115 | 5.00 | 35 | 24.0 | -- | 24.0 | 2.1 |

[1] In cases where the residence is connected to the sewerage system, the cost of water given in this column including the sewerage surcharge of 30 fils/$m^3$ (expected to increase to 35 fils/$m^3$).

TABLE B-3

REDUCED DATA FOR RESIDENTS OF SELECTED MIDDLE AND UPPER INCOME AREA

| House-hold No. | Per Capita Income/ Year (JD) | Persons per Room | Water Consumption (lpcd) | Cost of[1] Water/ Yr (JD) | Cost of Sewerage/ year (JD) | Total Cost/Year (JD) | Water + Sewerage Cost as percent of Household Income |
|---|---|---|---|---|---|---|---|
| 1. | 600 | 1.60 | 53 | 8.8 | -- | 8.8 | 0.29 |
| 2. | 240 | 1.00 | -- | -- | -- | -- | -- |
| 3. | 1440 | 1.25 | -- | -- | -- | -- | -- |
| 4. | 375 | 1.00 | -- | -- | -- | -- | -- |
| 5. | 1057 | 1.75 | 141 | 32.0 | -- | 32.0 | 0.4 |
| 6. | 640 | 1.00 | 37 | 3.6 | -- | 3.6 | 0.18 |
| 7. | 480 | 2.50 | 87 | 14.0 | -- | 14.0 | 0.58 |
| 8. | 685 | 2.30 | 44 | 10.0 | -- | 10.0 | 0.20 |
| 9. | 720 | 1.60 | 68 | 8.0 | -- | 8.0 | 0.22 |
| 10. | -- | 0.60 | 170 | 12.0 | -- | 12.0 | -- |
| 11. | 1170 | 1.00 | 110 | 27.4 | 305.0 | 51.4 | 1.09 |
| 12. | 160 | 3.00 | 148 | 64.0 | -- | 64.0 | 4.4 |
| 13. | 1400 | 0.75 | 62 | 6.0 | -- | 6.0 | 0.14 |
| 14. | 6000 | 0.50 | -- | -- | -- | -- | -- |
| 15. | 334 | 2.00 | 61 | 8.0 | 72.0 | 80.0 | 3.9 |
| 16. | 1476 | 0.60 | 160 | 68.0 | -- | 68.0 | 1.15 |
| 17. | 75 | 8.00 | 46 | 8.0 | -- | 8.0 | 1.3 |
| 18. | 300 | 1.50 | 58 | 10.0 | -- | 10.0 | 0.5 |
| 19. | 600 | 2.00 | 300 | 48.0 | -- | 48.0 | 2.00 |
| 20. | 1005 | 0.80 | 61 | 8.0 | -- | 8.0 | 0.19 |

[1] In cases where the residence is connected to the sewerage system, the cost of water given in this column includes the sewerage surcharge of 30 fils/$m^3$ (expected to increase to 35 fils/$m^3$).