Prime Ministry
The Hashemite Kingdom of Jordan

The Study of the Benefits to the Poor of Millennium Challenge Corporation Financed Projects in the Water Sector

SECOND DRAFT DIAGONISTIC REPORT

SUBMITTED TO:

MILLENNIUM CHALLENGE ACCOUNT JORDAN

BY

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Contents

List of Abbreviations

DOS	Department of Statistics
GDP	Gross Domestic Product
GIS	Geographical Information System
GoJ	Government of Jordan
HELI	Health and Environment Linkages Initiative
HHLDS	Households
JVA	Jordan Valley Authority
l/cap/day	Liter per Capita per day
MCA-J	Millennium Challenge Account - Jordan
MCC	Millennium Challenge Corporation
MENA	Middle East and North Africa
MWI	Ministry of Water and Irrigation
NRW	Non Revenue Water
O&M	Operation and Maintenance
PIZ	Priority Investment Zone
PMU	Programme management Unit
RFP	Request for Proposal
SAC	Study Advisory Committee
UFW	Unaccounted for Water
UNDP	United Nations Development Programme
WAJ	Water Authority of Jordan
WHO	World Health Organization
WSAU	Water Sector Audit Unit

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Introduction

1. In February 2009, MCA-J developed a Concept Paper assessment that proposed to the Government of Jordan four projects to achieve these objectives. MCA-J is targeting investments in the water sector to increase water availability for municipal use through lowering non-revenue water losses and freeing fresh water used by agriculture through substituting it by treated wastewater. However, it is of high importance for Government of Jordan and the Millennium Challenge Corporation (MCC) to ensure that this additional water supply will be reaching the poor (under consumers) to maximize benefits and to implement the feasible potential intervention in a cost effective manner.
2. A summary of the four proposed projects are listed below:

No.	Project Activity	Objective
1	Zarqa Governorate Water System Restructuring and Rehabilitation	To convert the existing pumping supply in major areas in Zarqa government into gravity feed by separation of distribution pipes from transmission pipes, replacing aging distribution and tertiary systems up to water meters and increasing storage capacity of reservoirs which will reduce NRW from 54% to 25%, reduce pumping cost and increase per capita consumption from 56 lpcd to 93 lpcd.
2	Zarqa Governorate Wastewater System Reinforcement and Expansion	To extend the coverage of the wastewater system in Zarqa Governorate to areas not currently served and increase the collection capacity of the main conveyors and trunk mains to serve until the year 2025 which will solve health and environmental problems and increase the connection rate from 72% to 90%.
3	Expansion of Zarqa Governorate Wastewater treatment capacity	To accommodate additional wastewater flows from Zarqa Governorate until the year 2025 by expanding the AS-Samra WWTP plus construction of conveyor lines through the negotiation with SPC/BOT company.
4	Zarqa Governorate Wells Rehabilitation	The project includes wells rehabilitation components and investment program for Zarqa and Azraq basins.

Study Objectives

3. The Study of the Benefits to the Poor of Millennium Challenge Corporation Financed Projects in the Water Sector has three principal objectives:

    - **Objective 1** – Distribution of Potential Benefits: Quantify the share of benefits arising from the MCC investments accruing to poor households and in particular to the poor on average consuming at or less than 50 liters per capita per day of water in total from network sources. Equivalently, validate the extent to which the current state of the water distribution infrastructure, its management and performance contribute to avoidable cost burdens upon the poor and to the under-consumption of water having health, medical expenditure and work-related consequences.
    - **Objective 2** – Cost Effectiveness and Feasibility of Potential Interventions: Estimate the cost effectiveness of possible interventions (initially proposed in Table 1 andin the Inception Report and elaborated and revised in Section 6) that might enhance the share of benefits accruing to the poor and under-consuming households from increases in urban water supplies and provide assessments of the efficacy of each. Based on cost-effectiveness and feasibility, present a recommended course of action for the implementation of interventions possibly to complement MCC-financed investments in urban water infrastructure.
    - **Objective 3** – The preparation of an investment proposal that presents a strategy to implement one identified recommendation for enhancing the relevance of selected improvements in urban water infrastructure to poor households and that would be suitable for consideration by MCC as part of the prospective Compact with Jordan. The prepared project must have GoJ support confirmed through MCA-J. The cost-effectiveness of the project must be objectively and readily verifiable. The project should take into account gender and/or other relevant social dimensions associated with water

consumption and household hygiene and sanitation. The project would also need to satisfy MCC requirements governing the suitability for investment.

Study Approach

4. To achieve the study objectives, the study team has compiled relevant data sets from different sources, assessed data for completeness and accuracy, cleaned up data and filled in the gaps, and designed the sample/questionnaire with MCA-J and MCC to be collected and analyzed by the Dept. of Statistics of Jordan (DOS).

5. These data sets were analyzed to understand:

    i. Water supply distribution among different governorates and supply zones and the underlying factors for the distribution
    ii. Water distribution among various use categories in Zarqa Governorate
    iii. Under consumption patterns, reasons, relationship with poverty status and poverty areas
    iv. Under consumption geographic distribution and relationship with network status and conditions
    v. The key factors that characterize the distribution of benefits to the under-consumers and to the under-consumers poor.
    vi. The potential benefits of interventions including those targeting the poor and the under-consumers.
    vii. The applicable costs of the interventions including management, infrastructure, systems, and operational improvements.

6. The approaches and tools used for analysis:

    - ✓ Correlation analysis at different levels of the system consumption factors
    - ✓ GIS mapping of consumption, network conditions, and poverty distribution
    - ✓ Feasibility analysis and cost effectiveness
    - ✓ Statistical analysis (exploratory approach and a formal demand model for multiple products using the Almost Ideal Demand System (AIDS) approach)

Overview of Water Supply and Consumption in Jordan

7. To understand allocation of additional water supply and the factors that affect this allocation, it is essential to examine the historic distribution of bulk water supply and analyze the factors affecting supply distribution. Data gathered from WAJ for the years 2001 – 2008 show that the lowest growth in water supply was in Northern governorates which also had the lowest per capita water supply. Aqaba and Mafraq witnessed highest

per capita water supply in 2008 of 341 and 186 lpcd respectively. The middle governorates had witnessed almost the largest growth per capita water supply although they have significantly higher per capita water supply than the northern governorates (excluding Mafraq).

8. Having a closer look at the Middle Governorates, it is noted that Amman and Balqa had larger per capita water supply than Zarqa and Madaba along over 2001-2008. The supply gap per capita widened in the years 2003 – 2006 when new supplies were brought into operation including Abu Ezeighan brackish groundwater desalination and the expansion of Zai water treatment plant. Operating these new supplies in 2003 and 2004 led to an increase in Amman and Balqa per capita water supply, while it almost remained constant for Zarqa and Madaba. However, it is noted that when additional substantial supplies put into operations i.e. Zara Ma'in project, water supplies were allocated to the other Middle Governorates (Madaba and Zarqa).

9. It is clear that Middle governorates and particularly Amman has been given the priority in developing new supplies and/or allocating existing supplies. It is only in 2006, existing supplies were allocated to Zarqa, when a substantial increase in water supply from Zara Ma'in system became available. The correlation analysis between wealth and water supply allocation, support this argument.

10. Unlike supply, analysis of billing and consumption is more complex, given the multiple factors that come into play including physical and administration water losses, accuracy of readings, metering and billing accuracy. For example, per capita water billing in Mafraq and Madaba has witnessed significant hikes, despite modest supply increases in Madaba and almost constant supplies in Mafraq.

11. In the Middle governorates, Amman the highest per capita billed water in 2008. In fact, Amman recorded the highest increase in per capita water billed over 2001-2008 although it had nearly similar increase in per capita water supply to the other middle governorates, due to noticeable reductions in NRW. Unlike Amman, Balqa governorate witnessed an increase in NRW and therefore, the 21% supply increase only provided 9% increase in billing. In general, the NRW ratios for all middle governorates except for Amman are above overall Jordan average.

12. It is evident that increases in water supply led to increases in water billing/consumption. There is strong positive relation between the increase in the water supply per capita and the increase in residential water consumption particularly in the Middle Governorates.

Zarqa Water Distribution

13. Comparing the water supplies and water billing in 2004, and 2008, it is shown that the considerable increase in supplies from 37.4 MCM to 44.8 MCM only added 2 MCM to Zarqa billing. The inability of the utility to reduce the NRW, improve operations, and deliver the supplies to the consumers may have affected the supply allocation directions at WAJ.

14. The increase in water supply historically led to a moderate and significant increase in the residential water consumption. However, the per capita residential billing in Zarqa was not affected by the increases in water supplies. The correlation analysis shows that there is no increase on the residential billed water as a result of water supply increase. The correlation result is neutral with almost a zero correlation factor.

15. Analysis of data at the zone level in Zarqa is problematic due to lack of supply data at the zone level, and therefore it was not possible to perform analysis on water supply to poor zones in Zarqa governorate. The analysis of water under-consumption in different zones in underway, and will be discussed once completed.

Under-consumption Analysis – Econometric Modelling

16. A general set of factors were identified which identify households according to socioeconomic characteristics and were likely to affect household water consumption. Each of these factors was considered for inclusion in the new household survey. These factors include: water price from different sources, supply frequency and duration of the public system, household storage capacity, water quality, household income and expenditure, number of household members, and household facilities.

17. A household survey was undertaken to obtain household specific data that could also be tied directly to metered household consumption, and quarterly WAJ meter data for those households in the survey that were connected to the public system were obtained for the years 2001 through the second quarter of 2009.

18. Initial examination of the household data indicated several characteristics that differed from other data sets. First, approximately 39% of the households reported sharing a meter with one or more other households, while WAJ data suggests that fewer than 25% share meters. Using the World Bank estimate of household income below which a household is considered "poor" (550 JOD per capita per week), the survey responses indicated approximately 43% of the households were "poor" while the DoS estimates about 15% of households are "poor," as defined by an index of assets and characteristics but not including income. Other characteristics, such as size of the household, appeared to be consistent with the other data sets.

19. Two types of statistical analyses were performed: the first was an exploratory approach to identify variables that were highly correlated to avoid any unnecessary problems with multicolinearity, to examine factors affecting total water consumption and under-consumption. Under-consumption has been defined as consumption less than 50 liters per capita per day (lcd). In addition, the data were separated into poor households and the exploratory analyses were completed on that sub-sample. The second approach was to develop a formal demand model for multiple products using the Almost Ideal Demand System (AIDS) approach first developed by Deaton and Muellbauer (1980) and used in many studies since. The data required two modifications of the approach. First, public water pricing is based on block pricing (different prices apply to different levels of consumption). Unfortunately, the marginal price (per unit price) for the lowest block is zero (there is only a connect charge). Thus, an average price for each consumer had to be used. Secondly, the questions about various quality parameters for water were collected only for water from the public system, so that households that were not connected to the public system could not provide responses to those questions, and only the 1177 "connected" households could be used in the analyses.

20. The results of the exploratory analyses suggest the following:

    - The most consistent variables in terms of increasing water consumption and household welfare appear to be assuring that all households have their own meter and that household perception of potability is improved.

- Household size, the existence of a garden and the amount of storage capacity available to the household consistently are significantly positively related to household total consumption, and sharing a meter is negatively related to consumption.
- Household storage capacity appears to be significant and positively related to consumption levels for the larger sample but not for the poor or under-consuming.
- Household size appears to be positively related to total consumption, but also positively related to under-consumption (the larger the household, the more likely it is that they will under-consume) for the entire sample. For the poor households, household size appears to be relatively significantly negatively related to consumption levels. For the under-consuming and poor and under-consuming households, household size is again positively related to consumption levels.
- Probability of reporting an illness is significantly and negatively related to households' perception of potability for all cases. Number of children is positively related to the probability of reporting an illness and negatively related to medicat expenditures for most cases, while household income is negatively related to the probability of reporting an illness and positively related to medical expenditures for the whole sample, but those variables become less and less significant as the subsamples are analyzed.
- As expected, the socioeconomic variables collected in the survey are highly correlated, and should not be used in statistical analyses without consideration of colinearity.

21. The AIDS model is designed to test the factors which affect household consumption from each of four sources: the public source, tanker water, water treatment center water, and bottled water. The model generates a set of linear coefficients that relate prices of water from the various sources to consumption from each of those sources (own price demand functions), with other variables serving as demand function "shifters." The results from the AIDS models for the total sample, the poor, the under-consuming, and the poor and under-consuming households are similar. The general conclusions from those results are as follows:

- The probability of consuming publicly supplied water increases with the hours of availability of the public system whereas the probability of consuming tanker water decreases as availability increases. Note the difference between the results from the exploratory models and the AIDS model with respect to hours of availability. The AIDS model suggests that tanker water will decrease while public water (using the expenditure from the tanker water) will increase substantially.
- The probability of consuming bottled water increases if the household has experienced an illness believed to be caused by publicly supplied water.
- As the potability of water delivered by the public system increases, households are less likely to purchase water from treatment shops.
- The share of expenditures allocated to water purchased from the public system will increase as hours of service increases, whereas the share of water purchased from tankers will decrease as hours of service of the public system increases. Given the relatively low price of public water in comparison to the price of tanker water, increasing hours of availability of the public system will increase the total quantity of water consumed by households.
- The share of water purchased from water shops and bottled water sources increases if the household has experienced a water-borne illness from consumption of publicly supplied water.

22. Water storage is not significant in the AIDS models, as opposed to the exploratory models. However, storage capacity is highly positively correlated with hours of availability and household size, and negatively related to sharing meters. This suggests that storage capacity is likely a dependent (endogenous) variable rather than an independent (exogenous) one which was the mode required for the AIDS approach.

23. Benefits analyses were completed for each solution to the AIDS model, using Excel files. Assumptions were made regarding changes in (1) hours of availability; (2) incidence of water-related illnesses; and (3) potability as a measure of the household's assessment of water quality. In addition, an analysis of the elasticity of demand of rich households (incomes greater than 1,050 JOD per capita per year) for public water.

24. Benefit calculation for given assumptions for the entire sample, the poor and the under-consuming poor are listed in the following tables:

Table ES1. Estimated benefits resulting from MCC project affects (entire population using per capita storage capacity)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	475,000	3,751,000
Increase availability, reduce illnesses to 0	2,430,000	19,186,000
Increase water availability, reduce illness, improve potability rating to 4	6,074,000	47,961,000
Increase availability to continuous flow, reduce illness and increase potability	6,973,000	55,057,000

Table ES2. Estimated benefits to poor households resulting from MCC project affects (using per capita storage capacity)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	191,500	1,512,000
Increase availability, reduce illnesses to 0	1,035,300	8,174,600
Increase water availability, reduce illness, improve potability rating to 4	2,500,400	19,742,200
Increase availability to continuous flow, reduce illness and increase potability	2,947,700	23,484,200

Table ES3. Estimated benefits to households consuming less that 50 lcd from the public system (using per capita storage capacity)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	185,150	1,462,000
Increase availability, reduce illnesses to 0	1,098,000	8,671,000
Increase water availability, reduce illness, improve potability rating to 4	2,728,000	21,542,000
Increase availability to continuous flow, reduce illness and increase potability	3,073,000	24,266,000

Table ES4. Estimated benefits to poor households consuming less than 50 lcd from the public system (using per capita storage capacity)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	214,000	1,690,000
Increase availability, reduce illnesses to 0	559,000	4,411,000
Increase water availability, reduce illness, improve potability rating to 4	1,151,000	9,086,000
Increase availability to continuous flow, reduce illness and increase potability	1,539,000	12,151,000

25. The most beneficial interventions will be those that (1) reduce the incidence of water-born illness, (2) increase the potability of water from the public system, and (3) increase the hours of availability of public water. While we are unable to determine these changes due to specific interventions, since we lack the engineering data, the assumptions we have made give a range of potential benefits to the various groups of households of interest.

Priority Investment Zones

26. As clearly indicated above, the interventions that support services improvements (duration and frequency) will have the highest benefits on the targeted zones. However, reducing the NRW through focusing on leakage reduction and rehabilitation of the tertiary will provide more supplies, and eventually improve services and make water available to targeted zones through operational management.

27. Due to data limitations (network data and age, NRW, water and wastewater lengths, etc), it was decided to use only the income level, population density, and water and wastewater complaints as a criteria to determine the priority investment zones.

28. Several scenarios were examined to prioritize the zones. The table below show the weights applied for different scenarios:

Scenario No	Weight value		
	Poverty	Complaints	Population
I	5	4	3
II	3	5	2
III	5	5	2
IV	2	5	2
V	2	5	4
VI	2	5	3

29. The analysis of the Priority investment zones show that about 20 zones come in as high priority regardless of the weights allocated for each criteria, and that all of them are located in Zarqa and Russaifeh. These zones are characterized by high population density, medium to high poverty, and poor infrastructure leading to high complaints. Many other zones located in Zarqa and Russaifeh did not come out as high priority, given that they have high income levels, low population density in these new areas, and acceptable conditions of network.

30. Water and wastewater priority investment zones presented in Table 49 and Table 50 respectively are recommended to be considered by the feasibility and design consultant.

31. The team working on the water network feasibility and design study has to identify further criteria to address more accurately the water networks condition such as the pipeline type, age of the network, pipeline sizing, water gravity distribution verses water pressurized distribution, etc.

32. Zones that do not have wastewater service are required further investigation by the Consultant carrying out the wastewater network feasibility and design study, where expanding wastewater service is considered a priority but cost effectiveness of the expansion should be assessed in compassion to other investment options.

Interventions Analysis

33. A set of policy, management and operation, infrastructure investments, and household infrastructure interventions were examined throughout the study. These interventions were analyzed according to a set of criteria to develop the interventions short-list.

34. The screening criteria included: a. addressing a key factor of under-consumption, intervention cost reflecting the technical and management complexity of the intervention, the ability of intervention to improve the operation and service level of the utility, the political and social constraints that will affect implementation, and whether the intervention is being considered by the government, donors and other groups.

35. The short-listed interventions are:

    I. **Improved water utility operational systems** - including improved information system and modelling for rationing schedule and setting pumping pressure, implementation of assets management system, capacity building and certification program for utility operators, and meters replacements.

    II. **Splitting the households that are connected to one shared meter** to reduce water payments, and consequently increase public system use.

    III. **Awareness program on water issues, water potability of available supplies, and participation in reducing leakages** through filing complaints with the utility.

    IV. **Restructuring water tariff** to achieve O&M cost recovery and keep cross-subsidy to benefit the poor.

V. **<u>Improving water storage to address quality and quantity issues</u>**, and rehabilitation of plumping systems of poor households.

VI. **<u>Geographically targeting the network rehabilitation and zoning</u>** in poor areas.

36. In discussion with the MCA-J and the MCC, it was agreed to conduct the cost effectiveness analysis for interventions 1 and 2 above. As these interventions are considered or will be considered by the planned initiatives of the management contract preparation and the World Bank study "Jordan Water and Wastewater Output-Based Aid Study", it is recommended to examine these interventions under the other planned initiatives.

37. Interventions 3 and 5 – Awareness program on water issues and improving water storage to address quality and quantity issues. The main objective and benefit of these two interventions is to improve water potability and water potability perception at the household level, to advance the use of the cheaper public water system, particularly by the poor. The implementation of the interventions' components requires the participation of various stakeholders, community based organizations, women organizations, public figures, and utility management and operational teams. Because of the overlap in objective and actors involved, the agreement was to combine the two interventions. The intervention "Household Infrastructure and Knowledge Improvement" will be considered in the cost effectiveness analysis.

38. Intervention 4 - Restructuring water tariff to achieve O&M cost recovery and keep cross-subsidy to benefit the poor - The water tariff in Jordan addresses policy issues of cross subsidy between different users groups and among the residential water users to provide subsidy to the low consumers. However, the tariff does not specifically target poor based on geographic location, land use zoning, or household areas, or household facilities.—it only targets based on quantities on water consumed. This intervention already is being considered by the government of Jordan and the Ministry of Water and Irrigation. The details of the policy consideration of tariff restructuring are not known, and therefore could not be analyzed here. These policy considerations may include: geographic location, user group, level of consumption, land-use and municipal zoning, household size and infrastructure. A targeted subsidy to poor consumers could be designed considering some of these policy aspects.

39. Geographic targeting in poor neighbourhoods and zones - As discussed in "Priority Investment Zones,"the neighbourhoods in Zarqa governorate were prioritized according to poverty, complaints density, and population density. In order to improve water availability (duration and frequency of service), poor neighbourhood zones came out as high priority assuming the nature of the rehabilitation directly improves duration and frequency of service. The MCC water supply system project (P1-B) scope includes hydraulic analysis of the system, modelling, and restructuring the network to work according to pressure zones. The pressure zones may not coincide with the priority neighbourhood zones, however, giving attention to restructuring the network in the priority investment zones by the P1-B team, will provide immediate benefits to the poor.

Cost Effectiveness of Interventions

40. A summary of the interventions cost effectiveness is presented in the table below:

Intervention	Cost Effectiveness
Utility Operations Improvement	6
Splitting High Consumers HH Sharing One Meter	3
Household Infrastructure and Knowledge Improvement	6

41. We strongly recommend incorporating the Utility Operations Improvements intervention in the corporatization and management contract program. The indirect benefits of this program go beyond the identified benefits to the poor and include systems' maintenance and sustainability of the investment, and providing the tools to operate the systems according to the envisioned design and international best practices.

42. The Splitting High Consumers Household Sharing One Meter intervention was analyzed for household sharing a water meter, and showed big potential. However, the legal and institutional aspects of splitting theses households will have to be considered further in addition to the wastewater connection fees. The access to water and wastewater connections by poor households is being addressed by the World Bank's "Jordan Water

and Wastewater Output-Based Aid Study" and we recommend to be considered for further analysis by the World Bank team.

43. The Household Infrastructure and Knowledge Management intervention has several benefits. It addresses water potability and reduction of illnesses. It can target poor areas and under-consumers that will be renovated so the benefits of MCC investment are fully realized in these areas. It builds awareness around potability and leakage reduction, and participatory approaches to improve utility efficiency. The indirect benefits of this intervention, particularly related top awareness and capacity building components provide benefits that are beyond the direct benefits to the poor identified in the cost effectiveness analysis. We recommend this intervention for phase 2 and program design.

Household Infrastructure and Knowledge Improvement – Interventions Components

44. The intervention will comprise of three components:

- Household Infrastructure Revolving Fund
- Awareness Program
- Capacity Building, Training, and Technical Assistance

45. This intervention is recommended for phase 2, to design the components, identify implementation mechanisms, test the potential benefits, and work out the considerations for implementation.

1 INTRODUCTION

The Government of Jordan (GoJ) through the Millennium Challenge Account - Jordan (MCA-J) within the Prime Ministry is seeking financing from the Millennium Challenge Corporation (MCC) for investments to increase the availability of water for municipal use by lowering non-revenue water losses and freeing fresh water currently used by agriculture through the substitution of treated wastewater.

The Study of the Benefits to the Poor of Millennium Challenge Corporation Financed Projects in the Water Sector was assigned to ECO Consult in August 27th 2009 by the Government Tenders Directorate in the Ministry of Public Works & Housing. The study will provide information to GoJ and MCC to estimate by whom this newly available water is likely to be used. The study will also provide GoJ and MCC with the cost-effectiveness analysis of several possible interventions with the potential to improve the likelihood of the poor to benefit from proposed water investment projects. Optionally at a later phase, the study will provide information on the most cost-effective intervention suitable for MCC financing and ready for project implementation.

1.1 PROJECT BACKGROUND

In 2008, Jordan completed a constraints and sector analysis that highlighted key challenges to long-term, sustainable economic growth in Jordan. Jordan also conducted a broad, participatory consultative process that included town hall meetings in each of the country's twelve governorates. These inputs identified the availability of water as a constraint to economic growth. In July, Jordan hosted a broad stakeholder workshop to identify key problems that might be addressed by an MCC investment in the water sector.

Based on the workshop results, Jordan developed a "concept paper" that focused on reducing non-revenue water and increasing wastewater treatment and reuse and submitted it to MCC in November 2008. The proposed water delivery and wastewater projects focused on Zarqa Governorate, one of Jordan's poorest governorates and home to its second and fourth largest cities.

MCC seeks to support projects that have the most positive impact on Jordan's economic growth and poverty reduction. Therefore, in February 2009, MCA-J developed a Concept Paper assessment that proposed to the Government of Jordan four projects to achieve these objectives. MCA-J is targeting investments in the water sector to increase water availability for municipal use through lowering non-revenue water losses and freeing fresh water used by agriculture through substituting it by treated wastewater. However, it is of high importance for Government of Jordan and the Millennium Challenge Corporation (MCC) to ensure that this additional water supply will be reaching the poor (under consumers) to maximize benefits and to implement the feasible potential intervention in a cost effective manner.

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1	Zarqa Governorate Water System Restructuring and Rehabilitation	To convert the existing pumping supply in major areas in Zarqa government into gravity feed by separation of distribution pipes from transmission pipes, replacing aging distribution and tertiary systems up to water meters and increasing storage capacity of reservoirs which will reduce NRW from 54% to 25%, reduce pumping cost and increase per capita consumption from 56 lpcd to 93 lpcd.
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3	Expansion of Zarqa Governorate Wastewater treatment capacity	To accommodate additional wastewater flows from Zarqa Governorate until the year 2025 by expanding the AS-Samra WWTP plus construction of conveyor lines through the negotiation with SPC/BOT company.
4	Zarqa Governorate Wells Rehabilitation	The project includes wells rehabilitation components and investment program for Zarqa and Azraq basins.

1.2 *OBJECTIVES OF THE STUDY*

As per the RFP document, the Study of the Benefits to the Poor of Millennium Challenge Corporation Financed Projects in the Water Sector has three principal objectives:

Objective 1 – *Distribution of Potential Benefits*: Quantify the share of benefits arising from the MCC investments accruing to poor households and in particular to the poor on average consuming at or less than 75 liters per capita per day of water in total from network sources. Equivalently, validate the extent to which the current state of the water distribution infrastructure, its management and performance contribute to avoidable cost burdens upon the poor and to the under-consumption of water having health, medical expenditure and work-related consequences.

Objective 2 – *Cost Effectiveness and Feasibility of Potential Interventions*: Estimate the cost effectiveness of possible interventions (initially proposed in Table 1 andin the Inception Report and elaborated and revised in Section 6) that might enhance the share of benefits accruing to the poor and under-consuming households from increases in urban water supplies and provide assessments of the efficacy of each. Based on cost-effectiveness and feasibility, present a recommended course of action for the implementation of interventions possibly to complement MCC-financed investments in urban water infrastructure.

Table 1 Preliminary List of Interventions for Cost-effectiveness and Feasibility Assessment

Interventions to improve quantity of network water available to under-consuming poor	
1. Redefine relevant governorates allocation of water **2.** Build improved information system and modelling for setting rationing schedule and setting pumping pressure **3.** Geographically target MCC financed improvements of the distribution network **4.** Constraints on high quantity consumers (meter repair, more progressive tariff, etc.)	**Listed in the RFP**
5. Improve the productivity of the existing water resources **6.** Develop new water resources **7.** Reallocate fresh agricultural water and substitute it with treated wastewater **8.** Introduce and subsidize water harvesting	**Suggested for discussion with MCA-J**
Interventions to improve under-consuming poor households' ability to utilize network water available	
9. Tariff adjustments **10.** Subsidize household water storage for the poor **11.** Improve water quality **12.** Improve the perception of water quality	**Listed in the RFP**
13. Introduce and subsidize gray water reuse system in the poor household **14.** Promote healthy habits through awareness campaigns	**Suggested for discussion with MCA-J**

Objective 3 - The preparation of an investment proposal that presents a strategy to implement one identified recommendation for enhancing the relevance of selected improvements in urban water infrastructure to poor households and that would be suitable for consideration by MCC as part of the prospective Compact with Jordan. The prepared project must have GoJ support confirmed through MCA-J. The cost-effectiveness of the project must be objectively and readily verifiable. The project should take into account gender and/or other relevant social dimensions associated with water consumption and household hygiene and sanitation. The project would also need to satisfy MCC requirements governing the suitability for investment.

It is worth noting that according to WHO, the basic need for water includes water used for personal hygiene, but defining a minimum has limited significance as the volume of water used by households depends on accessibility as determined primarily by distance and time, but also including reliability and potentially cost. Accessibility can be categorized in terms of service level.

A summary of the degree to which different levels of service will meet requirements to sustain good health and interventions required to ensure health gains are maximized, according to WHO, is shown in below table.

Table 2 Summary of requirement for water service level to promote health[1]

Service level	**Access measure**	*Needs met*	**Level of health concern**
No access (quantity collected often below 5 l/c/d)	More than 1000m or 30 minutes total collection time	Consumption – cannot be assured Hygiene – not possible (unless practised at source)	Very high
Basic access (average quantity unlikely to exceed 20 l/c/d)	Between 100 and 1000m or 5 to 30 minutes total collection time	Consumption – should be assured Hygiene – handwashing and basic food hygiene possible; laundry/ bathing difficult to assure unless carried out at source	High
Intermediate access (average quantity about 50 l/c/d)	Water delivered through one tap onplot (or within 100m or 5 minutes total collection time	Consumption – assured Hygiene – all basic personal and food hygiene assured; laundry and bathing should also be assured	Low
Optimal access (average quantity 100 l/c/d and above)	Water supplied through multiple taps continuously	Consumption – all needs met Hygiene – all needs should be met	Very low

Table 2 indicates the likely quantity of water that will be collected at different levels of service. The estimated quantities of water at each level may reduce where water supplies are intermittent and the risks of ingress of contaminated water into domestic water supplies will increase. Where optimal access is achieved, but the supply is intermittent, a further risk to health may result from the compromised functioning of waterborne sanitation systems.

[1] Domestic Water Quantity, Service Level and Health, World Health Organization, 2003

Therefore, as discussed and agreed in the Inception Report, a reasonable threshold of water under-consumption will be assumed to be 50 l/c/d instead 75 l/c/d initially proposed in the RFP.

1.3 TASKS AND DELIVERABLES

The main tasks and deliverables of this Study are summarized in the following table according to the approved Project Work Plan (included in Annex A):

Table 3 Tasks and Deliverables

TASK	DELIVERABLE
Task 1: Preparatory Work	Inception report including: • Detailed methodology and approach • Detailed workplan • milestones/deliverables • Data requirements and availability • Outline of diagnostic report • Overview of secondary literature review (social, institutional and regulatory contexts). *(9 weeks after mobilization, November 11th, 2009)*
Task 2: Analysis of Network Water Under-Consumption	Study Note 1 *(10 weeks after mobilization, November 22nd, , 2009)*
Task 3: Assessment of Intervention Options	*Diagnostic Report* *(6 months after mobilization, March 8st, 2010)* *Initial findings presentation to Study Stakeholders on March 15th, 2010* *Decision by MCC on moving to phase II by 16th March*
Optional	
Task 4: Preparatory Work for Project Preparation	*Inception Report Revision* *(5.6 months after mobilization, March 21st, 2010)*
Task 5: Project Preparation	*Consultant Diaries* *(6.9 months after mobilization, April 4th, 2010)* *Project Preparation Final Report* *(7.7 months after mobilization, April 12th, 2010)*

This Diagnostic Report is part of the Task 3 of the consultancy services for the ***Study of the Benefits to the Poor of Millennium Challenge Corporation Financed Projects in the Water Sector*** and addresses the following two objectives of the study as per the RFP:

Objective 1:

- Who are those consuming less than 50 liters per day per person?
  - What portion of these people are poor as defined by the national poverty line?
  - What are other key social and demographic characteristics of these people (gender, age, ethnicity, etc.)
  - Can the under-consuming poor be characterized in ways that might assist assessments or the targeting (and ex-post evaluation) of project implementation?
- Where are the under-consumers?
  - Are the under-consumers disbursed throughout the relevant governorates or concentrated in definable geographic areas?
- Measure the correlation between the location of sizeable physical water losses/age of water network/supply hours/ network pressure in the water distribution network and under-consumption of water by poor households.
- How do various factors shape the distribution of benefits to the under-consuming poor?
  - What are the relevant factors which determine the share of incremental water benefit to the under-consuming poor?
  - Which factors have the greatest effect on determining the share of incremental water benefit to the poor?
  - The answers to these questions will include regression analysis with consumption as the dependent variable and independent variables including but not limited to household storage capacity, local water network condition, operational conditions/constraints, income levels, governorate allocation, and tariff.
- What share of benefits arising from the MCC investments accrue to those consuming less than 50 liters per capita per day of network water and what percent of these household are poor?

Objective 2:

- What is the cost-effectiveness (change in share of water going to under-consumers per US dollar) of possible interventions?
  - For interventions that might directly target individual under-consuming households, what is the relative trade-off between increases in water consumption and cost of operations and intervention administration?
  - For interventions that are not directly targeting individual households, for a given increase in the share of incremental water going to under-consumers, what factors principally determine the cost of each intervention to achieve this increase?
- What is the feasibility of executing each intervention?
  - Do factors such as project complexity, political interest/opposition, required timeline, etc. make the projects more or less likely to be implemented successfully?
- On the basis of cost effectiveness and feasibility, which intervention should be developed as a project?
- To improve access of the poor to project benefits, are there zones in Zarqa and Rusieffa that should receive priority status for network rehabilitation?
  - This information will be used as one criterion for selecting the specific parts of the network to be rehabilitated under MCA-J's Network Improvement Project and provided to a separate consultancy assessing the engineering feasibility of the distribution network project.
- Given research conducted, are MCA-J Monitoring and Evaluation indicators presented in the Concept Paper appropriate? What should MCA-J's monitoring targets be? If targets cannot be determined with current data, what are the formulas for determining these targets once inputs are available? What strategy should MCA-J purse to track the outcome of the project related to rehabilitation of the water network, expansion of the sewage network, and all other relevant indicators included in Annex 7 of the Concept Paper (primary/secondary data collection required, frequency of data collection, arrangement for analysis, etc.)?

1.4 *LAYOUT OF THIS REPORT*

This report is divided into7 sections in addition to the Executive Summary section and is structured as follows:

Executive Summary: This section provides summary of the diagnostic report analysis, findings and recommendations related to all conducted analysis and econometric modeling for under consumption and priority investment zones and interventions analysis, assessment and recommendations.

Section 1 (this section): This section provides introduction and background to the study and review of the study objectives. The section provides briefing on the overall project approach and tasks and activities according to the project work plan.

Section 2: Provides background information on the project study area, local context, including social, demographic and economical activities contexts, and water and wastewater situation. The section includes description also on local health and gender issues relevant to the study.

Section 3: This section "Under-consumption Analysis" is divided into **three sub-sections**: *Assessment of Middle Governorates historical drinking water allocation*, and *Assessment of Zarqa Governorate Drinking Water Distribution affecting Under-consumption*, and the *Under- consumption analysis from the econometric model analysis*. The **first sub-section** provides details of conducted assessment of Middle Governorates historical drinking water allocation, provides overview of historical bulk water supply and demographics, and conducted correlation analysis for Middle Governorates in addition to testing of factors and listing those influencing water allocation and distribution. The **second sub-section** includes an assessment of Zarqa Governorate drinking water distribution affecting under-consumption along with historic overview of bulk supply and zones billing, demographics and water resources and supply. The sub-section includes also conducted correlation analysis for Zarqa Governorate drinking water distribution and testing of factors affecting water distribution and consumption in addition to findings and conclusions. The **third and last sub-section** provides the detailed analysis and findings of under-consumption analysis from the conducted econometric modeling analysis and lists factors determining the share of incremental water to the poor, provides review of the overall approach for conducting the analysis and data sources and limitations. The sub-section provides description of the used econometric models and describes the conducted detailed analysis and findings and conclusions.

Section 4: provides review of conducted benefits analysis including benefits to Zarqa Governorate consumers, benefits to Zarqa Governorate under consumers, and benefits to Zarqa Governorate poor under-consumers.

Section 5: Describes analysis, methodology, criteria and rationale for categorizing the priority investment zones for the project study areafor both water and wastewater investments, and highlights the used criteria parameters and weighting factors, data availability issues and limitations, and conducted analysis and tabulations for identifying priority zones.The section includes review of conducted analysis for different scenarios andthe produced GIS maps for the prioritized zones and describes how the results should be used by the consultants working on the feasibility studies of the MCC investments.

Section 6: This section focuses on the conducted interventions analysis, proposed list of interventions, and review of the evaluation criteria and selection approach leading to the short-list of interventions based on the conducted screening process, results from the household survey and consultation process with senior water officials and other ongoing relevant programs. The section provides assessment of each of the shortlisted interventions, description of their components, costs estimations and methodology for implementation in addition to the cost effectiveness analysis for each of the shortlisted interventions.

Section 7: This section provides review of the MCC proposed monitoring framework, recommended modifications, and proposed revisions.

Section 8 (Annexes): includes the following Annexes:

- Annex A Project Work Plan
- Annex B Econometric Analysis
- Annex C Socio-Economic Analysis
- Annex D Priority Investment Zones Analysis

2 STUDY AREA BACKGROUND

2.1 GEOGRAPHIC ZONE

It was agreed with MCA-J that the project study will cover Zarqa governorate for all data analysis related to:

- Under-Consumption of Water analysis
- Priority investment zones
- Cost Effectiveness and Feasibility of Potential Interventions
- Benefits arising from MCC investments in Zarqa to the under-consuming poor

However, and as agreed earlier at the inception phase of the project, the project team has looked at the drinking water allocation at the macro level for the Middle Governorates in order to assess if the water network system interconnectivity between Middle Governorates affects distribution of benefits to the poor living in these Governorates. This has been completed through conducting a global assessment of drinking water allocation explained further in section 3.1.

In addition, a high level assessment of benefits arising from MCC investment indirectly to the middle governorates will be completed based on the aggregate benefits estimated for Zarqa governorates (see section 3.1 for further details).

2.2 ZARQA GOVERNORATE LOCAL CONTEXT

2.2.1 Social Context

Population

Jordan's population has expanded from 4.1 million in 1994 to 5.9 million in 2008. Jordan's rapid growth has two sources: high birth rates and large waves of migration. Between 1952 and 1979 the Jordanian growth rate was 4.8%, although between 2000 to 2004, this dropped to 2.8% per annum, and between 2004 to 2008 it dropped further to 2.3% per annum. This drop can mainly be attributed to lower fertility rates - from 5.6 to 3.6 between 1990 and 2007, due to family and reproductive awareness programs by the government. Although demographic growth is slowing, total population is expected to reach almost 7 million by the year 2015.

Urbanization has become a core fact of life in Jordan; the number of citizens living in urban areas almost doubled from 40% to 79% between 1952 and 2002, dropping to 72.1% by 2004. Amman, Zarqa and Irbid combined make up 71.4% of the Jordanian population, as of 2008.

Between 1994 and 2004, the overall population growth rates within Amman and Zarqa Governorates were approximately 2.1% and 1.9% annually, respectively. Approximately 38% of the country's population lives in Amman, and approximately 15% of the population lives in Zarqa. Within Zarqa 95% of the population lives in urban areas. The average household size in Zarqa is 6.07 people (as of 2004). Across Jordan the average number is 5.4 people, as of 2004.

The Zarqa governorate is located to the North-East of Amman. It consists of 4,080 sqkm. As a close neighbour of Amman, daily work commuters from Zarqa to Amman number in the hundreds of thousands. Zarqa has also been placed high on the government development agenda, with an Industrial and Free Zone, as well as concessions for large-scale real estate projects. The governorate currently consists of two major universities: Al-Hashemite University which is public, and al-Zarqa University which is private. Other landmarks include historic sites, and the Zarqa River.

The two largest cities in the Zarqa governorate are Zarqa and Russeifa; with Zarqa City's population at about 52% of the governorate's total population. *Zarqa*, and *Russeifa*are also amongst the most densely populated subdistricts in the study area.

Table 4 Population within certain Zarqa Districts

	Total
Jordan	**5,103,639**
Zarqa Governorate	764,650
Dulayl – Sub District	32,606
Russeifah – Sub District	268,237
Beirein – Sub District	11,899
Hashemmiyyeh	46,311
Azraq	9,021
QasabetEzzarqa	450102

Source: DOS 2004 Census

Table 5 Percentage of Non-Jordanians within certain Zarqa Districts

Sub-District	Total Population	No. of Non-Jordanians	Percentage of Non-Jordanians
Zarqa	442,240	19,320	4.40%
Dulayl	36,360	10,180	27.90%
Russeifa	229,130	30,060	10.50%
Hashemiyyeh	51,640	1,510	2.90%

Source: DOS 2004 Census

Within Zarqa, the subdistricts of Dulayl and Russeifa employ a high rate of non-Jordanian (principally Egyptian and Sri Lankan) personnel. However, there have been reports of conflicts between these foreign personnel and local workers, resulting from the belief that these foreign personnel are using excessive amounts of water, putting strain on the water delivery system.[1]

Poverty

A Department of Statistics Study covering the 2002-2006 period said a Jordanian needed JD46 a month on average in order to meet subsistence requirements (JD26 on essential non-food products and JD20 for food).

As such, the Household Income Survey conducted by DoS in 2006 indicated that the national poverty line rose from JD392/ person a year in 2002 to JD 556/person a year in 2006; an increase of JD164 or 41.8%.

The average family spending on foodstuff increased by 11.9%, while the food price index increased by 29.6%, which means that the average food consumption of the families surveyed decreased by 14% during the years 2002-2006 (or that much cheaper food options were chosen over meats and fruits and vegetables), according to analysis by HE SamerTawil, former Minister and Trade in an August 2007 Article.

During this time, the average family consumption of vegetables, meat and poultry, cereals, fruits, dairy products and eggs decreased by 32%, 20%, 19%, 15%, and 12% respectively. Concomitantly, spending on fuel and electricity, transport and telecom, and education increased by 71.3%, 46.4% and 39.2%, respectively.

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

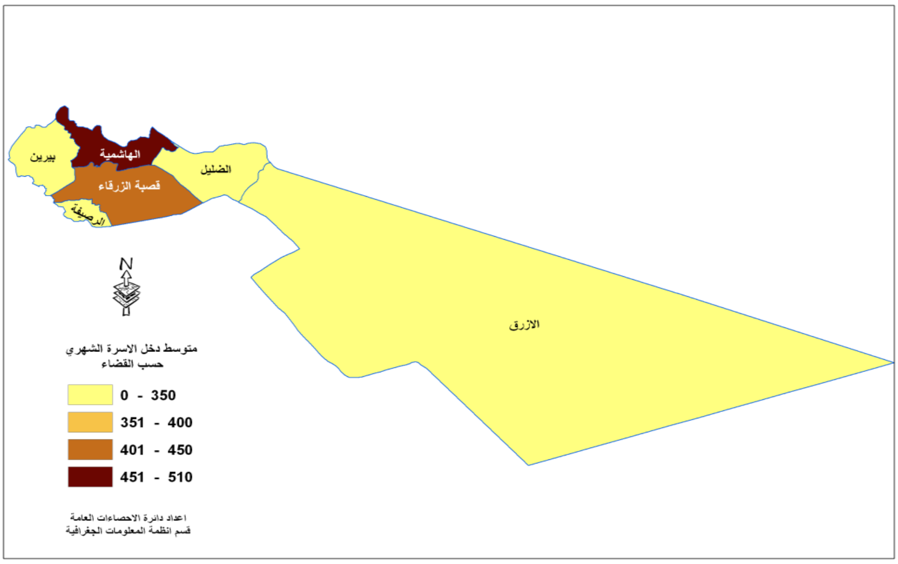
Table 6 Incidence of poverty

Governorate	2002	2006
Kingdom	14.2	13
Amman	9.2	9.4
Madaba	10.7	10
Irbid	13.8	12.1
Ma'an	24.1	12.7
Zarqa	22.3	14.9
Balqa	17.8	15.3
Aqaba	15.2	15.4
Jerash	18.4	16.7
Ajloun	9.7	17.7
Tafeela	10.6	19.1
Karak	12.2	21.7
Mafraq	25.4	23

Source: DOS, Kingdom Indicators, 2006

The 14.9% poverty rate is spread out over the Zarqa governorate with some pronounced poverty pockets. These include the Azraq district with almost 10% (see Table 7) of homes being temporary in nature (though with a total population of only just over 9,000 people in 2004). The monthly family income in Zarqa in 2006 amounted to 390 JD, in stark comparison with the Hashemite Kingdom of Jordan, which is 518 JD per family, monthly.

Figure 1 Monthly Average Family Income per Area, Zarqa, 2006



Source: DOS, Income and Expenditure Survey, 2006

As the above map and table clearly indicate, regarding Zarqa's districts, Beirein has the highest monthly income, of 502 JD, while the lowest earning district was Dulayl at 316 JD monthly.

In 2004, the Ministry of Planning and International Cooperation study on Poverty Pockets placed several areas within the Zarqa governorate amongst the poorest in the Kingdom. These included Beirein, Azraq and Hashemmiya. When the study was redone in 2006, however, these areas were removed from the Poverty Pocket list.

Due to the fact that the DOS income and expenditure data is not significant on the neighbourhood level, an independent DOS report about Zarqa created a new "asset-based" indicator as a proxy for the poverty levels by neighbourhood. The DOS indicator is based on the 2004 Census data, taking seventeen categories into consideration and ranking it on a 1-4 scale.

Figure 2 DOS Poverty Indicator, 2004 Census Based

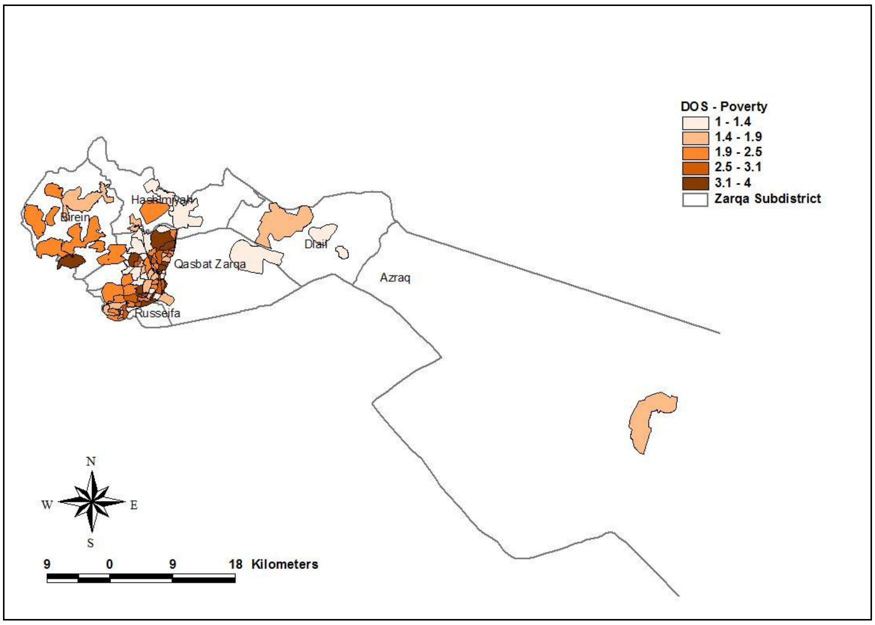


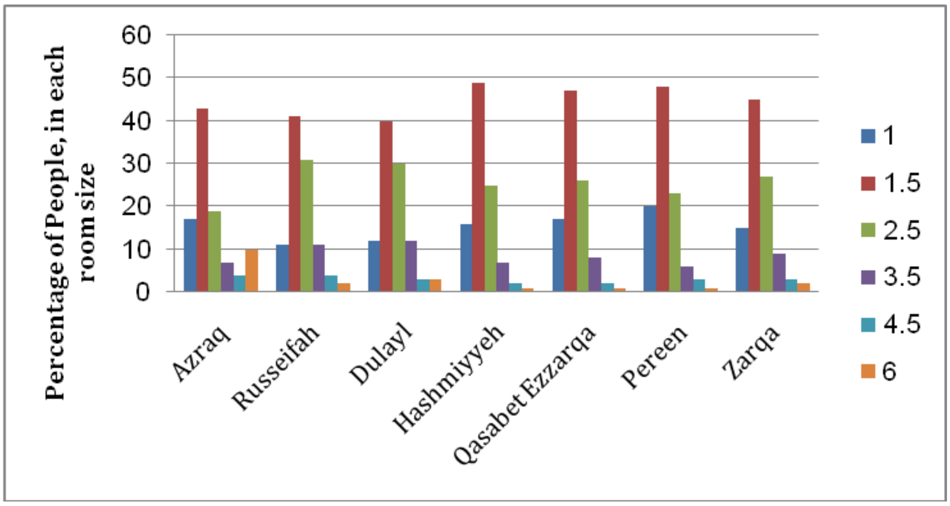
Table 7 Number of Buildings per Building Type, 2004 (%)

District/ Use	Amarah (%)	Dar (%)	Villa (%)	Barrack (%)	Tents (%)	Establishments (%)	Under Construction (%)	Other (%)	Grand Total (%)
Azraq	4.9	73.8	7.5	0.4	9.9	9.2	0.8	0.90	100
Russeifah	27.9	67.5	0.1	0.0	0.1	3.4	1.2	0.00	100
Dulayl	4.9	84.9	0.2	1.1	1.0	6.7	1.2	0.00	100
Beirein	19.5	74.1	0.2	0.4	0.1	4.2	1.5	0.01	100
QasabetEzzarqa	39.8	52.6	0.3	0.1	0.0	5.6	1.5	0.00	100
Beirein	1.9	90.2	0.1	0.0	0.1	4.0	3.8	0.00	100
Grand Total	30.1	62.8	0.2	0.2	0.4	4.8	1.5	0.03	100

Source: DOS, 2004 Census

As the above table shows, the vast majority of buildings in each sub-district (with the exception of QasabetEzzarqa) are Dars. In QasabetEzzarqa, however, they make little over half of the buildings in the district (with another 39.8% being Amarahs). Beirein, however, is almost exclusively made up of Dars, at 90.2% of all buildings in the governorate

Figure 3 Room Occupancy Rate per District, 2004 (%)



Source: DOS, 2004 Census

As the above figure makes clear, the vast majority of people in Zarqa have between 1 to 2.5 people per room, for example **Azraq** has 79% of its population between 1 to 2.5 people per room. It is also indicative that the vast majority of people in each district (that is, 80% or more, in each district), have 1.5 people, or more, per room. This shows that many residences in Zarqa suffer from overcrowding; and in places like Azraq, the situation is drastic with quite a significant portion living in rooms with 6 other people.

Education

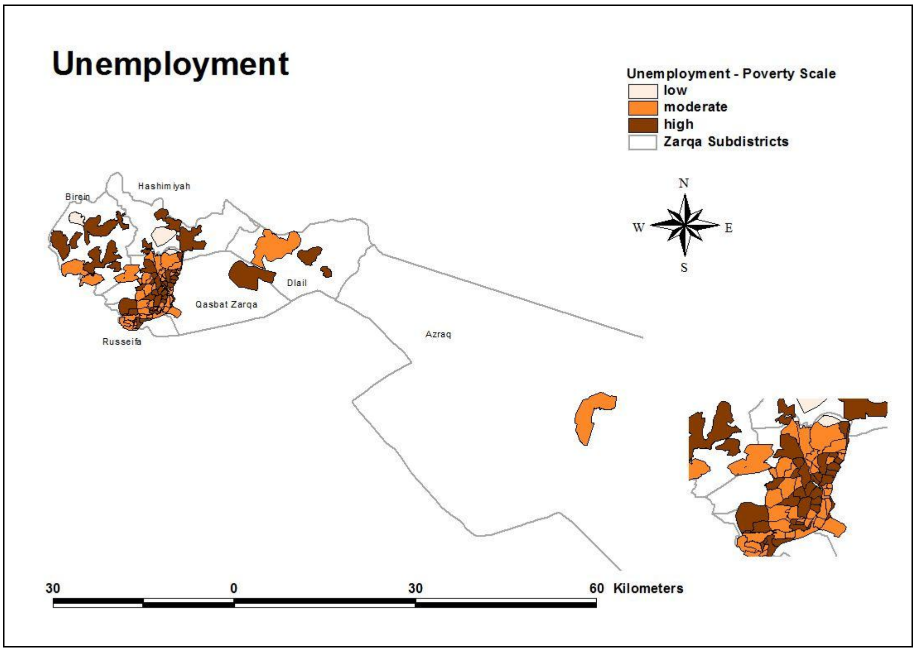
In 2002, Zarqa had the second highest literacy rates of the governorates in Jordan, however, it had the lowest combined primary, secondary and tertiary enrolment rates, implying that, without proper actions, it would see its ranking in literacy drop significantly in the future.[1] By 2004, 56.8% of young people were enrolled wither in primary, secondary or tertiary education.[2]

Employment and Unemployment

While in 2004 in Zarqa there were 165 thousand total employed, or 36% of the population above 15 years old; the unemployment rate has been rising. The increase in unemployment registered in Zarqaindicate that the living conditions must have become more difficult. In 2004, the male unemployment rate in Zarqa was 16.2%; compared to the female unemployment rate of 38.8%.

[1] Jordan Human Development Report, 2004, UNDP
[2] DOS, Population and Housing Census 2004

Figure 4 Unemployment Rate, 2004 by Neighbourhood



Unemployment is considered as a factor contributing to poverty and the percentage unemployed of the economically active population is taken as a percentage. **The highest rates appear to be in Birein and Zarqasubdistricts.**	**Measured in unemployment percentage:** **0 – 10%: Low** **11 – 19.9%: Moderate** **20 – 33.9%: High**

Health

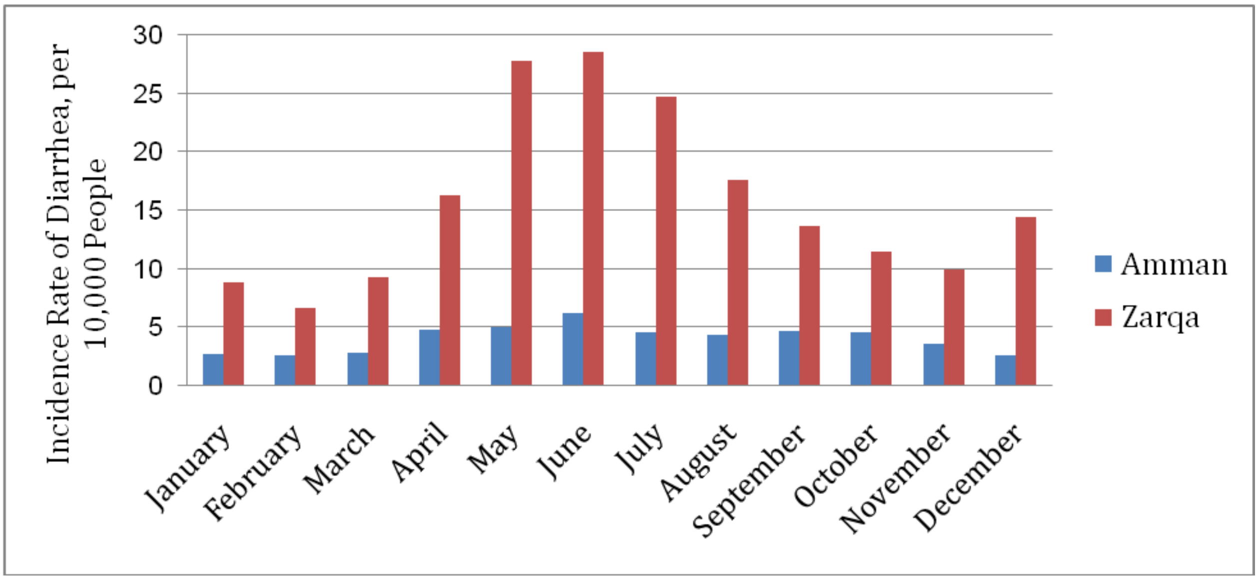
Two studies, the 'HELI' study and the *World Bank Poverty Report, 2004*, show that the lack of water in Jordan is one of the main issues exacerbating water associated illnesses, particularly diarrhea in children (a problem caused by both lack of water and poor quality water). While the poorest groups in Jordan would, as expected, have the highest infant mortality rates, the water problems greatly exacerbate this issue.[1]Most of the diseases found in the Zarqa Governorate are gastrointestinal (mainly diarrhoea; with 6% of homes reporting cases) although other diseases such as Hepatitis are also found. Amoebic infections are found

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

particularly in students; many maintained this was due to poor hygienic conditions in schools, as well as the dirty water supplied by WAJ and dirty water tanks.[1]

There are also cases of kidney stones; a significant percentage of children developed kidney diseases, most probably from the impure water. A school official pointed out that annually 2-3 children suffer from a kidney related illness or kidney failure in her school alone. There are also a rising number of people who have contracted cancer, made worse by the absence of adequate medical services. The bathrooms in the schools have no water, and students do not know how to deal with a situation such as this. Of the homes that utilize the governmental water system in Zarqa, approximately one quarter do not understand the fundamental steps of cleaning their water tanks.

Figure 5 Incidence Rate of Diarrhea, per 10,000 People, Amman and Zarqa, 2008



Source: MOH

Hygiene

The lack of water leads to poor hygiene standards among the inhabitants of Zarqa. In addition to the many problems faced by students previously mentioned, the lack of water (as well as proper hygiene practices) has led many students to suffer from lice; approximately 17% do not brush or take other care of their teeth, 7.5% do not wash their hands during meal time and

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

5.6% do not wash hands after going to the latrine, according to the 'Jordan Global School-based Student Health Survey.'1

Some women placed cotton (used for medical purposes) inside the tip of the tap, as an improvised filter. Knowledge of the link between diseases and hygiene is weak, for instance, many people wash their vegetables in the highly polluted/dirty Zarqa River. Many people also dump their trash outside of garbage cans, and it is apparent there is little regard for the environment.[2]

2.2.2 *Water*

Water poverty is one of the most pertinent cases of poverty within Jordan. The MENA region is a very arid part of the world, and this can be clearly illustrated in Zarqa, with its poor, and inequitable, supplies of water.[3]Only on 'Water Day,' is water supplied (usually between 4-5 hours during the day).[4] The water network is outdated and dilapidated, suffering from leaks, broken sections and extensive rusting. Zarqa's rapidly growing population, due to regular population increases as well as inter-governmental immigration, has put additional strains on this weak system.[5]

Most of the Middle Governorates' houses are connected to a water source; 97% of homes in Balqa Governorate and Zarqa Governorate are connected to a network, dropping to 90% in Madaba.[6]

On average, the Water Authority of Jordan (WAJ) supplies each family with 2 cubic meters of water weekly, meaning that many residents have to purchase their own water.[7]However, according to the survey conducted by DOS for the MCC Corporation, the average resident of

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

[2] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

[3] Millenium Challenge Account, 17 November 2008, Jordan, Country Concept Paper

[4] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

[5] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

[6] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

[7] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

Zarqa consumes 265 litres of water annually. The DOS survey for the MCC Corporation result is the higher estimate of the two figures, perhaps due to different research methods and questions asked.

The vast majority of homes (around 95%) are connected to a water meter; in Balqa Governorate and Madaba Governorate this increases to 99% and in Zarqa 94% of homes have water meters. Families and neighboring homes do share water connections, supplies and meters, occasionally, (approximately 5% of neighbors share water meters). In Zarqa, 6% of homes share a water connection.[1] In the survey conducted by DOS for the MCC Corporation, 37.5% of households shared a meter with at least one other household, in Zarqa.

The lack of water in Jordan is obviously exacerbated during the summer months, with almost all households going without water for long lengths of time. The rate of water supply, per week, is, for Balqa, Madaba and Zarqa respectively, 2.91 days, 1.55 days and 3.24 days.[2]

Demand for water during the summer, from water tanks specifically, jumps 12% and 17% in Zarqa and Russeifa, respectively. Water prices from these private sources are not moderated by oversight or governmental action; many people report that those with 'Wasta' get better deals than those without. While most Jordanians have to pay 4-7 JD per cubic meter, this can rise to 8 JD per cubic meter in Zarqa and Russeifa. Many individuals have to wait for up to 3 weeks to obtain water from this source; in summer and Ramadan, the waiting time increases.

The bias in water supplies, favoring those with high levels of disposable incomes, and urban areas, has engendered resentment, and in some cases disputes, among the inhabitants of Zarqa. It should be noted that within urban Zarqa, 91.6% of the population made use of the public water network, compared with 87.9% of rural Zarqa.

Zarqa residents, who took part in a recent study, the, Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II), stated that "If the swimming pools at the 5 star hotels in Amman were emptied people would have enough water to use."

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

[2] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

The lack of water leads to many issues of anger and resentment; many husbands cannot provide adequate water for use by their families, engendering arguments, fights, and sometimes divorces.[1]

Also, inadequate water supplies are a source of tension between neighbors, as some neighbors are accused of wasting this scarce resource, and sometimes even stealing it; disposing of the waste in cesspits might be a source of conflict in apartment buildings.[2]

During 2006, WAJ stated that water usage per person amounted to 75 liters per person daily in Balqa, 67 liters per person daily in Zarqa, and 76 liters per person daily in Madaba. Assuming a typical home has 6 people, water and sewage would cost 31 JD annually in Zarqa, 39 JD annually in Madaba and 32 JD annually in Balqa. However, if each household consumed 100 litres per day, this price would double.3

While different homes receive their water from a range of sources, from rainfall and springs (unprotected source) to the governmental network and water containers (protected source). Almost 80% of homes in the survey have the governmental network as their primary supply of water. Of the 1214 people taking part in the DOS survey, (performed for the MCC Corporation) the vast majority of respondents (97%)stated that they had a connection to the public network, whereas in the DOS census, almost 80% relied on this network. This is most probably due to the larger sample size in the DOS census.

Over one third of Jordanian homes (as well as Zarqa homes) treat or purify their water before consuming it; before treatment, many have complained that the water contained too much salt and chlorine, giving it a terrible taste.

As a result, four out of every five residents of Zarqa buy bottled water. This can cost as much as 2 JD for 45 liters; those that cannot afford such a price, have no choice but to consume public

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

[2] Ibid

[3] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

water.1 However, it should be noted that in the survey conducted by DOS for the MCC Corporation, only a tiny minority (4%) of respondents bought bottled water (one possible reason for this discrepancy could be the different ways in which the two surveys asked the question).

As many people believe that WAJ water is insanitary anyway, they do not take the necessary precautions to keep their water tanks hygienic, and in some cases even to place cesspits near the water tanks.2

The overwhelming majority of survey respondents (99%) had a water storage device in their home, each being able to hold (on average) 2.7 cubic meters. Six out of ten people wash their tanks according to the survey, Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I). The governorate with one of the highest percentage of people who washed their tanks was Madaba (at 82%), but in Balqa only 62% of people washed their tanks, compared to 56% in Zarqa.

Residents also believe that they are not getting a fair deal from their tax, due to a lack of transparency; many of the pipes are overland, making the possibility of excessive damage and leakage much higher. Many inhabitants who live in high, mountainous areas have no choice but to buy water tanks, as the low pressure of the pipes implies that the water cannot reach uphill locations. Response times from the WAJ are also extensive, with one example whereby a damaged pipe was not tended to until 10 days after the complaint had been registered; there is also minimal coordination between the various agencies involved. Those that cannot afford bottled water, have no choice but to drink filtered municipal water.[3]

2.2.3 *Wastewater and Sewage*

Approximately 86% of Zarqa is connected to a sewage disposal network; while a few of the newer locations are not, thus leading to many people relying on cesspits. Most families drain

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume II)" GFA Consulting Group

[2] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

[3] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

their cesspits monthly, putting extra strains on the families' budgets. In order to obtain a connection to the sewer, it may cost a family 400 JD.[1]

In Zarqa, approximately half of households drain their septic containers frequently; however hiring the specialized truck for this purpose can cost (for one load) between 21 JD to 40 JD (even though costs fluctuate with location and demand).[2]

Much like the water supply system, the sewage disposal system urgently requires modernization and repair. Aside from the consistent flooding from the sewage system, there is noise pollution, horrible smells and an abundance of insects and other pests. Some farms are located near the sewage system.

2.2.4 Gender and Water

The lack of water and poor sanitation standards are also a possible barrier to bridging the gap in the roles played by men and women.[3] Although there is little discrimination in water provision between men and women, the significant exception is when a woman is the leader of the home; there have been impediments to women attempting to receive water from WAJ when they lead the household.

Also, when it comes to the individual home, there is a clear bias towards certain tasks for each gender; women have the duties of cooking, cleaning, bathing children, filling the water tanks during 'Water Day,' and determining how much water to be used on which task. It is considered the man's duty to contact the government or company, water the garden, clean the car, order and purchase water services. Although, more women are making decisions regarding buying extra water, ordering the waste disposal truck for cesspits, for complaining to, and purchasing from, the WAJ. The task of cleaning the tank is varied across different communities, with some having women, and others having men, do it.

The*Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)*

[1] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

[2] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

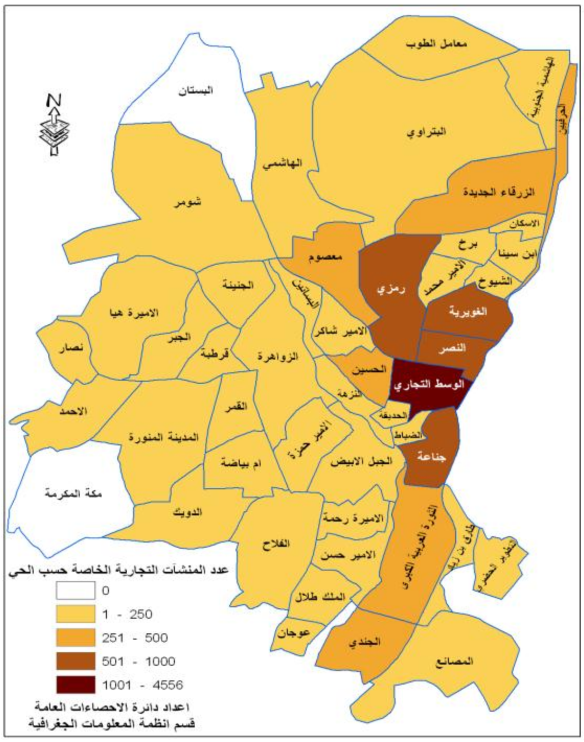
[3] August 2008, "Water Management Programme in the Middle Governorates – Zarqa, Balqa and Madaba, Socio-Economic Baseline Survey in the Water Supply and Sanitation Sector: Draft Final Report (Volume I)" GFA Consulting Group

identified family care as the priority of women; water is carefully rationed during the week, primarily for the care of the young members of the family, the sick, then water used for internal consumption, after that for home maintenance, after that hygiene and finally gardening. More women are turning to plants that can survive with minimal water to cope with the lack of water. The roles performed by men and women, relating to water are usually absorbed and imitated by the younger generation, to be repeated when they are older.

2.2.5 *General Economic Description*

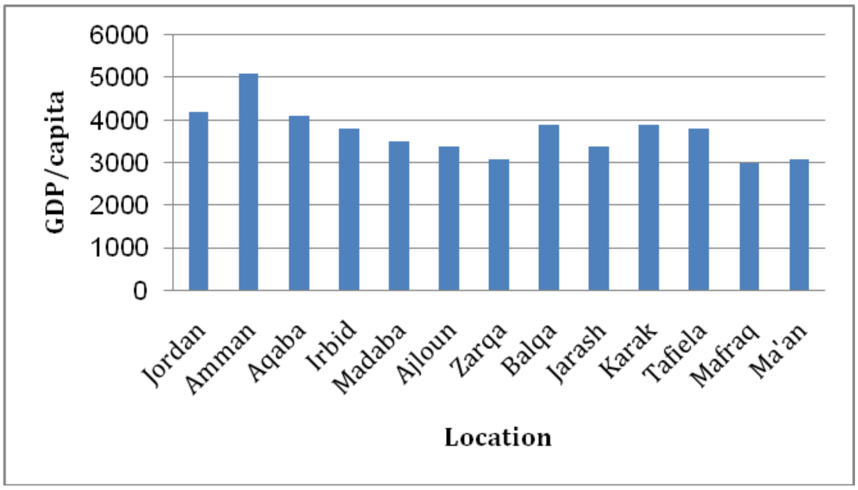
According to DOS, out of the 21,600 firms in Zarqa, the vast majority of them were dealing in retail trade (excluding automobile sales/repair) reaching almost 11,000 firms in 2006, or 50.9% of companies, far and above any other industry (the second biggest was manufacturing, at 2,549 firms, or 11.8% of firms, and the third biggest was the sales/repair of automobiles, at almost 2,300 firms, or 10.6% of firms). However, it should also be added that while manufacturing firms totalled only 11.8% of firms, they offer a high value added capability, while retail trade offers a quite low value added. 30% of businesses in Zarqa concentrated in an area called Wasat Al Tijaree:

Figure 6 Private Businesses per District, 2006



Source: DOS, GIS Department 2006

Figure 7 GDP/capita per Jordanian Governorate, 2002



Source: Jordan Human Development Report, 2004, UNDP

Comparing GDP/capita to other governorates, Zarqa has one of the lowest GDP/capita rates in the country (second only to Mafraq).

The GDP/capita decline in Zarqa over the period leading up to 2002 is reflective of an unemployment jump witnessed in the Governorate rising between 9.7% in 1997 to 15.9% in 2002, although it dropped to 8.9% in 2004, compared to 22.8% in the rest of Jordan. National unemployment reached 14% by the third quarter of 2009, up from 12.1% in the first quarter of 2009. Zarqa accounted for 15.5% of this unemployment.

3 UNDER CONSUMPTION ANALYSIS

The MCA-Jordan needs to assess the benefits and costs of the proposed improvements to the public water systems in Jordan, and, in particular, the Zarqa Governorate. A second step in the process is to examine the distribution of those benefits to residents of the Governorate, and particularly to poor and under-consuming households. In order to accomplish these assessments, the value of those improvements to consumers must be determined. Almost 97% of the households in Zarqa are connected to the public water supply, and their consumption is metered. However, since the public water supplies are not continuous and are sometimes very restricted in the hours that supply is available, households may, and many do, choose to purchase water from other sources, including water tankers, water treatment shops, bottled water, and other sources, usually at much higher prices than charged for public water. Thus, estimates of the demand for water from all these sources is required.

Moreover, Jordan is water-short, and a significant proportion of its households consume less that the amount of water identified by the United Nations and others as necessary for a healthy lifestyle . It is thought that many of these households are poor. It is hoped that the improvements will provide additional low-cost water supplies to all Jordanians, but particularly to the poor and under-consuming households.

The specific objectives of the analyses described in the following chapter, as defined in the RFP are:

1. To estimate the total benefits of potential interventions designed to improve the public water supply system in the Zarqa Governorate;
2. To estimates the portion of those benefits going to under-consumers;
3. To estimate the portion of those benefits going to the poor, and and under-consuming poor;
4. To examine the factors that determine the share of those benefits to the under-consuming poor.

The approach that the ECO Consult team employed in the under-consuming analysis was as follows:

1. A review of all the available data and reports was undertaken in order to determine if those data were adequate to accomplish the necessary demand analyses. These resources included the GFA Socioeconomic Baseline Survey, the Water Authority of Jordan (WAJ) Consumer Satisfaction Survey and its attendant metering data, and the Jordan Department of Statistics (DoS) socioeconomic census data.
2. The review indicated that the existing data sources were inadequate, since they failed to provide sufficient information about household consumption from all sources, socioeconomic data linked to specific households, and data on other important variables.
3. A new household survey instrument was designed by ECO Consult , in consultation with MCA-Jordan and DoSpersonnel, to collect the necessary data for demand estimates. The survey of a representative sample of Zarqa Governorate households was completed in mid-December, 2009. Billing and water meter data were obtained for the households in the survey from the WAJ.
4. Two econometric approaches were used: (1) an somewhat *ad hoc* approach which examined various aspects of both the data (including correlations among the data collected) and consumption (in what is termed "exploratory" analysis), and (2) a demand model based on the Almost Ideal Demand System (AIDS) approach which included analyses of the demand for all sources of water and their interactions.
5. Results from the two econometric analyses were used to determine the benefits to improving water supplies for the Zarqa population as a whole, for poor households, under-consuming households, and poor households that under-consume. The benefit analyses and the econometric results were the basis for making intervention recommendations.

The following sections describe in detail the data collected and analyses employed to accomplish the MCC objectives, as well as to examine other aspects of water consumption in the Zarqa Governorate.

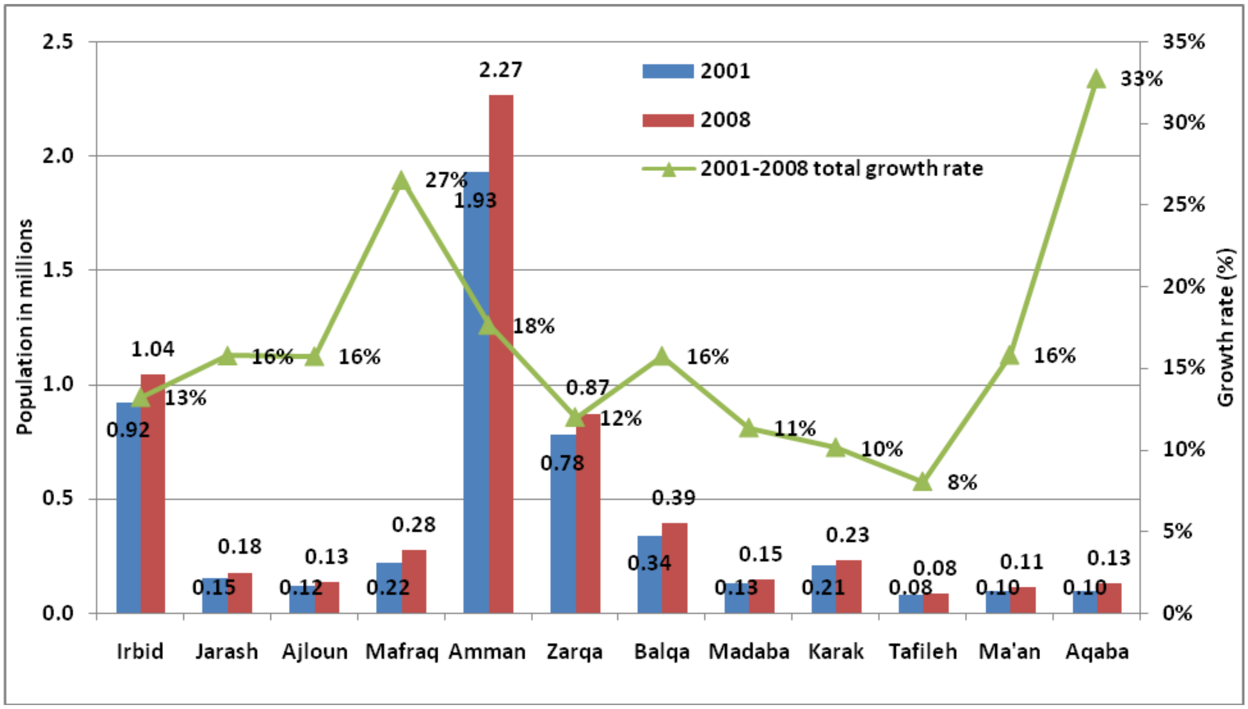
3.1 *ASSESSMENT OF MIDDLE GOVERNORATES HISTORICAL DRINKING WATER ALLOCATION*

3.1.1 *Overview of Historical Bulk Water Supply*

This section tries to investigate how domestic water supply have been allocated among Jordan's governorates and in particularly among the Middle Governorates through conducting analysis the historical data of water supply, water transfer quantities, water billed, income and economic activities, population growth, urban and rural distribution of populations and NRW. The final goal of this analysis is to understand how additional water supply would be allocated among middle governorates and to realize what factors are affecting on how water allocation is made among Jordan's governorates.

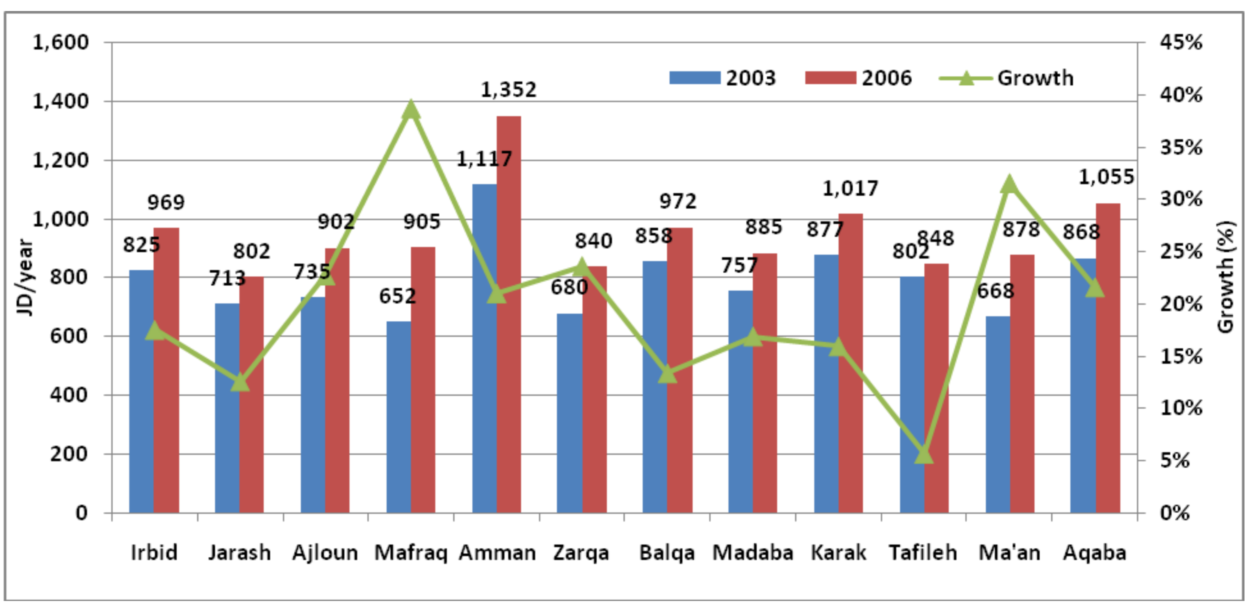
Demand growth as a result of population growth is a key factor that is expected to influence the amount of water supply among governorates. Population growth is driven by the economic growth and wealth in Jordan's governorates as shown in Figure 8 and Figure 9 in which it is clearly noticed that Amman, Mafraq, Ma'an and Aqaba has the highest population growth rates as well as income growth of household member. Amman and Aqaba have the first and second highest average income of household member in 2006 respectively. On the other hand, Mafraq and Ma'an are ranked correspondingly as the sixth and the ninth highest average income of household member in 2006, which means that Mafraq's member has an average income while Ma'an's member has a low income compared with the average national income level. Although, household members of Mafraq and Ma'an do not have the high income level as of Amman and Aqaba, they noticed high population growth rate than most other governorates also due to the social context and the high ratio of population living in rural areas as illustrated in Figure 10.

Figure 8: Governorate population number and growth over 2001-2008



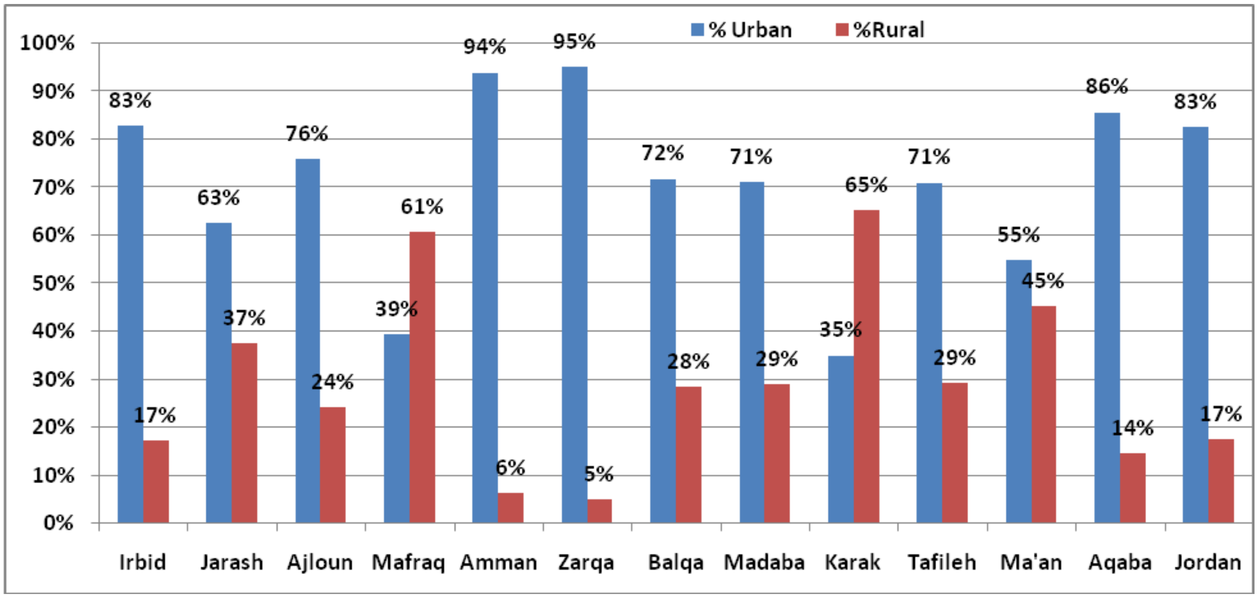
Source: DOS

Figure 9: Average annual Income of household member and its total growth rate in 2003 and 2006



Source: DOS

Figure 10: Population distribution on urban and rural in 2005

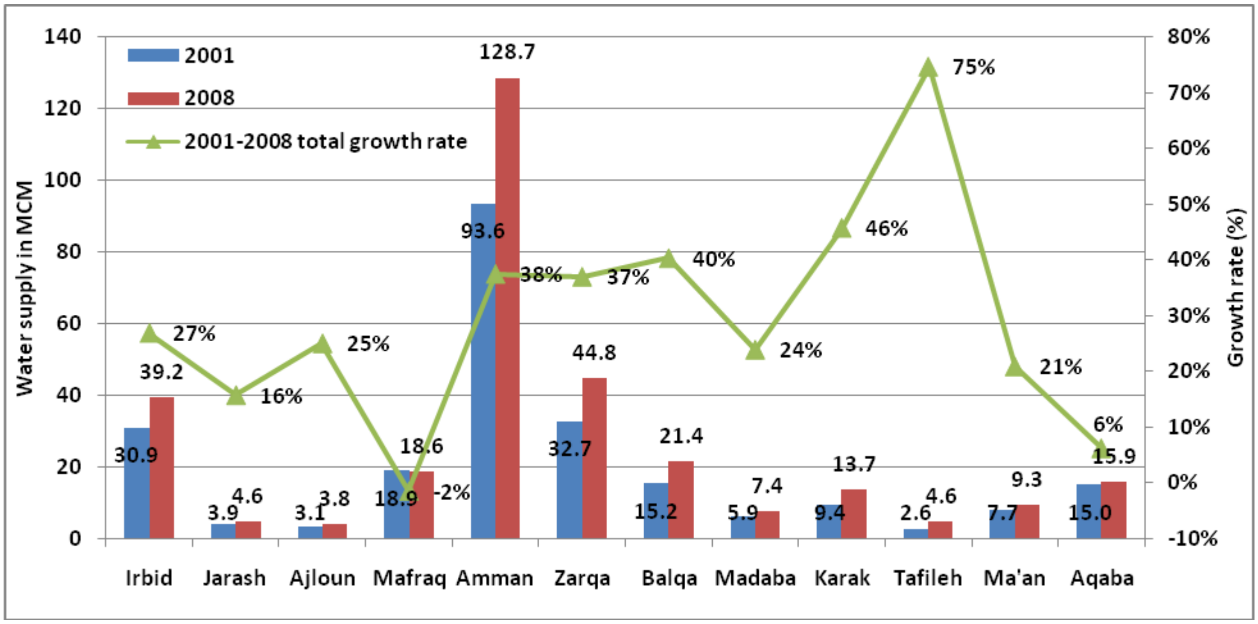


Source: DOS

Over 2001-2008, the lowest growth in water supply was in Northern governorates (Figure 11), which also had the lowest per capita water supply (Figure 12), in addition to Aqaba and Mafraq which on the opposite to the northern governorates were enjoying the highest per capita water supply in 2008 of 341 and 186 lpcd respectively.

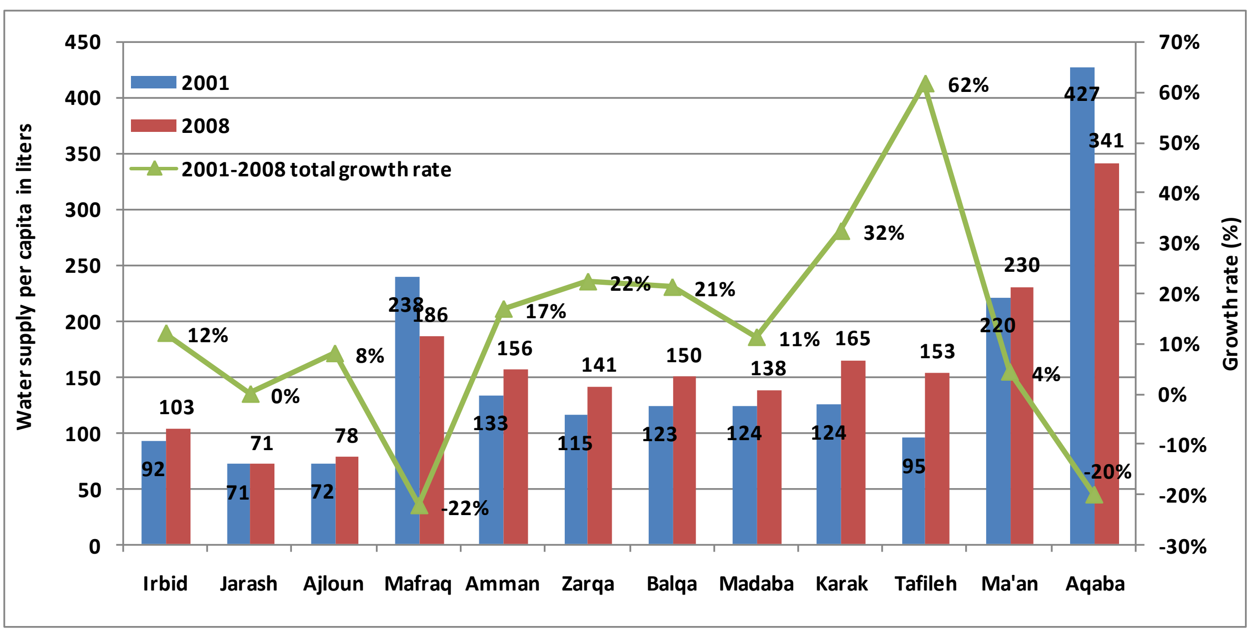
Tafileh, Amman, Zarqa and Balqa had the largest growth in water supply which enjoyed relatively average per capita water supply during 2001-2008. The comparison of historical water supply per capita and the growth rate in the water supply does not indicate that governorate with low water supply rates noticed an improvement in water supply quantities. The middle governorates had witnessed almost the largest growth per capita water supply although they have significantly higher per capita water supply than the northern governorates (excluding Mafraq).

Figure 11: Governorate water supply and its growth over 2001-2008



Source: WAJ

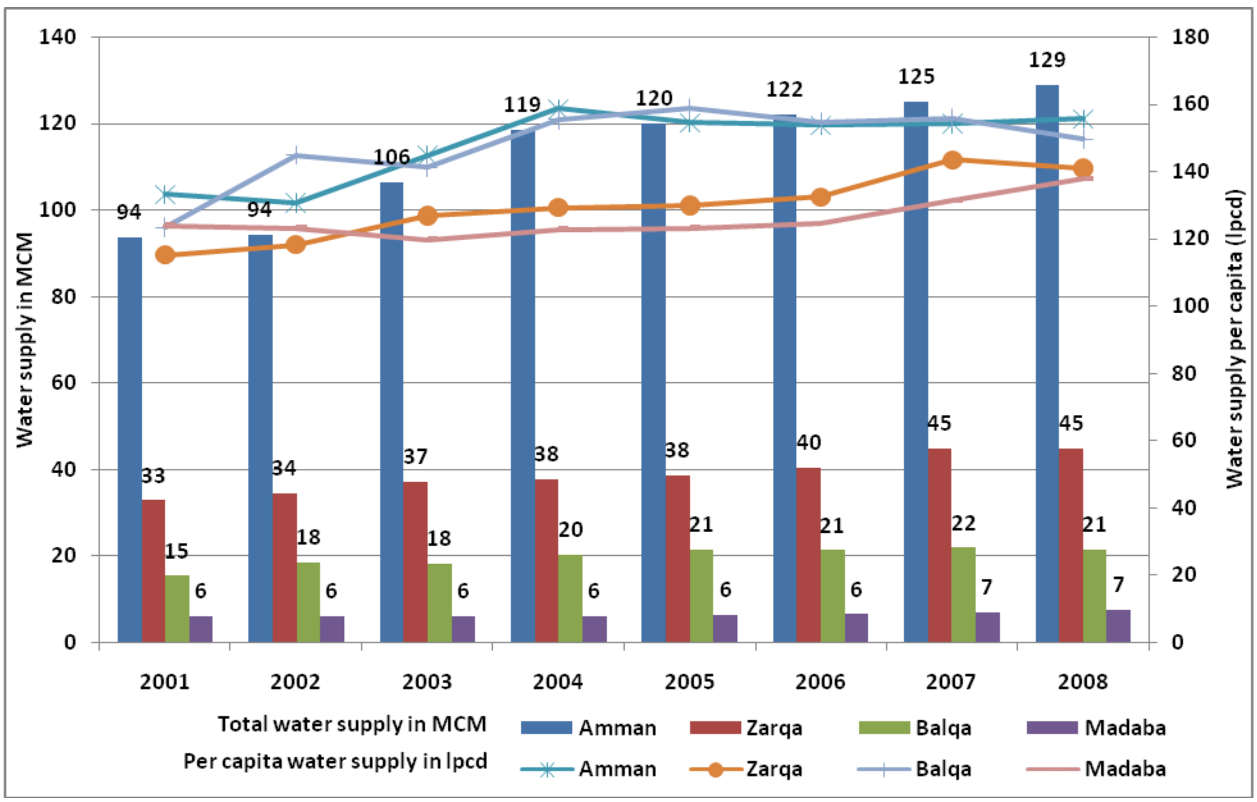
Figure 12: Governorate per capita water supply and its growth over 2001-2008



Source: WAJ

Within the Middle governorates, Amman and Balqa had larger per capita water supply than Zarqa and Madaba along over 2001-2008 as illustrated in Figure 13. It is also noticed that the gap between both group of the middle governorates was increased during 2003 and 2006, where the operation of Abu Ezeighan brackish groundwater desalination and the expansion of Zai water treatment plant in 2003 and 2004 respectively led to an increase in Amman and Balqa per capita water supply, while it almost remained constant for Zarqa and Madaba. This had been changed once Zara Ma'in started supply Amman with around 35 MCM by the end 2006 where no significant increase on the per capita water supply for Amman and Balqa is noticed as some of Khaw water supplied to Amman was reallocated to Zarqa and more quantity of Wala water was supplied to Madaba. This had led to good increase in per capita water supply in Zarqa and Madaba governorates.

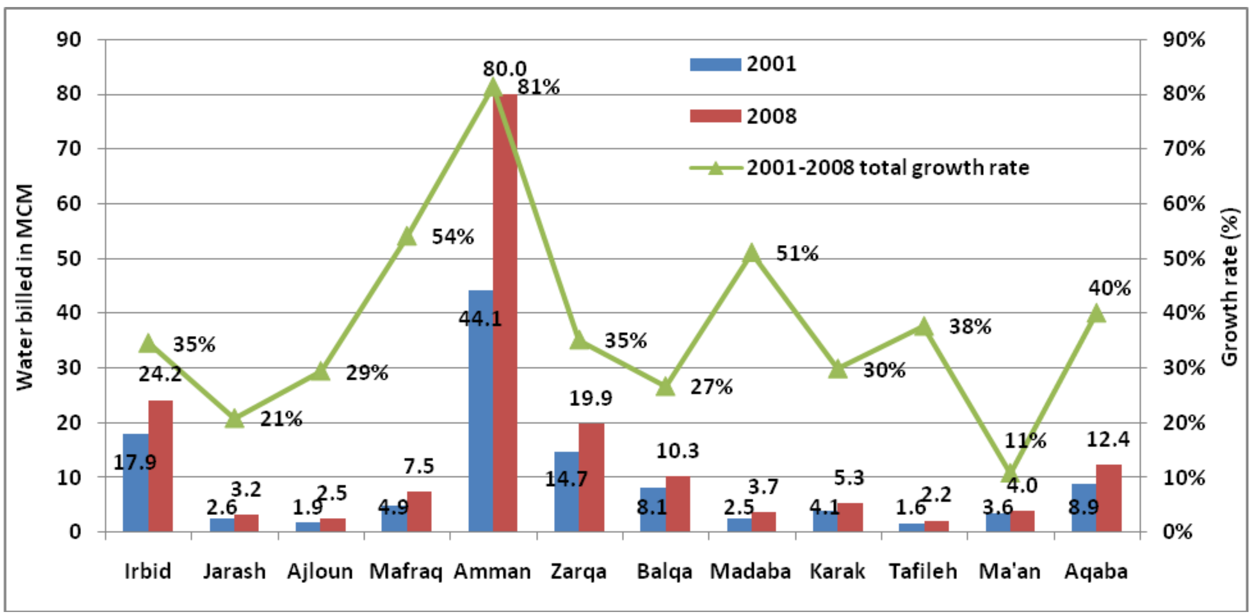
Figure 13: Middle Governorates total water supply and per capita water supply over 2001-2008



Source: WAJ

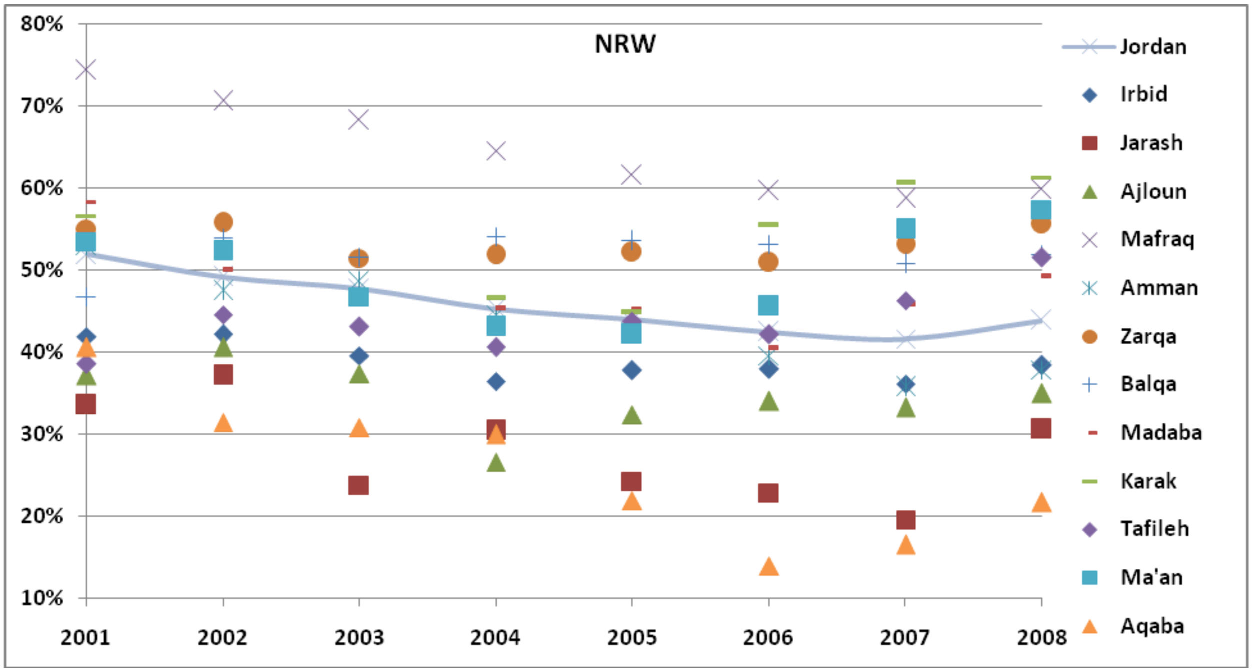
The water billed per capita in Amman and Aqaba during 2001-2008 was significantly increased (Figure 15) which is mainly driven by the high growth in water supply per capita in Amman and reduction in NRW in Amman and Aqaba. Although water supply in Madaba had increased by 24% during 2001-2008, the water billed had increased by more than double mainly because of the high reduction on the NRW. Furthermore, the significant reduction in NRW in Mafraq led to an around 54% increase in the billed water despite that the water supply stayed almost constant during 2001-2008. The revision and comparison of the historical water supply, water billed and NRW indicates the change in NRW has the most significant impact on changing the water billed quantities. **Error! Reference source not found.** Figure 15 illustrates the change in NRW over 2001-2008.

Figure 14: Governorate water billed and its growth over 2001-208



Source: WAJ

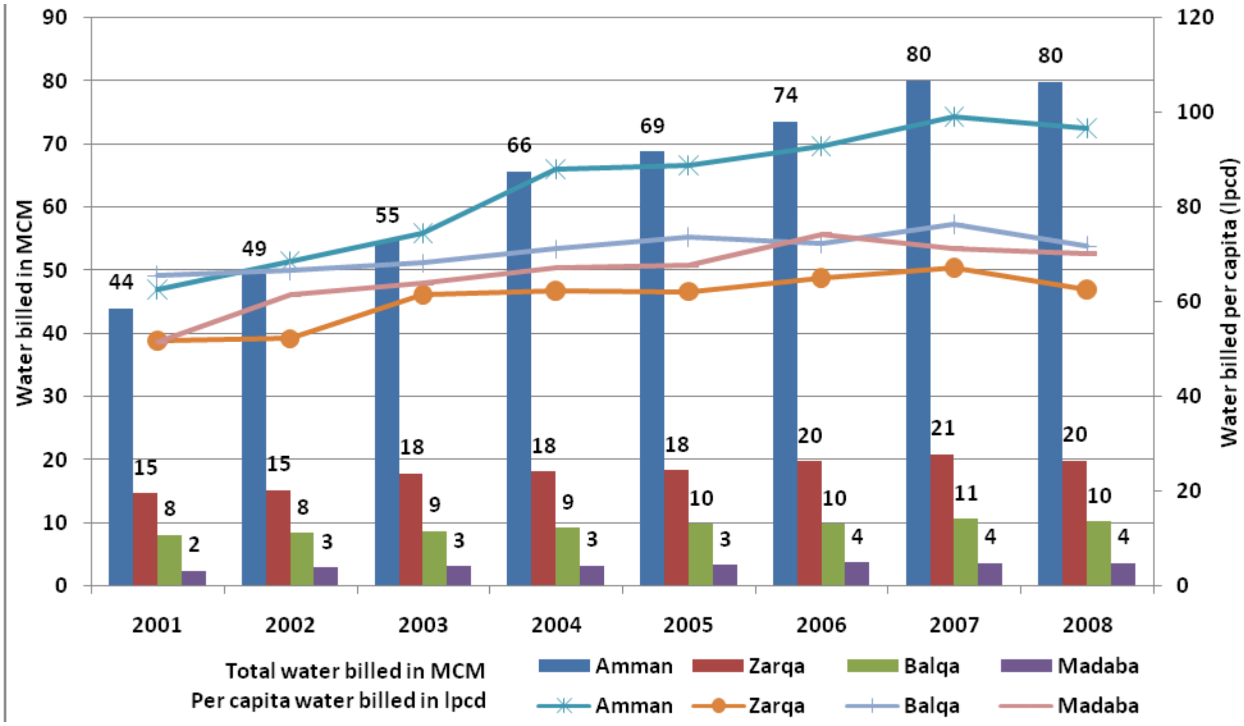
Figure 15: Governorates NRW over 2001-2008



Source: WAJ

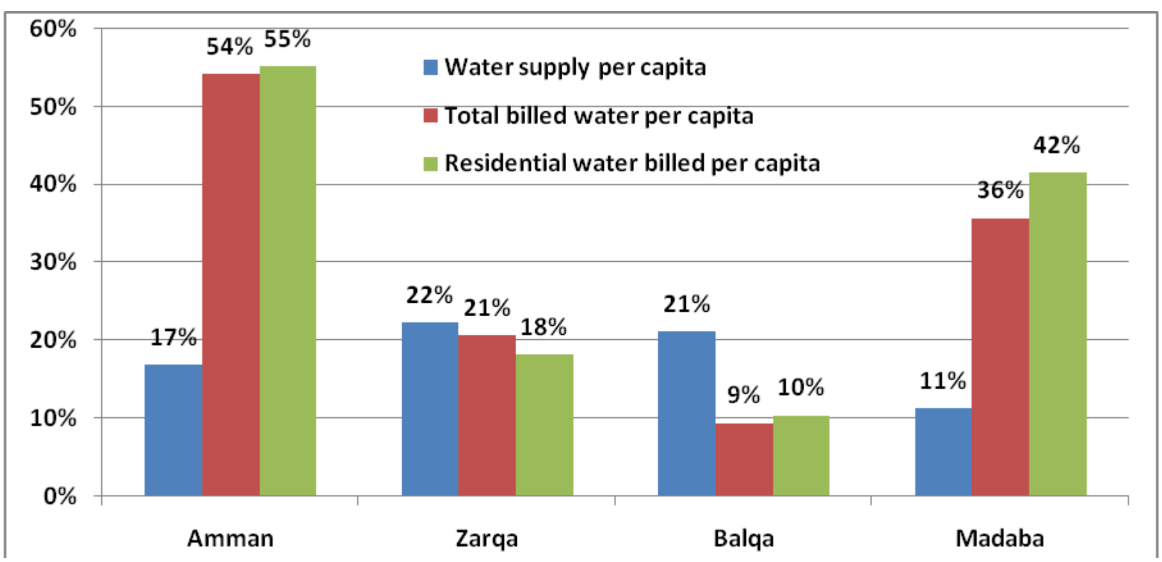
Amman compared with other middle governorates had the highest per capita billed water in 2008 as illustrated in Figure 16. In fact, Amman recorded the highest increase in per capita water billed over 2001-2008 although it had nearly similar increase in per capita water supply to the other middle governorates as presented in Figure 17. Again and as concluded previously, this is driven by the improvement on NRW. In contrast to Amman, Balqa governorate witnessed an increase in NRW which resulted in having an increase of 9% in billed water per capita despite the 21% increase in water supply per capita over 2001-2008. In general, the NRW ratios for all middle governorates except for Amman are above overall Jordan average (Figure 18).

Figure 16: Middle governorates total water billed and per capita water billed over 2001-2008



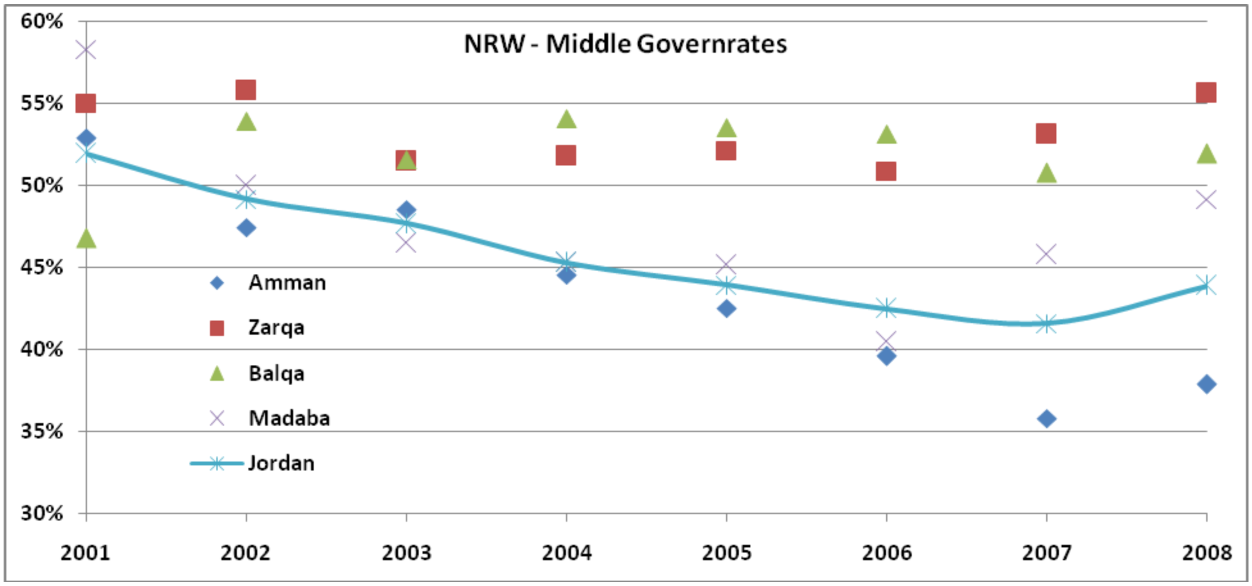
Source: WAJ

Figure 17: Change in water supply and billed water per capita in Middle governorates (2001-2008)



Source: WAJ

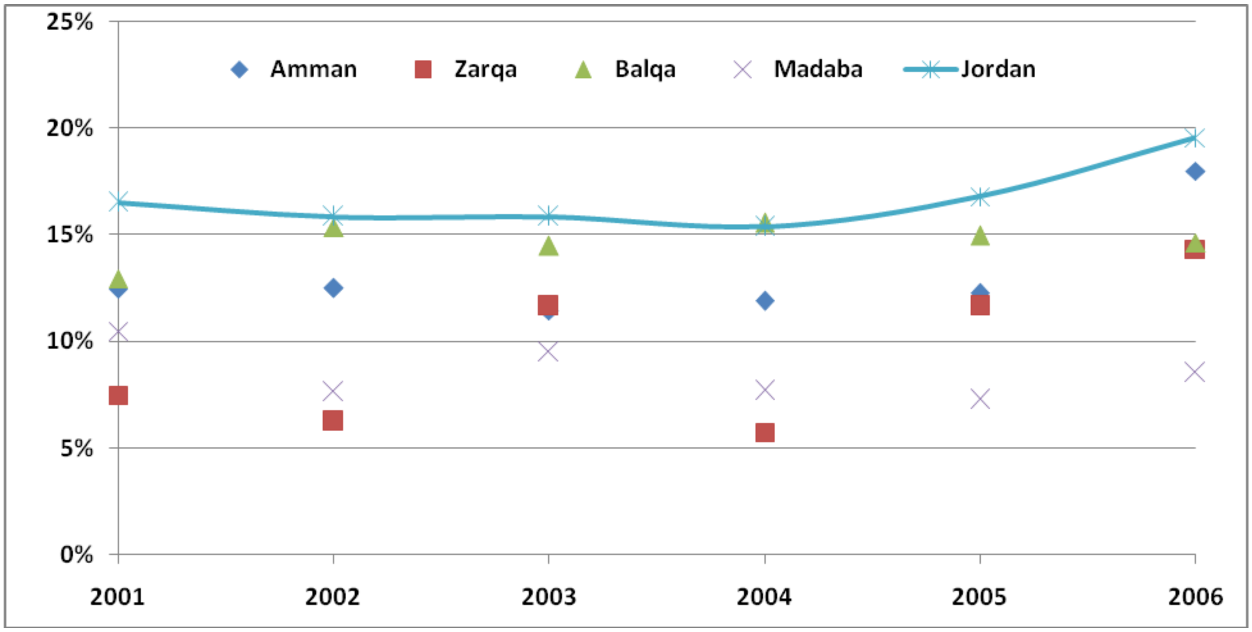
Figure 18: Middle Governorates NRW over 2001-2008



Source: WAJ

Ultimately, the type and size of the economic activities within each governorate should have an impact on the water needs. Therefore, it is expected to have larger per capita water supply and water billed in those governorates with more economic activities such as Aqaba and Amman. For example, in Aqaba around 70% of the total billed water is billed by the non-residential subscribers which resulted in having the per capita water billed to be three time the overall average of Jordan (82 lpcd). Among the other middle governorates; Amman has the largest ratio of the non-residential water billed to the total water billed (Figure 19) and has also the highest per capita water supply and water billed (Figure 13 and Figure 16). It is worth addressing that all middle governorates have lower percentage of non-residential billed water to the total billed water than the overall average of Jordan as shown in figure below.

Figure 19: The percentage of non-residential water billed to total water billed for middle governorates over 2001-2006



Source: WAJ

The demographic distribution in Jordan is concentrated in three governorates and their main cities (Amman, Zarqa and Irbid) where around 71% of Jordan's population is living those governorates. Moreover, these governorates in addition to Balqa have the highest population density. Such unbalance distribution of population increases the stress on the available water resources close to the populated areas and results in increasing the gap between the water available and demand on those governorates. Therefore, bulk water transfer among governorates particularly to those four governorates is expected. Table 8 summarizes the bulk water transfer among Jordan's governorates from the main water resources during 2001-2008.

In order to asses how the bulk water transfer among governorates is large, the per capita net water exported and imported is calculated and presented in Figure 20. It is clearly noticed Amman then Balqa has the largest per capita net water imported with around 115 and 53 lpcd of water supplied to each governorate respectively in 2008. In contrast, Mafraq has the largest per capita net water exported with around 71 lpcd in 2008. In general, the middle governorates have the largest exported water quantities.

Over 2001-2008, there is almost no significant variation on the per capita net water exported and imported among Jordan's governorates except for Mafraq which was exporting around 220 lpca in 2001 and dropped to around 70 lpcd by 2008.

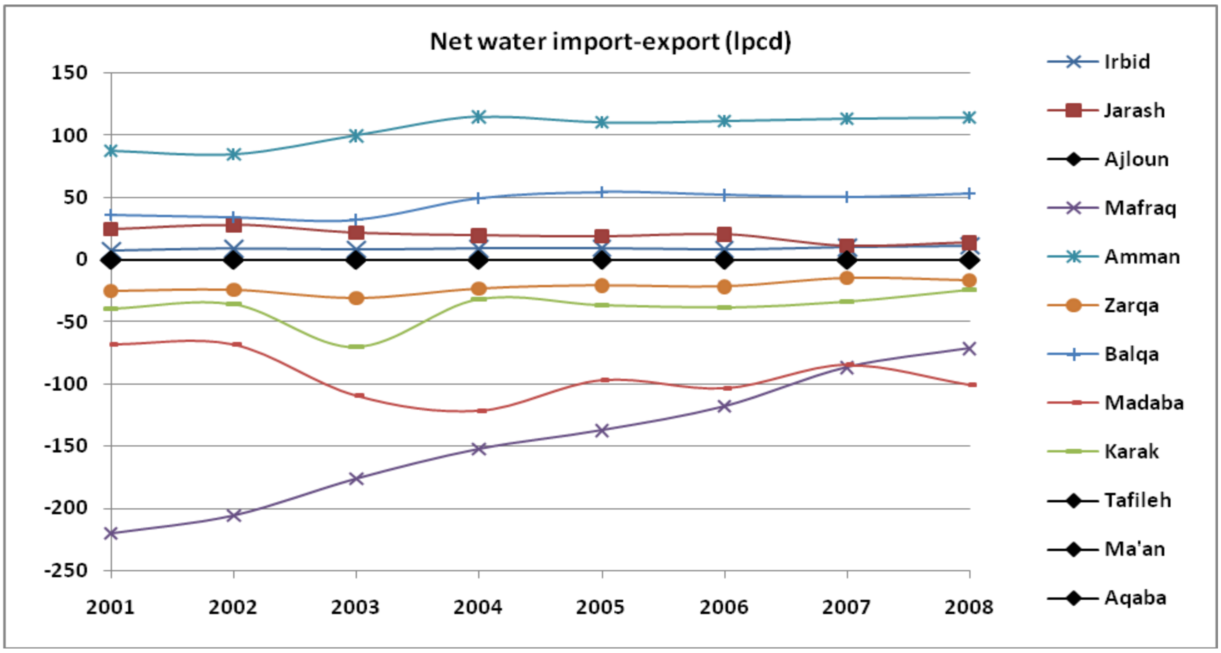
Net imported-exported water:
This is calculated based on the actual (physical) water resources locations not on the operational responsibility through subtracting the exported water from the imported water. Surface water resources including Zai and Zara Ma'in water system are considered external resources for all governorates since water is harvested in several governorates.

Table 8: Bulk water transfer among Jordan's governorates over 2001-2008 (based on the physical water source location)

Description from	2000	2001	2002	2003	2004	2005	2006	2007	2008
Za'atari (Mafraq) to Irbid	2,722,290	3,367,367	4,168,347	3,761,557	3,759,274	4,061,631	3,925,237	4,083,332	4,686,440
Za'atari (Mafraq) to Jarash	290,419	289,740	371,598	365,839	379,426	317,190	332,040	266,141	337,000
Za'atari (Mafraq) to Khaw (Zarqa)	15,319,579	13,923,955	12,297,186	11,200,830	9,864,861	8,621,172	7,096,568	4,217,057	2,248,230
Azraq (Zarqa) to Khaw (Zarqa)	15,759,260	15,972,985	12,277,270	14,765,880	14,043,990	13,328,758	13,183,030	13,585,716	14,240,022
Hallabat (Zarqa) to Khaw (Zarqa)	3,487,750	8,157,568	14,719,246	14,175,870	13,356,440	12,400,070	13,012,550	13,142,318	15,856,496
Corrodor (Zarqa) to Khaw (Zarqa)									
Khaw (Zarqa) to Amman	18,704,217	20,547,296	18,924,275	19,761,615	16,231,750	14,356,079	13,274,663	8,331,868	7,047,988
Khaw (Zarqa) to Zarqa	15,624,002	17,384,366	17,857,404	17,158,149	17,769,860	17,214,770	17,720,782	20,154,444	23,531,779
Zarqa to Mafraq	219,340	118,180	139,430	140,870	135,200	120,820	78,150	77,900	124,350
Zarqa to Balqa	117,720	117,720	80,357	77,327	98,571	48,751	75,897	65,823	59,027
Zarqa to Jarash	274,680	245,480	169,643	162,673	141,429	167,978	178,646	195,194	213,000
Irbid to Jarash	804,487	849,277	1,062,432	736,297	637,194	658,032	737,016	266,141	337,000
Lajjoun (Karak) to Amman		766,500	3,990,431	7,313,498	12,779,031	10,664,833	9,386,815	6,413,222	3,869,710
Lajjoun (Karak) to Karak			885,907	971,890	1,746,125	1,601,355	2,593,877	3,637,613	3,934,550
Wala-Lib (Mababa) to Amman	4,968,994	3,857,842	3,930,042	5,934,254	6,608,958	5,485,554	5,918,617	5,022,533	5,956,040
Wala-Lib (Mababa) to Madaba	4,967,983	5,350,226	5,468,067	5,340,250	5,442,121	5,548,632	5,749,443	6,255,745	6,775,361
Zai (External) to Amman	34,419,109	34,119,345	32,092,082	35,224,982	48,409,977	53,026,043	51,958,982	38,760,178	41,152,689
Zai (External) to Balqa	76,220	4,342,390	4,276,306	4,052,093	6,373,850	7,242,617	7,025,658	7,027,302	7,565,901
Zara Mai'n (External) to Amman)							5,524,936	31,209,546	35,529,588
Amman to Dhebaan (Maddaba)	613,990	594,269	583,008	554,624	620,644	624,203	619,799	599,616	594,826
Qatrana (Karak) to Amman	2,679,385	2,998,758	2,785,155	5,441,781	2,473,118	2,862,446	3,031,408	2,724,893	2,044,535

Source: WAJ

Figure 20: Net water quantity imported-exported in lpcd over 2001-2008



Source: WAJ

3.1.2 *Correlation Analysis for Middle Governorates*

This section is structured through imposing several and different hypotheses that examined in order to understand how water allocation is done among middle governorates through starting from the All Jordan governorates (AJG) level to the Middle Governorates (MG) level.

Hypothesis I: Does the increase in population leads to an increase in water supply?

Correlation analyzed: The increment of population with the increment of water supply for each governorate.

For years: *2001-2008*

Correlation results:

AJG

Multiple R = 0.5

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	164534.329	237733.811	0.692	0.4908	-308393.945	637462.602
X Variable 1	74.318	14.226	5.224	1.30E-06	46.018	102.618

MG

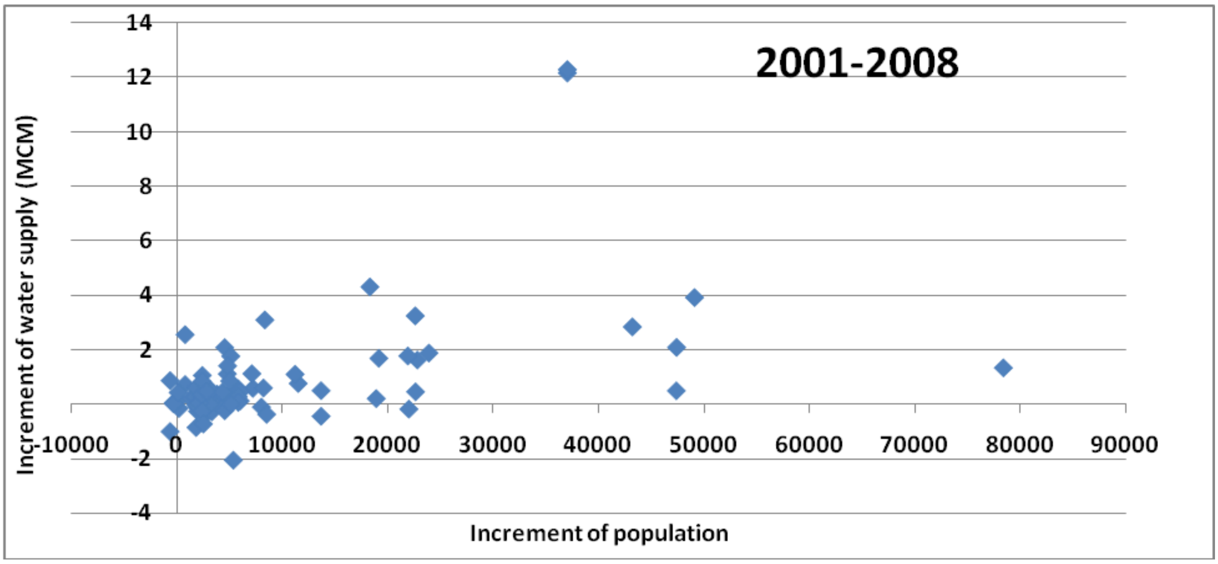
Multiple R = 0.4

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	829084.552	752840.420	1.101	0.281	-718401.079	2376570.2
X Variable 1	62.998	28.237	2.231	0.035	4.956	121.03882

Findings: There is average positive relation on both levels (AJG and MG) indicating that water supply is generally raised as the population grows. The coefficient variable is of significant value and has acceptable confidence level. Figure 21 illustrates this relation, however some points in the figure are scattered because of several reasons such as the large increase in the annual water supply of 12 MCM in Amman in 2003 and 2004 due to Zai expansion and Abu Ezeighan, the annul migration of tens of thousand Iraqi people after the American occupation of Iraq in 2003.

Implication and short conclusion: Population increase has moderate and positive significant influence on increasing the water supply but it is not the most significant factor that driving water supply increase.

Figure 21: Increment of population against increment of water supply over 2001-2008



Source: WAJ

Hypothesis II: Does the economic activity influence the water supply?

Correlation analyzed: The economic activity weight (measured as the % of Non-residential billed water to total billed water) with the lpcd of water supply.

For years: 2001-2006 and (2008 except for Amman and Aqaba)

Correlation results:

AJG

Multiple R = 0.92

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	73.3305	4.9667	14.7645	0.0000	63.4465	83.2145
X Variable 1	446.6350	21.1488	21.1186	0.0000	404.5474	488.7225

MG

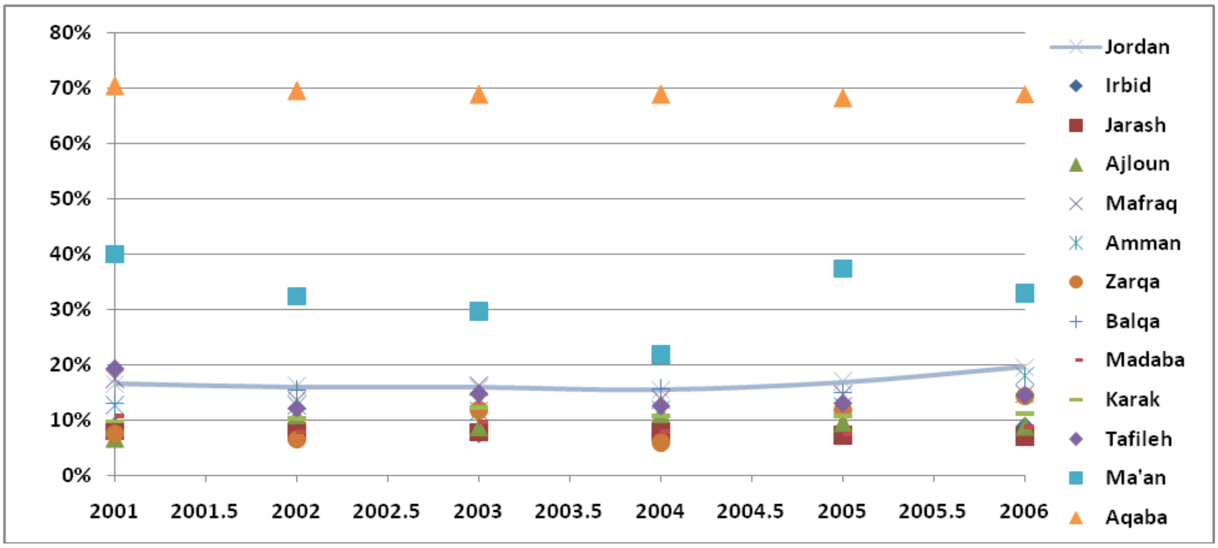
Multiple R = 0.7

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	101.1769	7.1600	14.1308	2.00E-13	86.4305	115.9232
X Variable 1	305.6419	60.6024	5.0434	3.331E-05	180.8288	430.4549

Findings: The results clearly support this argument and showed that the economic activity is positively highly significant. AJG has more positive relation than MG that can be justified by the high non-residential consumption in Aqaba and Ma'an on the AJG level and relatively low non-residential consumption in Madaba and Zarqa on the MG level. Figure 22 illustrates that most governorates except for Aqaba and Ma'an have lower non-residential subscribers ratio compared with the average overall Jordan. Additionally, the majority of the other governorates have non-residential subscribers ratio ranged between 6% and 19% while the overall average in Jordan of the non-residential water billed to the total water billed is 20% in 2006.

Implication and short conclusion: The economic activity is significantly influencing the per capita water supply in on overall Jordan's Governorates but it is less significant in middle governorates.

Figure 22: Non-Residential billed water to total billed water



Source: WAJ

<u>Hypothesis III: How the increase of the economic activities affects on NRW?</u>

Correlation analyzed: The increase in the non-residential subscribers (measured as the % of Non-residential billed water to total billed water) with NRW.

For years: 2001-2006 and 2008 except for Amman

Correlation results:

Multiple R for AJG = -0.28

Multiple R MG = -0.07

As it is not correlated, it is not necessary to examine the significance level.

Findings: The negative sign indicates that as the economic activity increase in the governorate the less is the NRW. However, the significance of the correlation value is low on the AJG level and almost close to zero the MG level. Historical NRW is shown Figure 15.

Implication and short conclusion: There is no influence of the increased the economic activities on improving the NRW.

Hypothesis IV: Does the level of imported water affect on the per capita water supply?

Correlation analyzed: The percentage of the net imported-exported water to the water supply per capita

For years: *2001-2008*

Correlation results:

AJG

Multiple R = -0.11

As the correlation coefficient (Multiple R) is close to zero, it is not necessary to examine the significance level.

MG

Multiple R = 0.73

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-3.9878	0.6962	-5.7282	0.0000	-5.4096	-2.5661
X Variable 1	0.0291	0.0050	5.7882	0.0000	0.0188	0.0393

Findings: On AJG level, there is negligible negative relation where more imported water leads to lower water supply per capita. However, on MG level there is good positive relation indicating that more net imported-exported water leads to more water supply per capita but the coefficient variable is not significant. This is justified by allocating more water to Amman than other MG during the last years. Figure 20 illustrates the change in net water imported-exported over 2001-2008. Eventually, additional water supply from external sources was allocated to Balqa which also influence the correlation value for the MG. Those governorates have the largest gap between the water demand and the available water resources compared with the other governorates.

Implication and short conclusion: On middle governorates level, the significant relation between the increase in the imported water and the increase in the supply per capita water reflects the political decision to transfer additional water quantities to Amman and Balqa from other governorates.

Hypothesis V: Does governorate wealth affect on the water supply per capita?

Correlation analyzed: Average annual income of household member with the per capita water supply.

For years: 2003, 2006

Correlation results:

AJG

Multiple R = 0.18

As the correlation coefficient (Multiple R) is close to zero, it is not necessary to examine the significance level.

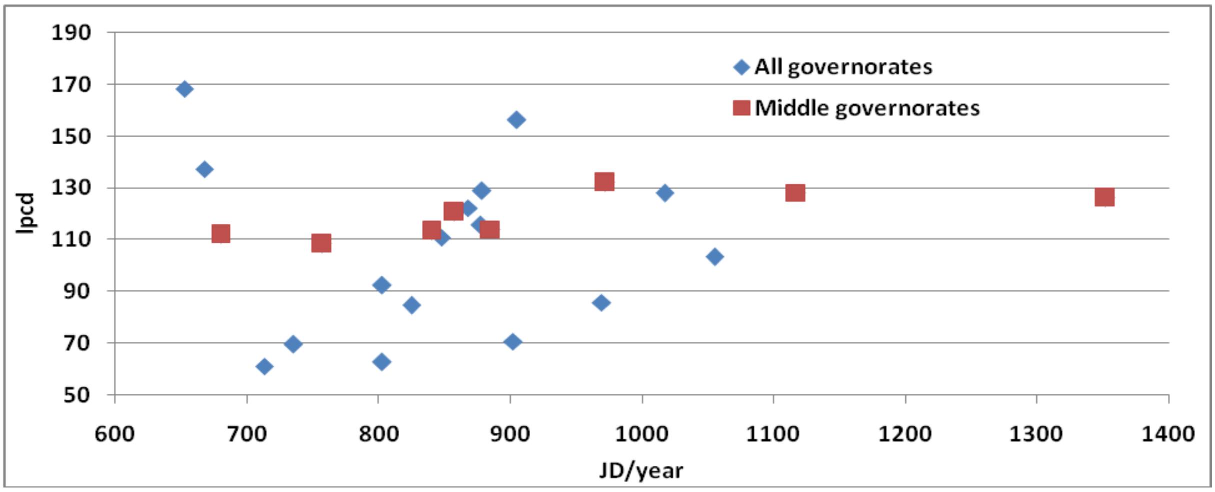
MG
Multiple R = 0.77

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	92.5615	15.3198	6.0420	0.0009	55.0754	130.0477
X Variable 1	0.0479	0.0161	2.9837	0.0245	0.0086	0.0872

Findings: In general the relation is positive indicating that there is more water supply allocated to the wealthier governorates. Additionally, it is clearly more influence on the MG level than the AJG level but with low significance. It is clearly seen that the richer governorate (Amman and Balqa) are receiving more water supply than the poorer governorates (Zarqa and Madaba). Figure 23 illustrates this relationship and clearly demonstrates that the relation on the MG level is more obvious than on the AJG.

Implication and short conclusion: The household member in the middle governorates who enjoys more income level is provided by larger water supply quantity.

Figure 23: Annual income of household member with per capita water supply



Source: WAJ and DOS

<u>Hypothesis VI: Does the bulk water supply increase in AJG and MG increase the bulk water supply in Zarqa Governorate?</u>

Correlation analyzed: Per capita water supply for AJG and MG excluding ZG with per capita water supply in Zarqa Governorate

For years: *2001-2008*

Correlation results:

AJG

Multiple R = 0.89

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-83.0284	43.5766	-1.9053	0.1054	-189.6566	23.5997
X Variable 1	1.5175	0.3109	4.8814	0.0028	0.7568	2.2782

MG

Multiple R = 0.84

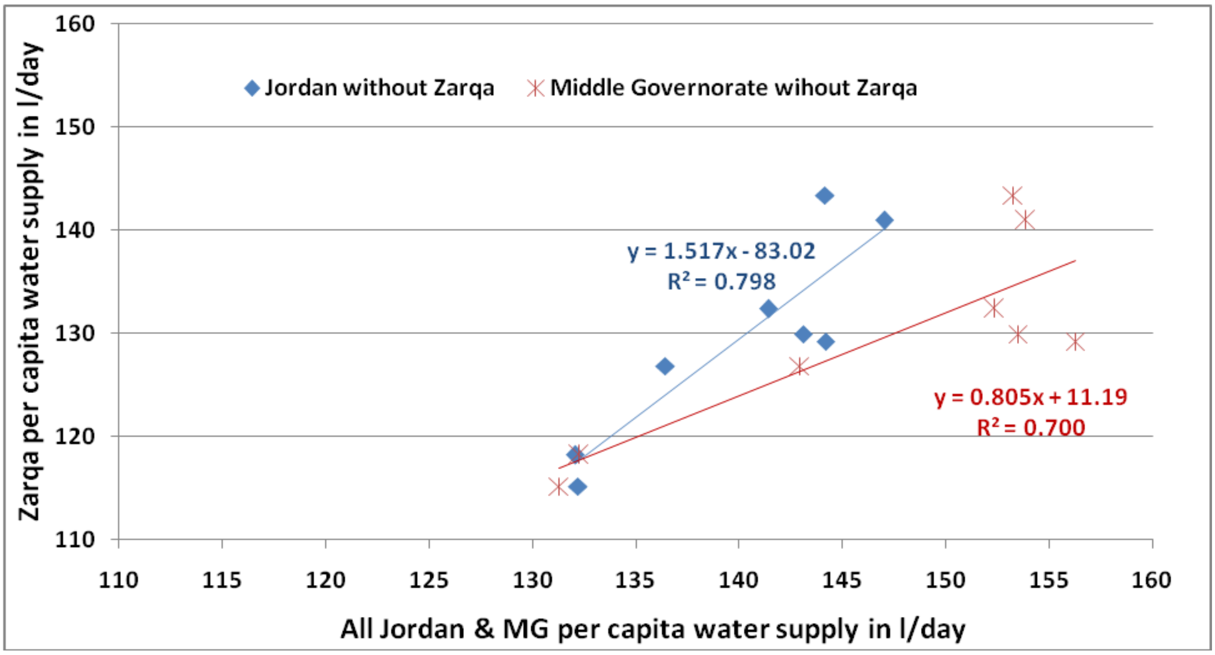
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	11.1955	31.6667	0.3535	0.7358	-66.2902	88.6811
X Variable 1	0.8052	0.2150	3.7447	0.0096	0.2790	1.3313

Findings: There is strong positive relation between the increase in the bulk water supply of AJG and MG and Zarqa water supply. However, an increase of 1 lpcd on the AJG level leads to an increase of 1.52 lpcd on Zarqa level while same increase on the MG level leads to only 0.8

lpcd on Zarqa level reflecting that the other MG benefits more from the overall increase on the bulk water supply. The interpolation equations shown in Figure 24 demonstrate this relation.

Implication and short conclusion: Zarqa governorate enjoys more increase in water supply per capita than other governorates but less increase than middle governorate when there is an increase in the per capita water supply in the AJG and MG respectively.

Figure 24: Per capita water supply in all Jordan and middle governorates against the per capita water supply in Zarqa Governorate during 2001-2008



Source: WAJ

<u>Hypothesis VII: Does governorate wealth affect on the residential water consumption per capita?</u>

Correlation analyzed: The average annual income of household member with the per capita residential water consumption.

For years: 2003, 2006

Correlation results:

AJG

Multiple R = 0.28

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	56.4836	19.7934	2.8537	0.0092	15.4347	97.5326
X Variable 1	0.0309	0.0223	1.3843	0.1801	-0.0154	0.0771

MG

Multiple R = 0.75

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	65.9912	8.3972	7.8588	0.0002	45.4441	86.5383
X Variable 1	0.0243	0.0088	2.7557	0.0330	0.0027	0.0458

Findings:

The result is very close to the hypothesis V which indicates that there is minor influence of governorate wealthy on the consumption rates in the AJG level, while this relation is good in the MG level but has low significance. In fact, the close result of this hypothesis and hypothesis V raises the need to examine the relation between the per capita water supply and the per capita residential water consumption in order to make sure the these variables are not dependent.

Residential Water consumption:
This is estimated through summing up the residential billed water and the administrative losses part consumed by the residential subscribers (that is calculated by estimating the overall administrative losses adjusted by the ratio of residential billed water to the total billed water). In all calculation administrative losses are assumed to be 50% of the NRW.

Implication and short conclusion: The household member in the middle governorates who enjoys more income level consumes more water.

<u>Hypothesis VIII: Does water supply per capita change affect on the residential water consumption per capita?</u>

Correlation analyzed: The per capita water supply with the per capita residential water consumption.

For years: 2001-2006, and (2008 except for Amman and Aqaba)

Correlation results:

AJG

Multiple R = 0.70

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	58.7917	3.1371	18.7406	0.0000	52.5486	65.0348
X Variable 1	0.1631	0.0186	8.7803	0.0000	0.1261	0.2000

MG

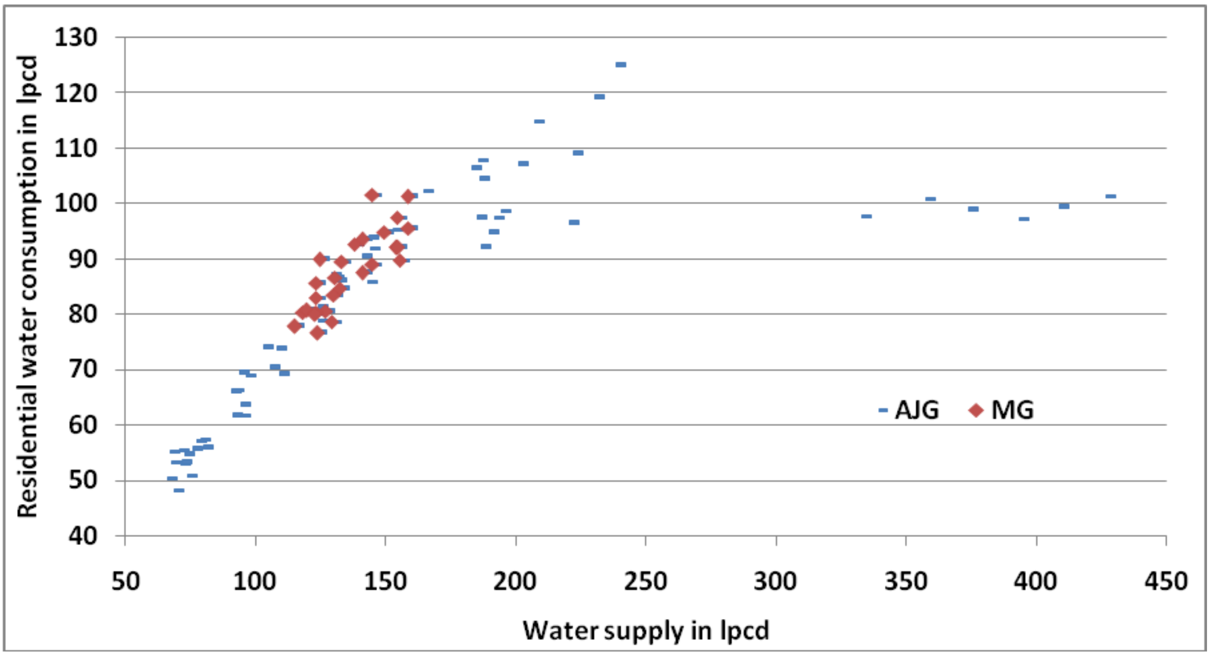
Multiple R = 0.84

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	28.8771	7.7371	3.7323	0.0010	12.9423	44.8120
X Variable 1	0.4317	0.0566	7.6242	0.0000	0.3151	0.5483

Findings: There is strong positive relation between the increase in the water supply per capita and the increase in residential water consumption particularly in the MG. However, the relation significance is moderate but it is more significant on the MG level than AJG level. Figure 25 clearly illustrates this relation. The few points on the right side of the figure are for Aqaba governorate in which the water supply per capita is much larger than other governorates due to the large non-residential consumers. Therefore, excluding Aqaba from the analysis will result in improving the correlation value on the AJG.

Implication and short conclusion: the change in water supply and the change is residential water consumption are dependent variables. The more water supply per capita, the more residential water consumption per capita will occur and more significantly in the MG.

Figure 25: Per capita water supply relation to per capita residential water consumption



Source: WAJ

3.1.3 Factors Affecting Drinking Water Allocation between Middle Governorates

The following table is summarizing the correlation analysis for the potential factors that might affect on the water allocation between Jordan's and Middle governorates.

However, there are many other factors that affect how water is allocated among middle governorates that are difficult to be address through the correlation analysis and these may include:

- political decisions;
- Infrastructure constraints such as pipeline size, pressure, transfer system availability, etc.;
- the political influence of the community voice; and

Additionally, the NRW and illegal water use behaviour and distribution are important factors that affect on the water consumption and allocation which are difficult to ensure its level of influence due to the difficulties in understanding where the NRW goes.

Table 9: Correlation analysis summary for AJG and MG

Hypothesis	**Short conclusion**	
	AJG	**MG**
Hypothesis I: Dose the increase in population leads to an increase in water supply?	Moderate influence and positively significant	Moderate influence and positively significant
Hypothesis II: Does the economic activity influence the water supply?	Very high influence significant and positively significant	high influence significant and positively significant
Hypothesis III: How the increase of the economic activities affects on NRW?	Minor improvement	No influence
Hypothesis IV: Does the level of imported water affect on the per capita water supply?	No influence	Noticeable influence but low significance
Hypothesis V: Does governorate wealth affect on the water supply per capita?	No influence	Good influence but low significance
Hypothesis VI: Does the bulk water supply increase in AJG and MG increase the bulk water supply in Zarqa Governorate?	High influence and significance, more increase in Zarqa than others	High influence and significance, less increase in Zarqa than others
Hypothesis VII: Does governorate wealth affect on the residential water consumption per capita?	Minor influence	Good influence but low significance
Hypothesis VIII: Does water supply per capita change affect on the residential water consumption per capita?	Moderate influence and significance	High influence and moderate significance

3.1.4 Findings and Conclusions

It can be concluded from the assessment carried out above that the population increase and the level of the economic activities are diving the water allocation among Jordan's governorates. It is also important to address that the overall increase in bulk water supply all over Jordan has led to greater influence than the overall increase in the bulk water supply over the middle governorates on the water supply increase in Zarqa governorates, which reflects the political power to transfer more water to Amman and Balqa in the middle governorates.

Additionally, there is clear influence and significant impact of the increase in water supply per capita on the residential water consumption per capita, which implies that the limited water supply quantity has significant impact on the ability of Jordan's population to consume more.

3.2 ASSESSMENT OF ZARQA GOVERNORATE DRINKING WATER DISTRIBUTION AFFECTING UNDER-CONSUMPTION

3.2.1 Zarqa Governorate Historic Overview

Table 10: Water supply of Zarqa Governorate's districts in m^3/year

District	2004	2005	2006	2007	2008
Zarqa + Bireen	28,721,352	23,416,876	24,098,459	27,218,658	28,055,992
Al_hashmeieh		2,240,660	2,468,470	2,487,200	2,940,910
Azraq		1,591,350	1,954,850	2,308,360	1,914,153
Al_Dhulial		1,955,843	2,176,030	2,438,370	2,332,660
Russaifeh	8,689,220	9,185,711	9,496,774	10,126,245	9,592,791
Total	**37,410,572**	**38,390,440**	**40,194,583**	**44,578,833**	**44,836,506**

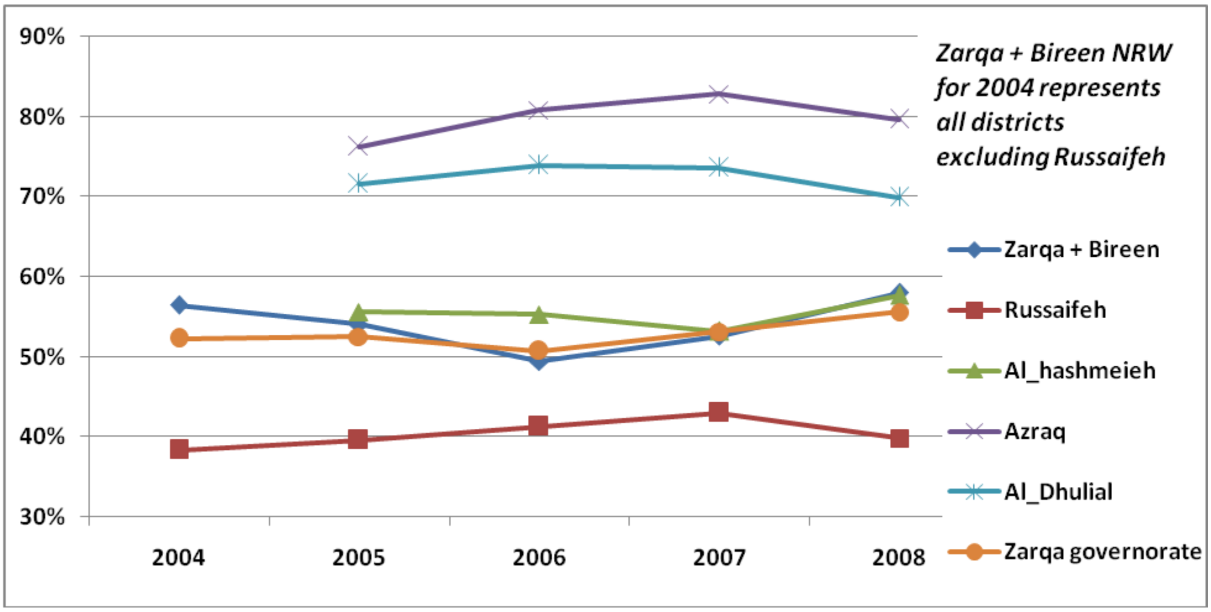
Source: WAJ

Table 11: Total water billed of Zarqa Governorate's districts in m^3/year

District	2004	2005	2006	2007	2008
Zarqa + Bireen	12,503,946	10,747,152	12,177,376	12,906,892	11,784,183
Al_hashmeieh		994,141	1,102,414	1,163,343	1,242,897
Azraq		377,537	374,890	396,225	389,428
Al_Dhulial		554,869	567,531	642,454	701,035
Russaifeh	5,356,155	5,548,131	5,574,461	5,769,900	5,772,529
Total billed - Zarqa	**17,860,101**	**18,221,830**	**19,796,672**	**20,878,814**	**19,890,072**

Source: WAJ

Figure 26: NRW of Zarqa governorates districts over 2004-2008



Source: WAJ

3.2.2 *Correlation Analysis for Zarqa Governorate*

Hypothesis I: Does the increase in Zarqa water supply increase the billed water for residential?

Correlation analyzed:

The increment of per capita water supply with the increment of per capita residential water billed

For years: *2001-2008*

Correlation results:

Multiple R = -0.002

As there is no correlation, it is not necessary to examine the significance level.

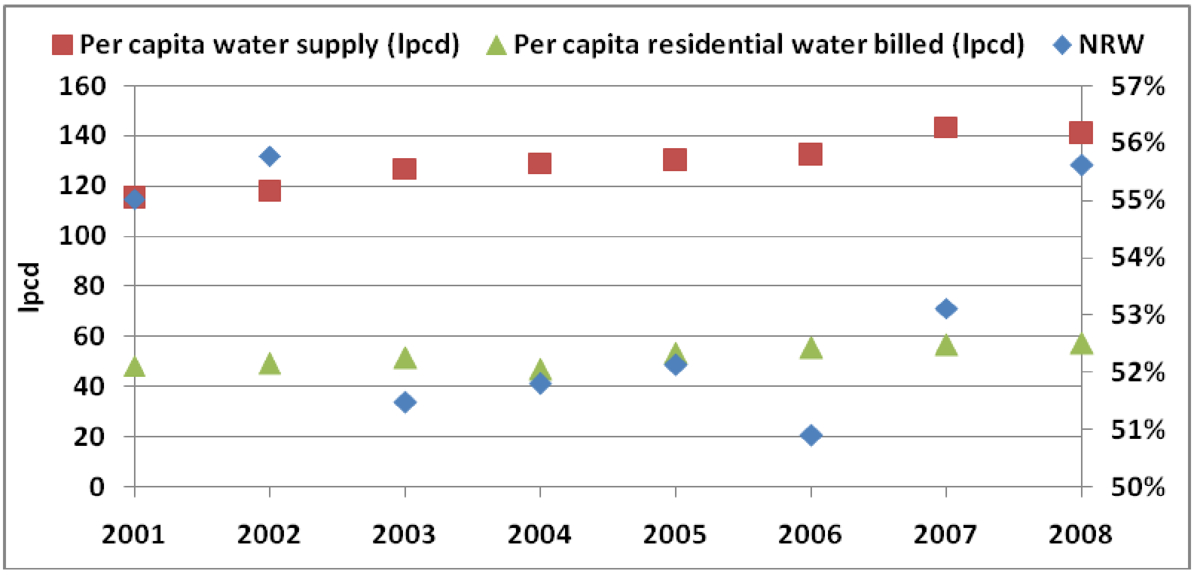
Findings:

There is no increase on the residential billed water as a result of water supply increase. The correlation result is neutral with almost a zero correlation factor.

Implication and short conclusion:

The more water supply quantities in Zarqa governorate will not lead to more water billed. The key factor is the NRW.

Figure 27 per capita water supply, billed water and NRW for Zarqa Governorate



Source: WAJ

<u>Hypothesis II: Does the increase in Zarqa water supply increase the water consumption for residential?</u>

Correlation analyzed:

The increment of per capita water supply with the increment of per capita residential water consumption.

For years: *2001-2008*

Correlation results:

Multiple R = 0.612

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.1343	1.8283	0.0735	0.9443	-4.5654	4.8341
X Variable 1	0.5612	0.3240	1.7319	0.1438	-0.2718	1.3942

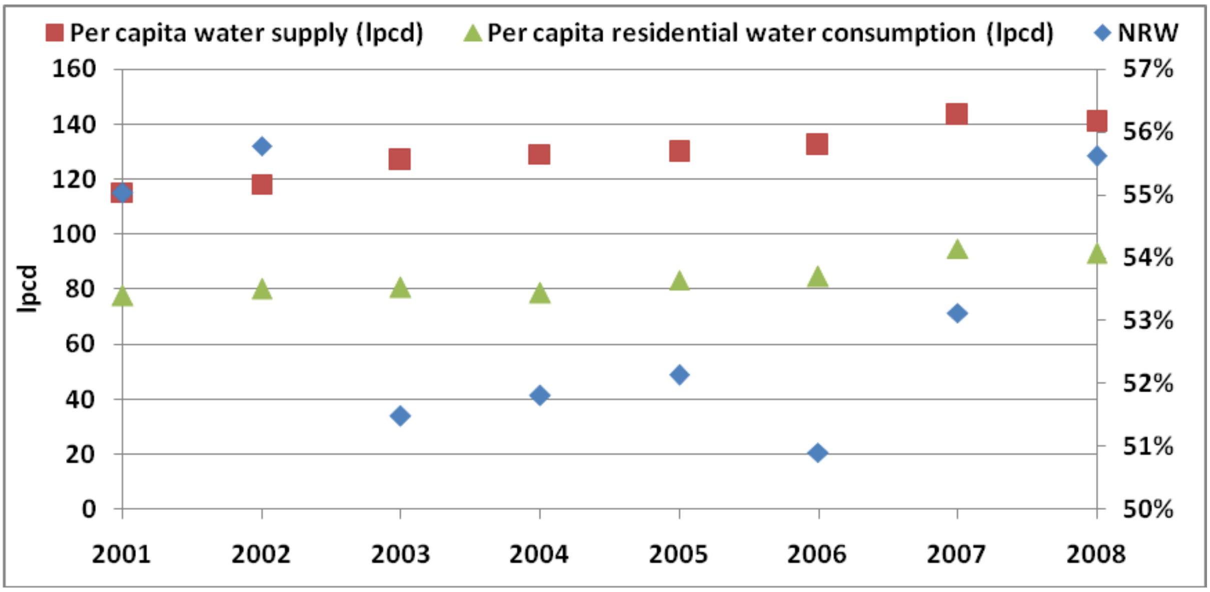
Findings:

The increase in water supply historically led to a moderate and significant increase in the residential water consumption. This is opposite to the previous hypothesis where the administrative losses (50% of the NRW) that are assumed to be consumed by the water subscribers are important factor that affects on the water consumption level. Therefore and due to moderate influence, it is important to deal carefully with this hypothesis.

Implication and short conclusion:

Theoretically, the increase in water supply will lead to an increase in residential water consumption due to the high administrative losses where high portion of these losses are due to the illegal use of water.

Figure 28 per capita water supply, water consumption and NRW for Zarqa Governorate



Source: WAJ

<u>Hypothesis III: Does the increase in Zarqa water supply increase the billed water for residential on zone level?</u>

Correlation analyzed:

The increment of per capita water supply overall Zarqa with the increment of per capita water billed for residential on zones level.

For years: 2004 and 2008

Correlation results:

Multiple R = 0.22

As there is no correlation, it is not necessary to examine the significance level.

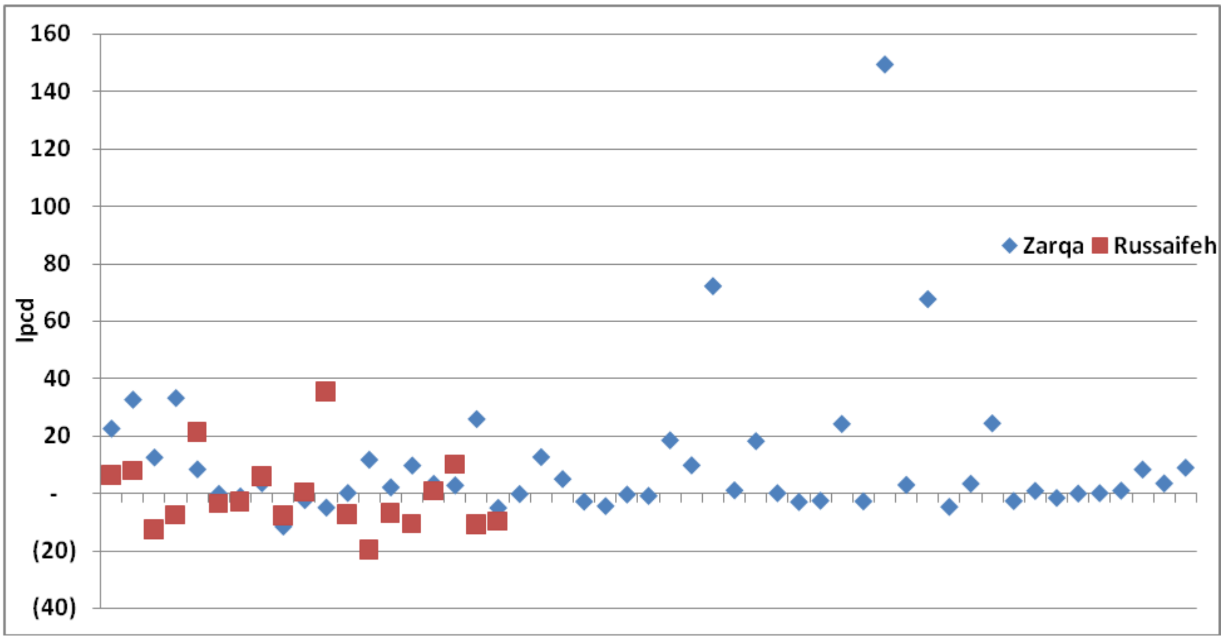
Findings:

Water supply per capita in Russaifeh has decreased from 91 to 88 while for over Zarqa regions have increased from 136.5 to 143.8. The correlation is positive but weak which means that the increase per capita in water supply leaded into an increase in per capita residential water billed. Moreover, the available water supply data on district level only does not allow performing good analysis on zones level. Therefore, it is difficult to argue if there is influence. See Figure 29 for illustration.

Implication and short conclusion:

No practical conclusion and implication can be extracted.

Figure 29: Change in residential water billed in 2004 and 2008



Source: WAJ

<u>Hypothesis IV: Does the increase in Zarqa water supply increase the billed water for poor residential on zone level</u>

Correlation analyzed:

The increment of per capita water supply overall Zarqa with the increment of per capita water billed for the poor residential on zones level. Poor zone has been identified according to DOS scale of 1-4 at 1.75.

For years: 2004 and 2008

Correlation results:

-0.304

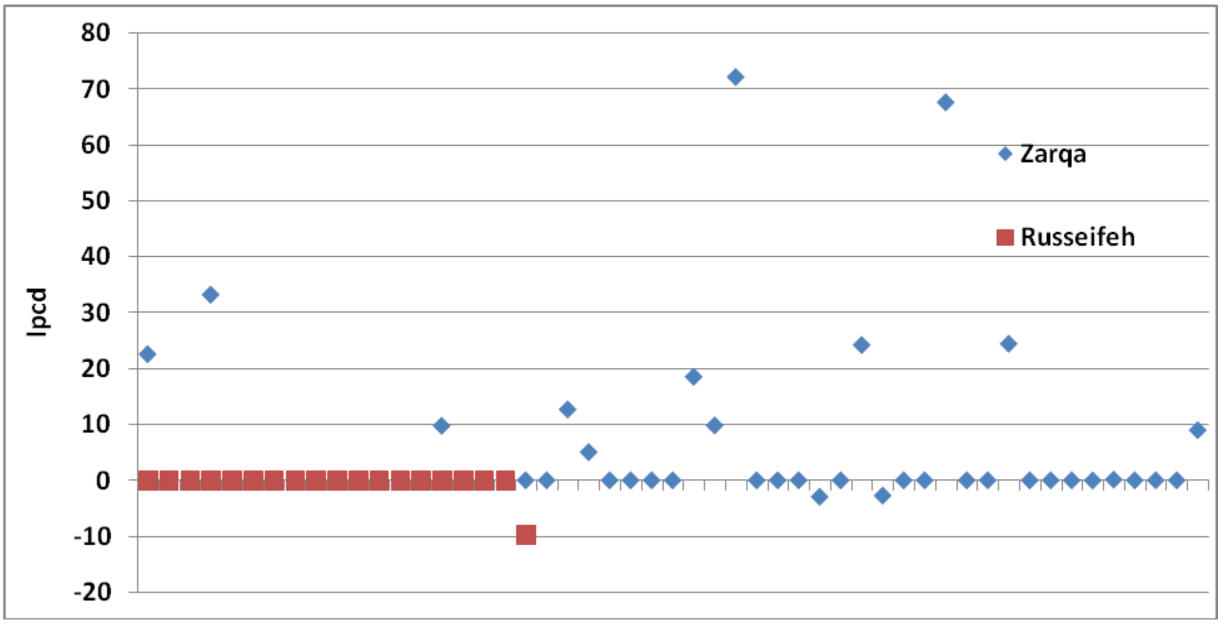
Findings:

The result shows that poor zones have noticed decrease in residential water billed per capita when the water supply per capita has increased. Similar to the previous hypothesis, the limited water supply data availability does not allow performing confidence level of the analysis. Figure 30 show change in residential water billed for the poor zones. Points located at the zero consumption rates are for the non-poor zones which are left to show the number of poor zones to the non-poor zones.

Implication and short conclusion:

No practical conclusion and implication can be extracted.

Figure 30: Change in residential water billed for poor zones in 2004 and 2008



Source: WAJ

Hypothesis V: Does residential water consumption decrease by poverty rate reduction?

Correlation analyzed:

Per capita residential water billed with poverty rate (1=high, 4=low)

For years: 2008

Correlation results:

Analysis on All Neighborhood Zones = -0.16

Analysis on Selected Neighborhood Zones (All zone excluding those listed **Table 46**) = -0.04

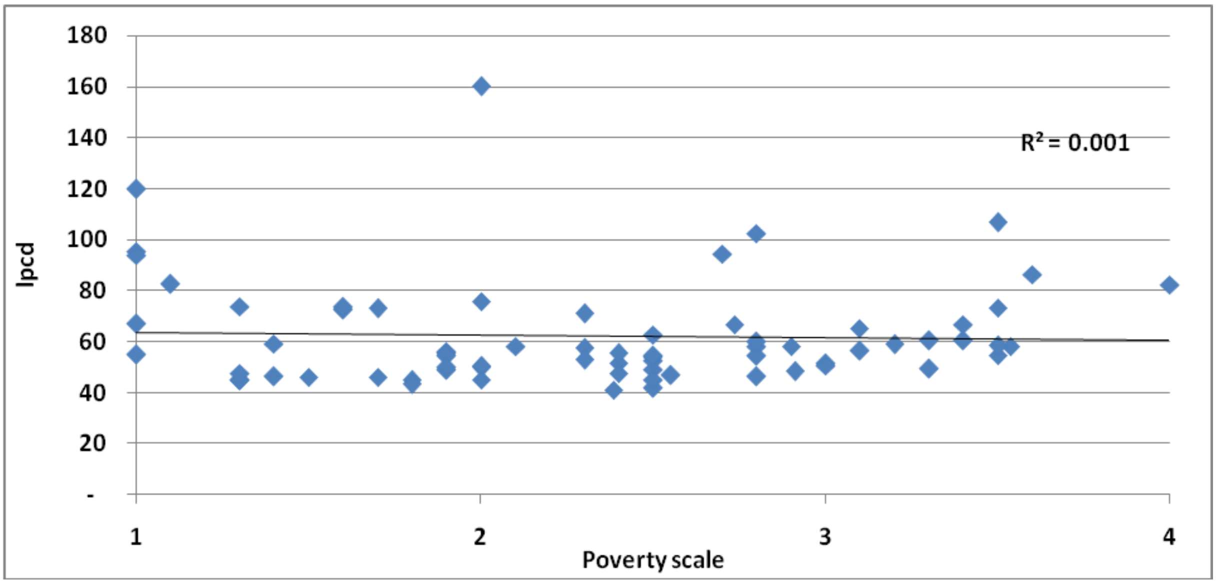
Findings:

The negative sign indicates that more poverty indicates higher residential billed water. However, the correlation value is close to zero which means that poverty rate has almost no effect on consumption.

Implication and short conclusion:

There is no relation of being poor with the water consumption level

Figure 31: per capita water billed against poverty scale on Zarqa priority investment zones



Source: WAJ

3.2.3 *Factors Affecting Water Consumption*

The following table summarized the correlation analysis that addresses the potential factors that might affect on the water consumption rates on Zarqa governorate level.

Table 12: Correlation analysis summary for Zarqa Governorate

Hypothesis	**Short conclusion**
Hypothesis I: Does the increase in Zarqa water supply increase the billed water for residential?	No influence
Hypothesis II: Does the increase in Zarqa water supply increase the water consumption for residential?	Moderate influence and high significance
Hypothesis III: Does the increase in Zarqa water supply increase the billed water for residential on zone level?	Weak assessment due to data limitation
Hypothesis IV: Does the increase in Zarqa water supply increase the billed water for poor residential on zone level	Weak assessment due to data limitation

Hypothesis V: Does residential water consumption decrease by poverty rate reduction?	No influence

There are other factors that are difficult to assess through the correlation analysis that can affect on the water allocation and consumption similar to those mention in section 3.1.3.

3.2.4 Findings and Conclusions

The main finding is that the more water supply quantity is put in the system the more residential water consumption is expected by water subscribers. Additional, poverty does not seem to have any influence on the residential consumption rates.

3.3 UNDER-CONSUMPTION ANALYSIS – ECONOMETRIC MODELLING

A general set of factors were identified which identify households according to socioeconomic characteristics and were likely to affect household water consumption. Each of these factors was considered for inclusion in the new household survey. A list of those factors and their potential use is discussed below:

1	**Price/tariff:**	The price of water from each source may be an important variable in determining consumption from that source and other sources. Consumption of water is expected to be inversely related to the prices paid, but many studies have found that the elasticity of demand (price responsiveness) is low, implying that water consumption is not very sensitive to price changes. Price responsiveness may vary across households, particularly across different income levels. Moreover, it is likely that the price households pay for water from different sources will vary across households and locations
2	**Supply frequency**	The public system does not provide continuous flow of culinary water to most households in Zarqa. The number of days per week that a household has access to water in part determines how much water it will consume.
3	**Supply duration**	The number of hours per day that water is available also determines, along with supply frequency, how much water the households can access. In fact, the number of hours per week (frequency of supply multiplied by duration of supply) determines the household access to water, although line pressure and supply pipe size can also influence the amount of water a household can take from the system.
4	**Household storage capacity**	Since public water supply is not continuous, and may be of limited frequency and duration, most households in Jordan have invested in household storage facilities, usually ranging from 1 to 3 cubic meters per unit, and frequently including more than one unit. This storage capacity provides households with the ability to store bulk water from public or other (tankers) suppliers and extend their effective access to potable water.

5	**Water quality**	The quality of water delivered by the public system can vary substantially. Households can be expected to shift among water sources as the perceived water quality varies. Perceived water quality It has several components, including color, taste, purity (in terms of particulate matter), and general potability. Water quality also plays a role in the amount of treatment a household may employ to improve water sources with diminished water quality, as well as potentially affecting family health.
6	**Household income and expenditure**	These data permit the analyses of the consumption of various strata of households, including poor households, one of the specific objectives of the study.
7	**Number of household members**	The size of the household may have significant impacts on wate consumption, both because of increased demand for water by large households, but also through decreasing disposable income effects with increasing size.
8	**Household facilities**	These data permit the classification of households by both their socioeconomic status and by their use of various kinds of facilities to conserve water. Included in these variables are such items as low-consumption devices, rainwater and grey water storage and reuse,

3.3.1 Data sources and sets

ECO Consult team carefully reviewed the three existing data sets identified above to determine if they were adequate to estimate household demand functions for the multiple water sources.

The GFA Consultants developed a detailed baseline study of the water consumers inZarqa Governorate, as well as theBalqa and Madaba Governorates. The results of this study suggested thatZarqa Governorate had the lowest per capita consumption of the three governorates, as well as having the lowest average income and expenditure per household of the three governorates. Thus, Zarqa Governorate was selected for the MCC intervention projects aimed at improving the conditions of the poor. Unfortunately, the data sets collected by GFA did not permit a detailed econometric analysis of the consumption of and demand for water in that Governorate, in particular because the links between individual household responses and consumption data were not available. Eco Consult found the following problems with this data set:

- Specific household income missing for some households
- Specific household consumption from other than public sources not available

- Most household characteristics are not included
- Household reservoir/tank availability and size not included

The second data set was from the DoS census data. While this data set included many of the appropriate variables for household characteristics, it was available only on an aggregated block basis. The team could not identify specific households with these data. For that reason, the DoS data could not be used in the analyses.

The third data set included two different kinds of data from the WAJ: metered delivery and consumer satisfaction. The metering data provided could not be identified with specific households from the GFA study, so that metered consumption by household could not be obtained. Moreover, consumption from other sources was not included. The consumer satisfaction data could not be linked with specific households, either. Thus, the ECO Consult needed to develop data bases consistent with the need for econometric analyses.

We obtained three different sets of data for specific households withinZarqa Governorate. These included : (1) a new household survey completed by the Jordan Department of Statistics (DoS); (2) meter and billing data for the households in the DoS survey from the Water Authority of Jordan; and (3) selected data from the Water Authority of Jordan (WAJ) on complaints received by WAJ about the public system and reliability of the system.

A discussion of each data set file and its use is discussed below.

- *Household survey data*

Following the findings reported in the Inception Report regarding the inadequacy of the existing data sets for an analysis of household-level demand for water, a household survey of a stratified random sample of households in Zarqa was undertaken by the Jordanian Department of Statistics (DoS), using a questionnaire formulated by the ECO Consult in consultation with MCA-Jordan and DoS (see Annex B). These data were collected during the period from about the first of December, 2009, to mid- December, 2009. On December 16, the data were provided to the ECO Consult team and MCA-Jordan.DoS provided a weighting value for each observation based on its probability of being selected relative to a random sample. The formula for calculating those weights is found in Annex B.

To begin our analyses, we examined the standard statistical measures (mean, standard deviation, minimum, and maximum) of the variables that we selected for use in both the exploratory analyses and the more complex multi-equation demand analyses. These standard measures can be found in Table 1 of Annex B. Selected measures are presented in Table 13. In addition, we developed correlation matrices based on those selected variables. These correlation matrices can be found in Tables 2 and 3 of Annex B.

ECO Consult has agreed with MCA-Jordan on the initial list of correlations that need to be looked at and that were found important to the project (see Annex B). Within that list were several variables for which data were either very sparse or problematic. The list in Annex B is annotated with respect to the correlations examined, those that were not, and why.

The DoS data set is generally of very high quality; the significant instances of missing data were expected, both because some respondents did not use some of the sources of water (for example tanker water use) and because some were reluctant to provide responses to certain portions of the questionnaire (for example, the reduction in observations on household income).

These data indicated that 1177 households, or approximately 97 percent, reported being connected to the public water system. Thus, separate statistical analyses for the remaining 37 households would have been problematic due to the small sample size.

- *Meter and Billing Data*

Quarterly meter readings and billings from the WAJ were obtained for each of the sampled households from the first quarter of 2001 through the second quarter of 2009. We concluded that the data from the past three years (Quarter 1, 2006 through Quarter 2, 2009) would be sufficient data for our analysis. For that period, of the 1177 households reporting that they were receiving public system water, we received meter and billing data for an average of 955, or approximately 81%, of the households. The number of households for which we received meter and billing data increased throughout that period, with an average of about 975 for the first through fourth quarters of 2008. We determined that using the most recent billing periods would be preferable to using longer term averages.

The data indicated an average quarterly meter reading of approximately 42 cubic meters, with a standard deviation of about 17 cubic meters. For the high-use seasons (the third quarter) of 2006, 2007 and 2008, the average meter reading was approximately 50 cubic meters, with a standard deviation of approximately 32 cubic meters. For the low use season (first quarter) of those same years, the average meter reading was approximately 35 cubic meters with a standard deviation of 23 cubic meters. We determined that the focus of our study should be on the high demand season because the demand pressure on the public system was much higher, and the likelihood of water shortage appeared would be correspondingly higher. In fact, there was sufficient variation across the meter readings that we focused on the third quarter of 2008 as the appropriate period for our multiple demand analyses. It should be noted that approximately 39% of households reported sharing a meter with up to 7 other households, which accounts for the discrepancy between metered water data and household water use from the public system found in this report's tables. It should be noted that the benefits calculations (found below in Section 4) are based on the 3rd quarter data, so that it is likely that the Net Present Value is overstated.

Table 13 Standard statistical measures of selected variables (adjusted for sample weighting) for Spring quarter, 2008 (note that some variables have a significantly reduced number of observations

Variable	Mean	Standard Dev.	Min obs.	Max obs.	Number reporting
HH Income (JOD) per month	306.45	202.20	40	2,500	1198
HH Expenditure (JOD) per month	318.28	198.71	40	2,500	1203
HH size (persons)	5.39	2.29	1	18	1214
House area (m^2)	125.98	51.31	20	427	1214
Storage tank capacity (m^3)	3.29	3.56	1	68	1208
Average hours of public water available/week	37.00	30.81	0	168	1214
Average quantity of public water use per household/quarter (m^3) [WAJ data]	36.00	22.23	0	172	937
Average quantity of tanker water use per household /quarter (m^3)	31.71	25.58	2	160	130
Average quantity of shop water used per household/quarter (m^3)	0.55	0.40	1.12	0.012	402
Average quantity of bottled water used per household/ quarter (m^3)	0.104	0.113	0.16	0.009	49

The study is focused on the under-consuming households, poor households, and poor households that under-consume. Table 14presents a categorization of the respondents by income levels and consumption levels. Note that not all households reporting income also had consumption data from the meters and not all households with metered data reported incomes. Of the approximately 39% of households reported sharing a meter with other households, 204 were poor (40.5%), 182 were medium income (41.6%), and 70 were rich (29.9%).

Table 14Water consumption by income category

Consumption/ Income group	Numb of hhlds	<20 m³/quart	20-40 m³/quart	40-60 m³/quart	60-80 m³/quart	>80 m³/quart	<50 l/cap/day
Poor (<550 JOD per cap/yr	504 (46.8%)	40 (9.8%)	124 (30.2%)	112 (27.3%)	66 (16.1%)	68 (16.6%)	256 (50.8%)
Medium (>550, <1050 jOD per cap/yr	437 (40.6%)	40 (11.1%)	105 (29.1%)	96 (26.6%)	63 (17.5%)	57 (15.8%)	175 (40.0%)
Rich (>1050 JOD per cap/yr	234 (21.7%)	31 (15.9%)	72 (36.9%)	51 (26.2%)	22 (11.3%)	19 (9.7%)	72 (30.8%)

We also examined the number of poor households who reported sharing meters with respect to reported WAJ 3rd quarter consumption. Table 15 indicates the survey results.

Table 15 Consumption for the 3rd Quarter by poor households sharing meters

Consumption (in cubic meters)	Number	Percent
<20	9	5.8
20+-40	32	20.8
40+-60	39	25.3
60+-80	33	21.4
>80+	41	26.6
< 50 lcd	136	66.7

- *Complaint and Reliability Data*

WAJ provided data on complaints by block as well as some data on reliability of the system by sub-district. The complaint data indicated the number of complaints received by the WAJ for various neighbourhoods in the Zarqa Governorate. These neighbourhoods were linked to the household survey location designation. The new household survey collected information from households about the household's satisfaction with various aspects of the WAJ service (availability, quality, and reliability). Our analysis suggested that the complaint data and the household survey data were not particularly consistent. Moreover, the complaint data showed that some segments of the public water delivery system had zero complaints over a lengthy period of time, reducing the prospect of a successful analysis. Our decision to use the household data, therefore, was reinforced.

3.3.2 *Models of Consumption*

During the period of data collection, ECO Consult reviewed various approaches to estimating the demands for water from multiple sources. Several factors entered into consideration of the modelling and econometric approach. First, although access to the public supply is almost universal (approximately 97% of households), household access is restricted by the amount of time water is available. Second, this restriction leads households to attempt to obtain water from various sources (including tanker water, treatment shop water, and bottled water), and storing water obtained from the public system and tankers. Third, prices of water from all the sources, the quality of water delivered by the public system, and various socioeconomic characteristics of the households are likely to influence both the quantity of water consumed and the sources from which it is obtained. Thus, we determined that a demand system estimation for water obtained from different sources was the appropriate theoretical and empirical approach. However, prior to estimating our formal demand models, we considered a set of exploratory specifications that were useful in determining the general correlation and relationships among variables in the household survey. It should be kept in mind that the exploratory analyses deal directly with the total amount of water consumed and the explanatory variables. The demand analyses are based on expenditure shares, as the dependent variable, and not quantity of water consumed.

- *Exploratory Analyses*

The exploratory analyses and model specifications were not guided by economic theory; rather, the following models represent an attempt to "get to know" the data and the relationship between different variables. Such models allow us to pare down the candidate variables for use in our formal demand models connected tightly to economic theory and to examine the factors which affect total consumption patterns across households. It should be noted that, for the most part, the goodness of fit measures (R-squared and adjusted R-squared) were relatively low (as is common with cross-sectional data), although the F tests, where appropriate, were very significant, indicating that these equations and the variables included therein are significant in explaining the relationships tested. In response to a request by MCC, regressions included either the storage capacity of the household or the storage capacity per capita of the household. The sign and significance levels did not differ between these two variables, although the coefficients for per capita storage were generally about one-tenth of those for the storage capacity.

- *Socioeconomic Variables*

The first exploratory analysis was to examine the relationship among households' socioeconomic characteristics. We completed this task in order to try to avoid significant multi-colinearity among the independent (exogenous) variables in our models. Although multicolinearity does not result in biased estimates of coefficients, it does increase the variances associated with the estimation of model coefficients, often causing a finding of non-significance. Moreover, if strong multi-colinearity exists among variables, one must either adjust the data to eliminate it (for example, by dividing the set of variables by one of its members), or one can use one of the variables as a proxy (noting that the estimated coefficient then represents the "set" of variables). In addition, these initial regressions were, at least in part, a response to the request for correlations among the socioeconomic variables (see Annex B). Our regressions of household income and household expenditures against various household asset values (such area of house, number of cars and phones, and number of bathrooms) demonstrated multi-colinearity clearly, as can be seen in Table 16 (details are available in Table 4 of Annex B.) Note that all our analyses use the weights provided by the DoS in order to adjust for sampling characteristics (found in Annex B). Table 5 in Annex B reports the same results using household expenditures as the dependent variable.

In general, household income is significantly[1] and positively related to area of the house, number of baths, number of cars, and number of phones, and somewhat less significantly negatively related to the type of house and positively to storage capacity in the house. Note that the negative sign on the type of house is unexpected, since the coding would indicate that households dwelling in houses and villas have lower income, as opposed to apartments. This may be due to the fact that few villas were observed (3 cases) and that apartments may, in fact, be more desirable than some houses. There was no significant relationship between household income and household size but there was a significant positive relationship between household size and household expenditures, as would be expected. Other results for household expenditures were essentially the same as for household income. Thus, we chose to use household income as a proxy for the socioeconomic characteristics of the household, such as house size, number of cars and cell phones owned, etc. It should be kept in mind that results related to the household income variable relate to the economic "status" of the household and not just its reported income.

[1] Statistically significant at a minimum of the .01 level.

Table 16 Socioeconomic regression

Variable	Coefficient ("t" statistic)	Statistical Significance
Constant	78.58 (3.64)	.0003
Household size	1.578 (0.658)	.51
Type of house	-21.723 (-2.02)	.043
Size of house (sq met)	0.629 (5.35)	.0000
Bathrooms	28.27 (2.99)	.0000
Garden	17.84 (1.36)	.173
Cars	72.36 (7.43)	.0000
Phones	32.02 (8.50)	.0000
Storage Capacity	3.563 (2.41)	.016

- *Consumption Analyses: All Observations*

Next, we ran exploratory models using the average total consumption of the third quarter for the past three years (including public, tanker, shop, and bottled water use). This was not a demand model, since it included no price effects, because the household faces a different price for each source of water. In fact, prices vary across households for each of the sources, and we have no observed price for households that choose not to consume water from certain sources, so we do not have a single "price" of water that can be used in this model. (Later in this section we outline the assumptions used to develop a water price index for our formal water demand modelling.)

We used the metered quantity of water for these regressions. However, because meter data was missing for approximately 20% of the observations for those connected to the public system, we also used a combination of meter and household survey data for amounts of public consumption. Where no meter data were available for a household, but the household reported their summer consumption, we used the household observation as the consumption. These latter regressions are termed "augmented" in the reported results. For households who share their water meter, the amount of consumption was simply the reported quantity for the meter divided by the number of households sharing the meter, although the self-reported consumption was used as stated in the response (assuming that each household reported its share of consumption).

Table 17 and Table 6 in Annex 4 indicate the results of the exploratory water consumption model using only metered data. The model suggests that total household consumption has a significantly positive relationship to the number of individuals within a household, whether or not the household has a garden, whether it is treating public water, and its storage capacity; a significant negative relationship to whether or not the household is sharing a meter; a slightly significant negative relationship to household income, and no significant relationship to hours of water availability (using the households' reported number of hours of availability), reported health problems, and having a sewer connection. Note that storage capacity (positively related to consumption) is significant at least the 5% level, even though it appeared to be positively collinear to some degree in the initial estimation for household income and the significance levels of one or both variables could have been reduced.

Table 17 Regression of total consumption using metered data (unadjusted)

Variable	Coefficient ("t" statistic)	Statistical significance
Constant	33.20 (10.00)	.0000
Household size	1.11 (3.48)	.0005
Garden	7.18 (4.04)	.0000
Hours of available water	.0087 (0.37)	.7116
Households sharing meter	-7.14 (-10.02)	.0000
Treat public water	3.11 (2.08)	.038
Report health problems	1.02 (0.52)	.601
Sewer connection	-0.722 (-0.33)	.743
Storage capacity	0.905 (4.11)	.0000
Household income	-0.0057 (-1.54)	.125

While some of these results (negative income and sewer connection relationships, for example) have an unexpected sign, most seem intuitively reasonable. Nevertheless, the evaluation of the MCC program based on these results would suggest that there would be no significant impacts from augmenting water availability on water consumption, in that availability is not a significant variable. Thus, an alternative (and more theoretically correct) approach to demand modelling (see the AIDS model discussion below) was indicated. (Table 4.4 in Annex 4 reports similar results for the augmented consumption analysis. The only difference was that household income was significant at the .02 level, but continued to have the negative sign).

In discussions with local experts, it appears that households develop storage capacity in order to mitigate public water shortages. The data from the survey suggests, however, that even households who are not connected to the public system invest in significant storage capacity. In order to examine the relationship between storage capacity and other variables, we completed a regression using storage capacity as the dependent (endogenous) variable, and hours of availability as well as other explanatory (exogenous) variables we considered as likely to be related. Results are found in Table 18. Note that Storage capacity is clearly negatively related to hours of availability (that is, more hours of water availability from the public system leads to less household investment in storage capacity). Also, household size, number of households sharing a meter, and household income were all positively related to the amount of household storage capacity. These results suggest that storage capacity is an endogenous variable. Because developing storage capacity was considered as a likely intervention in the MCC program, we included it as an exogenous (independent) variable in many of our exploratory and our formal demand models, although we recognize the econometric problems associated with the potential multi-colinearity and misspecification.

Table 18 Results from the exploratory regression for storage capacity

Variable/Results	Coefficient	Standard error ("t" statistic)	Significance level
Constant	2.4834	0.353 (7.03)	.0000
Household size	0.1314	0.0433 (3.03)	.0024
Share meter	-0.2813	0.0968 (-2.91)	.0037
Hours available per week	-0.01056	.00319 (-3.31)	.0009
Household Income	0.00296	.00049 (6.04)	.0000

Results similar to the metered (unaugmented) consumption model were obtained for the augmented consumption model were obtained (Table 7, Annex B), except that household income became significant with a negative coefficient. The negative coefficient on household income is somewhat troubling. However, the coefficient estimates are small (less than 0.01) relative to the income levels. For example, a 10% increase in income would lead to only a 1% reduction in total consumption. Nevertheless, these results also suggest that the more appropriate multi-demand approach is necessary.

Since reducing "under-consumption" of water has been identified by MCA-Jordan and MCC as an important goal of improvement in the water system, our next estimation tried to identify those factors that cause households to under-consume. Measures of under-consumption are somewhat arbitrary, but international studies have identified the consumption of 75 liters per capita per day (lcd) as a threshold under which households tend to have increasing health problems, nutrition problems, child development problems, and so on. As mentioned earlier, after some discussion with MCA-Jordan on Zarqa local context, it was agreed that 50 lcd is an appropriate threshold measure due primarily to unmetered (illegal) consumption from the system. Approximately 63% of the surveyed households (525 households) reported consuming less than 75 lcd in total and 43% reported consuming less than 50 lcd. If the adjusted consumption was used, those percentages decreased to about 57% and 37%, respectively. Approximately 49.5% of households reported consuming less that 50 lcd from the public systems, and 44.3% reported "under-consuming" for the augmented public consumption.

Table 19 (Table 9 in Annex B) presents the results of probitmodels which examined the probability that a household will consume more than the threshold amount of (total) water using the metered public consumption for 50 lcd (the results using the 75 lcd and the augmented consumption can be found in Tables 8 through 11 in Annex B). The results appear relatively consistent between the 75 lcd and 50 lcd estimations. Sharing a meter appears to be a significant negative indicator of that probability (as expected).Household size (numbers of persons) is consistently significantly negative (the larger the household, the less the probability of consuming more than the specified lcd). The higher the proportion of public water, the more likely the household is to consume above the threshold (indicating that those who consume less probably consume higher proportions of non-public water). Storage capacity appears to play a positive role in consuming more than the threshold amount, although the level of significance of that variable declines for the lower level of consumption. Finally, and household income again appears to be negative and somewhat significant for the 75 lcd but insignificant in 50 lcd case. The results are the same for the probit models using the augmented consumption data (Tables 10 and 11 in Annex B). Other potential determining variables were examined in alternative models, but none appeared significant.

Table 19 Probit analysis for consuming more than 50 lcd using metered public consumption

Variable	Coefficent ("t" statistic)	Statistical significance
Constant	-0.011 (-0.03)	.974
Household size	-0.243 (-10.29)	.0000
Garden	0.44 (3.59)	.0003
Hours of water available	0.000001 (.001)	.999

Households sharing meter	-0.440 (-8.36)	.0000
Sewer connection	-0.27 (-1.69)	.091
Storage capacity	0.0202 (1.63)	.103
Household income	-0.0003 (-1.16)	.248
Proportion of public water	2.843 (9.92)	.0000

- *Health Analysis: All Observations*

Finally, an examination of health issues related to consumption of water was undertaken. The question posed in the survey asked the respondent whether or not the household suffered illness related to the **public system** water. Thus, only the 1,177 households connected to the system were considered. A Heckman selection model was used to (1) identify those who reported an illness due to public water, and (2) to estimate the variables that are significant in determining the amount of the expenditure necessitated by those illnesses given that the household reported illness (termed the "selection" model). Table 20 reports the results of the probit analysis and Table 21 reports the results of the selection model of expenditures (Tables 12 and 13 in Annex B indicate the full results of those analyses). In general, the probability of a household reporting illnesses due to public water was significantly positively related to the number of children in the household, negatively related to household income, and negatively related to the household's evaluation of potability of the public water (high values indicate high satisfaction). Thus, the larger the family, the more likely the household was to report an illness and the higher the family's income, the less likely it was to report an illness. Reported treatment of public water was negatively related to the probability of reporting an illness, as would be expected, but the coefficient was not significant. Note that measures of under-consumption of water, connection to the sewer, or cleaning tanks were not significant.

The second step of the equation related the amount of expenditure on medical treatment **given** that the household reported an illness. Several alternative models were tried, but in general only household income and the number of children in the household were significant variables, with number of children negative (probably because of the increasing cost of additional children to the household) and household income positive. Note that the inverse Mills ratio (lamda) is not significant, indicating that the probability of having an illness does not affect the amount spent on medical treatments. Note also that the power of this estimation was not great in that the adjusted r squared value is only about 6%; however the significance level of the model was about 99%.

Table 20 Probit results for reporting an illness

Variable	Coefficient ("t" statistic)	Statistical significance
Constant	-0.395 (-1.87)	.006
Number of children	0.084 (3.28)	.001
Garden	-0.119 (-1.00)	.316
Potability of water	-0.246 (-5.66)	.0000
Treatment of public water	-0.0499 (-0.51)	.611
Sewer connection	-0.151 (-1.07)	.287
Cleaning storage tanks	0.077 (0.32)	.751
Household income	-0.00055 (-2.07)	.0382
Consume greater than 50 lcd	0.092 (0.94)	.375

Table 21Selection model of medical expenditures

Variable	Coefficient ("t" statistic)	Statistical significance
Constant	110.82 (1.333)	.182
Number of children	-26.764 (-2.75)	.006
Household Income	0.259 (2.98)	.003
Consume greater than 50 lcd	-20.50 (-0.61)	.542
Lamda (probit weighting)	0.0477 (.003)	.997

- *Consumption and Health Analysis: Poor Households*

One of the objectives of the MCC program is to aid the poor. Thus, we examined the relationships between the same sets of variables for the poor households and poor households that "under-consume" as for the general sample. The World Bank poverty index definition of "poor" in Jordan is a per capita annual income of 550 JOD (2006 data). It is likely that that amount has increased 15 to 20% in the past two years, but no official data are available at this time. The corresponding monthly household income is approximately 275 JOD. We calculated the per capita annual income for each household (the monthly household income multiplied by 12 and divided by the number of persons reportedly in the household). There were 524 households which fell below the World Bank threshold, or approximately 43% of the sample. This is a much higher percentage than the DoS suggests for poor families (approximately 15%). The difference is likely due to the two definitions of "poor." The DoS characterizes families using a set of variables, rather than income. In fact, household income is not included in this set (although household expenditures are). For our purposes, we chose to use the World Bank definition. Table 22 reports some of the characteristics of the "poor" households. As can be seen, the poor households have less average income by about 100 JOD per month, smaller houses, and slightly smaller storage capacity than the sample average, and consume slightly larger amounts of water from tankers and water treatment shops. However, other than the income variable, none of these differences appear to be statistically significant. Moreover, the percentages of households reporting consumption of tankers was slightly higher for the poor than for the general sample (12.5% compared to 10%) but lower for the other two sources (30% vs 33% for shop water and 2% vs 4% for bottled water).

Results for total unadjusted water consumption levels for the subsample of the poor are presented in

Table 23. (Results from all the statistical analyses for the poor can be found in Tables 14 and 15 in Annex B.). They are less robust and significant for the poor subsample than for the whole sample. Only household size and garden (negative and positive, respectively) are significant, and then usually only at relatively low levels (10% for the household size variable). The negative sign on household size appears to indicate that, for the poor, the larger the household, the lower the consumption of water.

The probit models for under-consumption among the poor are also not as informative as for the entire sample. Only the household size and sharing meters were consistently significant, and they were both positively related to under-consuming. The existence of a garden was negatively and somewhat statistically significantly related to under-consuming. Results for poor households consuming more than 50 lcd are reported in

Table 24 (all under-consumption results for poor households can be found in Tables 16 through 19 in Annex B).

Reporting water-related health problems was significantly related only to potability, and the relationship was negative, as expected, as can be seen inTable 25. There were no significant variables in the selection model for medical expenditures, given reported health problems for this subsampleso no table is presented (both the Probit and selection model results are available in Tables 20 and 21 in Annex B).

Table 22Characteristics of poor households (adjusted by sample weights) for summer quarter, 2008 (note that some variables have significantly reduced numbers of observations)

Variable	Mean	Standard Dev	Min obs.	Max obs.	Number reporting	Entire sample means
HH Income (JOD)	208.72	75.61	40	550	508	306.45
HH Expenditure (JOD)	238.68	101.74	40	800	507	318.28
HH size (persons)	6.69	2.12	1	18	508	5.39
House area (sq met)	118.38	47.79	20	427	427	125.98
Storage tank capacity (cu	3.02	2.48	1	34	503	3.29

met)						
Average hours of public water available/week	35.92	29.79	0	168	487	37.00
Total Quarterly Consumption of water (cu met)	34.11	30.30	0	159	471	37.00
Average quantity of public water use/quarter (cu met)	36.199	35.70	0	320	471	36.00
Average quantity of tanker water use/quarter (cu met)	24.57	19.87	1	26	66	31.71
Average quantity of shop water used/quarter (cu met)	0.59	0.46	0.015	3.36	160	0.55
Average quantity of bottled water used/ quarter (cu met)	0.09	0.10	0.015	0.36	15	0.104

Table 23 Unadjusted water consumption for poor households

Variable	Coefficient ("t" statistic)	Statistical significance
Constant	30.67 (5.40)	.0000
Household size	-0.713 (-0.673)	.290
Garden	8.438 (2.85)	.004
Hours of water available	0.015 (0.375)	.708
Households sharing meter	-0.770 (-.807)	.420
Treatment of public water	-1.87 (-0.773)	.440
Report health problems	0.804 (0.298)	.766
Sewer connection	0.594 (.178)	.859
Storage capacity	0.100 (.211)	.833
Household income	0.006 (.320)	.749

Table 24 Probit results for poor households consuming less than 50 lcd (unadjusted)

Variable	Coefficient ("t" statistic)	Statistical significance
Constant	1.941 (6.07)	.0000
Household size	-0.203 (-5.09)	.0000
Garden	0.378 (2.409)	.016
Hours of water available	0.0019 (0.882)	.378
Households sharing meter	-0.458 (-6.87)	.0000
Storage capacity	0.0152 (.641)	.522
Household income	-0.00085 (-0.795)	.427
Proportion of public water	.211 (1.52)	.128

Table 25 Probit results for reporting health problems in the poor households

Variable	Coefficient ("t" statistic)	Statistical significance
Constant	-0.116 (-0.348)	.728
Number of children	0.0360 (0.909)	.363
Garden	-1.32 (-0.735)	.462
Potabilty	-0.255 (-3.97)	.0001
Treatment of public water	-0.136 (-0.923)	.356
Sewer connection	-0.146 (-0.721)	.471
Clean tank	0.699 (1.573)	.116
Household income	-0.0007 (-0.702)	.483
Consume more than 50 lcd	0.153 (1.10)	.272

- *Consumption analysis: Under-consuming households*

Table 25 and Table 26 present selected characteristics of households consuming less the 50 lcd (unadjusted) and poor households consuming less than 50 lcd. Some general conclusions can be drawn from these selected characteristics. The most important of these is that there appears to be no consistent relationship between poverty and under-consumption. This observation is consistent with the statistical results reported in "Meter and Billing Data" section that household income is generally insignificant and has an unexpected sign.

As indicated in Table 25, there were 567 households that reported consuming less that 50 lcd (unadjusted) from the public system. We used the same models (variables) as those for the general sample. Our findings are consistent for the "under-consumers" from the public system with those in the general population, although not as robust (Table 22 to 25, Annex B). Household size is a positive, significant variable in determining consumption levels, while sharing a meter is negative and significant. No other variable (including storage and storage per capita) were significant. It should be noted that the coefficients for storage and storage per capita, although insignificant, had the same sign and differed by about an order of magnitude (about the same size difference as that between the two measures). Results for reporting medical problems and expenditures were less significant; for the probit model for reporting an illness, the coefficient for potability was negative and significant, and household income was negative and barely significant at the 5% level. The coefficient for number of children was positive, as expected, but no significant. This suggests that under-consumers react somewhat similarly to the general sample. The only variable that was even slightly significant in medical expenditures was number of children, and its coefficient was negative (the more children, the less the expenditure). That result is also consistent with the general sample. Our conclusions are that under-consumption is likely distributed across the whole sample, and not concentrated in the poor households. In fact, the raw data indicate that the poor households are only about 6-7% more likely to consume less than 50 lcd for the entire sample.

There were 288 poor households who reported under-consuming. Note that of those, 32 were not connected to the public system. For the sample containing poor households consuming less than 50 lcd from the public system, results are consistent with those of the households consuming less that 50 lcd (Table 26 to 29, Annex B). Household size was positive and significant, sharing a meter was negative and significant, as is generally the case for the other subsamples. The remaining variables were insignificant. Again, only the potability of the water was significant (and negative) in determining whether or not a household reported a water-related illness and none of the variables were significant in determining the level of medical expenditures given that an illness was reported.

Table 26 Selected characteristics of households consuming less than 50 lcd from the public system

Variable	Mean	Standard Dev	Min obs	Max obs	Number reporting
HH Income (JOD)	308.02	215.17	50	2500	557
HH size (persons)	6.08	2.30	1	18	567
Storage tank capacity (cu met)	3.08	3.64	1	68	564
Average hours of public water available/quarter	36.09	32.09	0	168	567
Average consumption from public source/quarter	20.62	9.56	0	68.33	328
Proportion of public water (%)	72.40	41.9	0	100	497

Table 27Selected characteristics of poor households who consume less than 50 lcd from the public system

Variable	Mean	Standard Dev	Min obs.	Max obs.	Number reporting
HH Income (JOD)	215.74	74.50	50	600	278
HH size (persons)	7.07	2.24	2	18	288
Storage tank	3.04	2.91	1	34	285

capacity (cu met)					
Average hours of public water available/quarter	34.42	30.63	0	168	288
Average consumption from public source/quarter	22.64	10.55	0	68.33	183
Proportion of public water (%)	75.80	40.14	0	100	227

- *Conclusions from the Exploratory Studies*

The results of the exploratory analyses suggest the following:

- The most consistent variables in terms of increasing water consumption and household welfare appear to be assuring that all households have their own meter and that household perception of potability is improved.
- Household storage capacity appears to be significant and positively related to consumption levels for the larger sample but not for the poor or under-consuming.
- Household size appears to be positively related to total consumption, but also positively related to under-consumption (the larger the household, the more likely it is that they will under-consume) for the entire sample. For the poor households, household size appears to be relatively significantly negatively related to consumption levels. For the under-consuming and poor and under-consuming households, household size is again positively related to consumption levels.
- Probability of reporting an illness is significantly and negatively related to households' perception of potability for all cases. Number of children is positively related to the probability of reporting an illness and negatively related to medical expenditures for most cases, while household income is negatively related to the probability of reporting an illness and positively related to medical expenditures for the whole sample, but those variables become less and less significant as the subsamples are analyzed.

- *Formal Demand Analysis*

As indicated in the previous sections, the exploratory analysis of water consumption is useful to determine general relationships and correlations between variables and, in doing so, allows us to identify the most important factors influencing water choices. Thus, the exploratory analyses permit us to pare down the number of variables to be considered in the more formal analysis. However, such analyses did not allow us to untangle the complex relationship between different sources of water and the characteristics of them, nor did it allow us to investigate the effects of the different prices of water. To accomplish this goal, we move to a formal demand analysis.

The technical details of our "Consistent Two-Step Almost Ideal Demand System" (CTS AIDS) model are given in Annex 5, but the basic intuition of demand system modelling is quite straightforward. A system approach to the demand for water recognizes that the demand for water from any one source is closely related to the demand for one or more alternative sources of water. That is, the demand for water from tankers is likely related to the demand for water from the public water system. Similarly, the demand for water from the public system is likely related to the demand for water from tanker. Further, both tanker and public demands are connected to the demand for water from water treatment shops and bottled water. Our goal is to estimate a system of water demand models that is consistent with economic theory, where the restrictions of economic theory (which requires a certain relationship between economic variables) between the demand for one source of water and the demand for other sources of water are imposed. . One of these restrictions is that the total expenditure on water (from all sources) remains constant. That is, while households may change the share of expenditures from one or more water sources, the sum of those expenditures remains constant. As households shift among various sources, the quantity of water they consume may change as a result of differences in prices of water from those sources.[1]

Rather than using the quantity of water from source*i* as the dependent variable, the CTS AIDS model (like all AIDS models) focuses on the share of expenditures each household devotes to purchasing water from each source. After determining the total amount of money a household spent on water from all sources, the share of, say, expenditures spent on publicly supplied water, is calculated simply as public water expenditures (price times quantity) divided by total expenditures on water. This is done for all sources of water; in our application, we calculate the share of total water expenditures that were allocated to publicly supplied water, water from tankers, water from treatment shops, and bottled water. The shares, of course, must sum to one.

Using an "expenditure share" as the measure of demand instead of quantity, the explanatory variables of an AIDS system are exactly those one would expect in a demand system: the good's own price, the prices of all substitute and complementary goods, a measure of real expenditures (income), and other shift variables. The measure of real expenditures arises from the two-stage budgeting assumption of the AIDS model, and is the total expenditure on water divided by a price index calculated from the prices of all sources of water (see Annex B for details). The shift variables of the model allow one to include important demand factors besides price and income; in our application these factors will include hours of service and the perceived potability of water received from the public system. Finally, the formal application

[1] Note that for existing conditions, shifting from a higher price source, such as tanker or shop water, to a lower priced source, such as public water, would result in substantially increasing water consumption from the public source. Such an increase might not be possible given the restricted nature lf access to water supply in Jordan, but since a major goad of the MCC project is to increase public supply availability and to determine the benefits thereof, the ability to predict such shifts is critical.

of the demand systems approach means that one imposes a set of restrictions required for the model to be consistent with the utility maximization principles of economic theory. These restrictions are detailed in Annex B.

- *An Empirical Issue to Resolve*

We have two important empirical problems to resolve prior to estimating the demand system: (1) we do not observe the price paid for a unit of water from a given source if the household did not purchase any water from that source, and (2) we wish to include measures of water quality, but which should be selected from the many measures available? We answer each of these questions in turn.

For non-public sources of water—tanker, shop, and bottled—one could adopt a fairly simple approach to the missing price problem, using perhaps the mean or the median price as a proxy for the price faced by households who did not consume water from those sources. Unfortunately, this would raise collinearity problems in the econometric model, especially for water sources from which relatively few households purchase. For example, only 4% of the sample households purchased bottled water; if we were to use the mean or median price of bottled water, the price would be almost perfectly collinear with the intercept of the demand equation. Hence, we take advantage of the observed spatial difference in water prices by estimating regression equations that capture how prices differ across districts and sub-districts in the area. The models are presented in Table 28. District 3 is the omitted district, so the water price for the i^{th} source in that district is simply the constant. Prices in the other districts can be calculated by simply adding the coefficient of the given district to the constant. For example, our estimated price of tanker water for households located in District 1, Sub-district 1 is 5.49 JD (2.87+2.62). We use the equations in Table 28 to impute prices for all observations not purchasing water from that particular source.

Table 28 Price Regressions, by Source of Water (t-statistic in parentheses)

	Price of Tanker Water	Price of Shop Water	Price of Bottled Water
Constant	**2.87** **(3.33)**	**36.51** **(3.21)**	**339.05** **(5.70)**
District 1, Sub-district 1	**2.62** **(2.65)**	**31.75** **(2.49)**	-30.37 (-0.43)
District 1, Sub-district 2	0.65 (0.55)	17.66 (0.67)	**-145.10** **(-1.84)**

District 2	**1.90** **(1.83)**	8.92 (0.64)	**-154.12** **(-1.71)**
Adjusted R^2	0.047	0.023	0.061
Observations	130	402	49

Numbers in bold text indicate statistical significance at α<0.10

Our next question concerns measures of water quality. Section 7 of the survey conducted by the Department of Statistics included a number of questions that measure the quality of the water delivered by the public system. Satisfaction with public water quality was measured on a 5-point Likert scale, ranging from a value of "1" (Very Dissatisfied) to "5" (Very Satisfied). The questions explored quality dimensions such as color, purity, taste and potability. As one might expect, the variables were highly correlated (Table 29) Every variable combination in the table has a correlation of at least 0.81, indicating that perceived water quality in one dimension is closely related to the other characteristics of publicly supplied water. Including more than one of these variables in the regression model would likely result in multi-collinearity between the measures, which has the effect of biasing the standard errors upward (placing all hypothesis testing in doubt). Water that is "potable" is considered fit or suitable for drinking, whereas as water that has a nice color, taste or purity could be lacking in potability. Hence, we choose to use the potability measure in the statistical modelling.

Table 29 Correlation Matrix for Water Quality Measures

	Color	Purity	Taste	Potability
Color	1.000			
Purity	0.934	1.000		
Taste	0.881	0.911	1.000	
Potability	0.814	0.846	0.883	1.000

- *Water Demand System Modelling*

Our modelling focuses on the primary sources of water: publicly supplied water (Public), water supplied by tankers (Tanker), water supplied from treatment shops (Shop), and bottled water (Bottled). Our first model includes as many observations as possible, but does not include households that are not connected to the public system. After deleting observations for missing values and those not connected to the public systembecause those households could not provide quality parameters for public water, our dataset consists of 948 observations (a loss of 266 observations from our total of 1214). Table 30 shows the distribution of the sample, by source of water consumed.

Table 30Distribution of Observations, by Source of Water Consumed (948 observations)

	Consumers	Non-consumers
Public Water (100% consuming)	948	0
Tanker Water (8.6%)	82	866
Shop Water (33.2%)	315	633
Bottled Water (4.2%)	40	908

The censored demand system modelling approach using consistent two-step method (see annex B) has two parts: (1) for all sources of water that do not have 100% of the sample consuming it, we estimate a probit model to predict the probability that a given household will consume water from a given source, and (2) we estimate a set of share equations following the expenditure share specification outline in Annex B, adjusted for censoring. Results are summarized in Table 31 and Table 32 (complete results can be found in Tables 30 and 31 in Annex B).It should be noted that our CTS AIDS model includes*all* observations with complete data; that is, in any given share equation we include households that consume that type of water (and who have positive expenditures) and households who do not consume that source of water (and whose expenditures are zero). Finally, our expenditure share models provide information on statistical significance for only three of the four share equations because of the need to drop one equation from the model (we chose to drop bottled water and report the share models for public, tanker, and shop water). This is to avoid a singular covariance matrix, which would occur had we included all four equations and imposed all parameter constraints implied by economic theory. Instead, we estimate the model with three of the four equations, and impose the constraints associated with homogeneity, symmetry and adding up conditions consistent with economic theory. The parameters of the omitted share equation (in this case, bottled water) are determined from the constraints and estimated parameters of the included equations. Note also that our measure of public water consumption was based on the 3rd quarter consumption in 2008. The large variability across the past three years of the metered data caused us to focus on that period.

Water Demand System: Maximum Sample Size

Turning first to the probability models in Table 31 (complete results can be found in Table 30 of Annex B), all model specifications are statistically significant as a whole (testing the hypothesis that all coefficients with the exception of the intercept are equal to zero). In each case, the own price response is negative: as the cost of obtaining water from a given source increases, the household is less likely to purchase from that source. The probability that households will purchase tanker water is negatively related to the hours of service provided by the public system: as the number of hours that water is delivered by the public system increases, fewer households will use tankers. If a household experiences water-borne illnesses it is more likely to purchase bottled water; experiencing an illness is not statistically related to buying water from tankers or water treatment shops.

As household perceptions of the potability of public water improve, the probability of purchasing water from treatment shops falls. Potability is statistically unrelated to the probability of seeking water from tanker or bottled water sources, though the p-value for the tanker equation is 0.13, just outside the conventional 0.10 level of significance. Monthly household income is a significant and positive determinant for the purchase of shop and bottled water, but not tanker water. Household size was significant only in the shop equation—as the number of people in the household increases the probability of purchasing water from treatment shops declines—and was significant in the tanker model if one uses a p-value of 0.11. As household size increases, the probability of purchasing water from tankers increases.

Table 31Probability of Purchasing Water, by Source, All Observations (n=948)

	Tanker	Shop	Bottled
Constant	-0.033 (-0.09)	**3.250** **(7.51)**	0.987 (0.94)
ln(P Tanker)	**-0.773** **(-4.44)**		
ln(P Shop)		**-0.689** **(-6.95)**	
ln(P Bottled)			**-0.553** **(-2.93)**
Hours of Service, Public System	**-0.011** **(-4.35)**	-4.13×10^{-4} (-0.30)	0.001 (0.57)
Health Problem	-0.047 (-0.30)	0.022 (0.19)	**0.701** **(4.11)**
Potability	-0.087 (-1.54)	**-0.385** **(-8.98)**	-0.019 (-0.26)
HH Income	4.33×10^{-4} (1.48)	3.95×10^{-4} (1.64)	$\mathbf{6.93\times10^{-4}}$ **(2.06)**

HH Size	0.043 (1.62)	**-0.056** **(-2.73)**	-0.015 (-0.45)
χ^2, β=0	**47.30**	**155.72**	**26.52**

Numbers in bold text indicate statistical significance at α<0.10.

The results of the probability models were then transferred to the expenditure share stage of the CTS AIDS model following the procedure of Shonkwiler and Yen (again, see Annex B for details regarding how the censoring adjustment is implemented.) The own-price coefficient is negative and significant in each share equation: as price of a good increases the share of expenditures allocated to that good decreases. Four of the six cross-price parameters are statistically significant, indicating that the system approach to the demand modelling is appropriate. More interesting for the purposes of this study are the shift variables associated with hours of service from the public system, perceived potability of publicly supplied water, health problems believed to be caused by public water, and per capita household storage capacity.

The share of expenditures devoted to water purchases from the public system is greater in areas that have greater hours of public service; the share of water expenditures spent on tanker water is lower in areas with more hours of service. In an unexpected statistical result, households that have experienced health problem believed to be associated with water from the public system spend a lower share of expenditures on water from treatment shops than households that have not experienced a similar health problem. This finding is difficult to explain. Potability, on the other hand, enters the share models in the expected manner. As perceived potability increases, households increase the share of water expenditures on public water sources, while decreasing the share of expenditures devoted to water purchased from tanker and treatment shops.

We now turn to the final two variables in the model: household size and per capita water storage capacity. The coefficients on household size is negative and significant in the public water share equation, and negative but insignificant in the other share equations. Per capita water storage is negative and significant in the public share equation and positive and significant in tanker share equation. These two variables were added to the model at the request of MCC, but we have concerns regarding this specification. Recall the model in Table 18, where storage capacity was shown to be a function of hours of public system service and household size. It is the authors' belief that storage capacity is an endogenous variable that is determined primarily by the restrictions of the public system (less than 40 hours per week of water delivery, on average) and the availability of tanker water. In other words, storage capacity does not *cause* the public and tanker water expenditure shares, but is instead a reaction by households to the limitations of the current water delivery system. Including an endogenous model in the current analysis would have greatly complicated an already time-constrained process; though our preference would have been to drop these variables, we have chosen to comply with the MCC request in this and subsequent models.

Table 32 *AIDS Model for Water Demand, Maximum Observations (n=948)*

	Public	Tanker	Shop	Bottled
Constant	**0.680** **(11.92)**	**0.039** **(2.52)**	0.035 (1.34)	----
ln(P Public)	**-0.022** **(-2.48)**	**0.030** **(2.00)**	**0.155** **(12.70)**	-0.163 —
ln(P Tanker)	**0.030** **(2.00)**	**-0.162** **(-2.52)**	0.051 (1.37)	0.082 —
ln(P Shop)	**0.155** **(12.70)**	0.051 (1.37)	**-0.710** **(-11.77)**	0.504 —
ln(P Bottled)	**-0.163** **(-10.96)**	0.082 (1.44)	**0.504** **(14.68)**	-0.423 —
ln(x/P)	**0.094** **(27.57)**	**0.113** **(3.91)**	**-0.188** **(-17.78)**	-0.019 —
Hours of Service, Public System	**5.61×10^{-4}** **(2.62)**	**-0.008** **(-2.95)**	-8.36×10^{-4} (-1.454)	
Health Problem			**-0.020** **(-1.90)**	
Potability	**0.034** **(5.18)**	-0.077 (-1.43)	**-0.230** **(-6.03)**	
HH Size	**-0.007** **(-2.40)**	-0.025 (-1.25)	-8.17×10^{-4} (-0.09)	
Per Capita Water Storage Capacity	**-0.015** **(-2.22)**	**0.084** **(1.87)**		

Density	—	0.113 (0.69)	**1.422** **(9.43)**	
Adusted-R^2	0.454	0.088	0.454	—

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

- *Analysis Using Households Defined as "Poor"*

Based on consultations and agreements with MCA-Jordan and MCA-Jordan, we used a household per capita income measure of 550 JOD per year as the definition of "poor" households. Restricting the sample to these households reduces the number of usable observations to 394, where this sample of households has an average per capita annual income of 382 JOD (note that missing variables in the data set result in a reduced number of usable observations for the demand analysis compared to the *exploratory* analyses). Given the close association between per capita household income and per capita water consumption, one can think of the following analysis as being of potentially water constrained households. (Detailed results of the analyses summarized below can be found in Tables 34 and 35 in Annex B)

In the probability models, the own-price effect is negative and statistically significant for tanker and shop source water, but the own-price effect is statistically insignificant for bottled water Table 33). The probability that a poor household will purchase any tanker water appears to be driven by the hours of service of the public system, whereas the probability a household will purchase any water from treatment shops is driven by potability of the public supply. For these income-constrained households, the probability that a household will purchase bottled water increases if the household experiences a water-borne illness believed to be caused by publicly-supplied water, and as income rises.

The expenditure share models show that the basic economic relationship between the price of a good and the quantity demanded holds even for poor households: all own-price effects are negative and statistically significant (Table 34), and all cross-price effects are statistically significant. In contrast with the variables implied by economic theory, the shift variables of the share equations have a limited effect. The hours of service of the public system has no significant effect on the share of expenditures allocated to publicly-supplied water, but as the hours of service increase, we should observe a statistically significant decrease in the share of expenditures devoted to water purchased from tankers. Neither experiencing a water-borne illness nor perceived potability of the public system affects the expenditure share for bottled water but as perceived potability of water delivered from the public system increases, households are more likely to increase the share of water expenditures for public water.

Table 33 Probability of Purchasing Water, by Source, Poor Only (n=394)

	Tanker	Shop	Bottled
Constant	-0.680 (-1.25)	**6.064 (6.84)**	**-5.972 (-2.06)**
ln(P Tanker)	**-0.468 (-1.90)**		
ln(P Shop)		**-1.445 (-6.79)**	
ln(P Bottled)			0.379 (0.75)
Hours of Service, Public System	**-0.012 (-2.89)**	-0.004 (-1.47)	0.004 (0.81)
Health Problem	0.048 (0.22)	0.058 (0.34)	**0.771 (2.32)**
Potability	0.031 (0.35)	**-0.346 (-4.83)**	0.192 (1.31)
HH Income	4.81×10^{-4} (0.33)	3.17×10^{-4} (0.26)	0.002 (1.17)
HH Size	0.034 (0.70)	-0.035 (-0.84)	0.061 (0.93)
χ^2, β=0	**13.66**	**86.90**	**11.78**

Numbers in bold text indicate statistical significance at α<0.10.

Table 34AIDS Model for Water Demand, Poor Only (n=394)

	Public	Tanker	Shop	Bottled
Constant	**0.806 (11.80)**	**0.080 (2.61)**	**0.087 (3.54)**	
ln(P Public)	**-0.046 (-4.27)**	**0.071 (3.70)**	**0.146 (7.03)**	-0.171
ln(P Tanker)	**0.071 (3.70)**	**-0.235 (-1.90)**	**-0.093 (-2.61)**	0.257
ln(P Shop)	**0.146 (7.03)**	**-0.093 (-2.61)**	**-0.368 (-5.05)**	0.315
ln(P Bottled)	**-0.171 (-7.60)**	**0.258 (2.15)**	**0.316 (6.39)**	-0.403
ln(x/P)	**0.036 (7.76)**	**0.141 (3.51)**	**-0.112 (-9.88)**	-0.065
Hours of Service, Public System	5.27×10^{-4} (1.51)	**-0.008 (-1.71)**	-8.23×10^{-4} (-1.05)	
Health Problem			-0.006 (-0.78)	

Potability	**0.026 (3.12)**	-0.141 (-1.43)	-0.049 (-1.61)	
HH Size	-0.005 (-1.37)	-0.04 (-0.16)	0.013 (1.47)	
Per Capita Water Storage Capacity	-0.015 (-0.65)	0.029 (0.14)		
Density	—	-0.282 (-0.82)	**0.633 (5.14)**	
Adusted-R^2	0.247	0.056	0.279	—

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

Richest 20%

MCC requested an examination of rich households' consumption with respect to pricing changes for public wateras one of the potential interventions. The models in

Table 35 and Table 36 (full results can be found in Table 36 and 37 of Annex B) are for the richest quintile of households in the data set (greater than 1050JOD per capita per year). As might be expected for households in which water expenditures are a small portion of overall expenditures, the economic variables do not have the strong behavioural effect that was observed in the previous set of models that focused on poor households. In the probability models explaining the choice to purchase water from different sources, the only economic variable that is statistically significant is the price of tanker water. The purchase of water from treatment shops is driven by the potability of water delivered by the public system. In the demand system, only two of the three of the own-price coefficients are statistically significant, with four of the six cross-price effects significant--three of those associated with the demand for bottled water. Potability is the only shift variable that matters in a statistical sense: as potability of public water increases households will purchase a greater share of public water and a smaller share will come from treatment shops.

Table 35 Probability of Purchasing Water, by Source, Richest 20% (n=193)

	Tanker	Shop	Bottled
Constant	0.912 (1.00)	**1.67 (1.97)**	-2.32 (-1.05)
ln(P Tanker)	**-1.482 (-2.99)**		
ln(P Shop)		-0.266 (-1.40)	
ln(P Bottled)			0.027 (0.07)

Hours of Service, Public System	-0.004 (-0.91)	-0.002 (-0.66)	0.004 (0.82)
Health Problem	0.846 (1.46)	0.208 (0.63)	0.627 (1.40)
Potability	-0.136 (1.06)	**0.497** **(5.08)**	-0.096 (-0.55)
HH Income	3.72×10^{-4} (0.33)	3.80×10^{-4} (0.26)	3.26×10^{-4} (0.41)
HH Size	0.054 (0.49)	-0.062 (-0.74)	0.039 (0.30)
χ^2, β=0	**16.37**	**37.40**	6.76

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

Table 36AIDSModel for Water Demand, Richest 20% (n=193)

	Public	Tanker	Shop	Bottle
Constant	**0.668** **(5.67)**	**0.042** **(1.83)**	**-0.103** **(-1.98)**	—
ln(P Public)	-0.002 (-.09)	0.029 (0.90)	**0.106** **(5.08)**	-0.133 —
ln(P Tanker)	0.029 (0.90)	**-0.174** **(-1.62)**	-0.021 (-0.32)	0.166 —
ln(P Shop)	**0.106** **(5.08)**	-0.021 (-0.32)	**-0.371** **(-4.06)**	0.285 —
ln(P Bottled)	**-0.133** **(-4.39)**	**0.166** **(1.86)**	**0.285** **(5.58)**	-0.318 —
ln(x/P)	**0.117** **(17.04)**	0.033 (0.52)	**-0.236** **(-13.45)**	0.086 —
Hours of Service, Public System	5.59×10^{-4} (1.33)	-0.005 (-1.46)	6.03×10^{-4} (0.66)	
Health Problem			0.066 (1.50)	
Potability	**0.057** **(4.36)**	-0.022 (-0.21)	**-0.466** **(-3.85)**	
HH Size	**-0.017** **(-2.65)**	-0.039 (-1.03)	0.006 (0.38)	
Per Capita Storage Capacity	-0.013 (-1.42)	-0.015 (0.15)		
Density	—	0.066 (0.26)	**2.284** **(6.11)**	
Adjusted-R^2	0.562	0.091	0.634	

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

- *Under-consuming Households and Under-consuming Poor households*

As indicated above, MCC requested that we examine the cases of those households consuming less the 50 lcd from the public system, and the poor households consuming less than 50 lcd from the public system. Results can be found in Table 37 and Table 38 (as well as Tables 38 and 39 in Annex B). There is some correspondence between "under-consuming" households and poor households so that, relative to the results for the richest quintile of households, one may observe in the models a return to statistical significance of economic relationships for water demand. We also note that our definition of under-consumption is based solely on water from the public systemonly for this analysis, as requested by MCC; these households may consume well in excess of 50 lcd per capita by choosing to purchase water from the other three sources. For those households consuming less than 50 lcd per capita from the public system, two of the three own price effects for the probability of purchasing water from a given source are statistically significant, as in household income. As monthly income increases, households are more likely to increase water shares from tanker, shop and bottled water sources. The shift variables perform well, with the expected negative sign of hours of public service in the tanker equation, and negative and significant effects of potability in the tanker and shop equations.

In the water demand system, all own-price effects are negative and significant and five of the six cross-price effects statistically significant. For the shift variables, hours of public service is never significant.

Table 37 Probability of Purchasing Water, by Source, Households Consuming < 50 lcd per capita (n=448)

	Tanker	Shop	Bottled
Constant	-0.031 (-0.06)	**3.714 (5.58)**	-1.352 (-0.61)
ln(P Tanker)	**-0.734 (-3.07)**		
ln(P Shop)		**-0.801 (-5.19)**	
ln(P Bottled)			-0.150 (-0.38)
Hours of Service, Public System	**-0.008 (-2.63)**	-0.002 (-0.94)	-0.0002 (-0.06)
Health Problem	0.147 (0.74)	-0.017 (-0.11)	**0.877 (3.56)**
Potability	**-0.157 (-2.00)**	**-0.332 (-5.46)**	-0.082 (-0.70)
HH Income	**6.933×10^{-4} (1.73)**	**6.36×10^{-4} (1.78)**	**0.0008 (1.94)**

HH Size	0.042 (1.14)	**-0.077** **(-2.47)**	-0.002 (-0.03)
χ^2, β=0	**25.57**	**71.46**	**17.69**

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

Table 38CTS AIDS Model for Water Demand, Households Consuming < 50 lcd per capita (n=448)

	Public	Tanker	Shop	Bottle
Constant	**0.869** **(9.64)**	**0.077** **(3.52)**	**0.086** **(3.51)**	------
ln(P Public)	**-0.031** **(-2.26)**	**0.079** **(3.09)**	**0.191** **(9.10)**	-0.239
ln(P Tanker)	**0.079** **(3.09)**	**-0.335** **(-3.81)**	0.025 (0.50)	0.231 —
ln(P Shop)	**0.191** **(9.10)**	0.025 (0.50)	**-0.805** **(-9.11)**	0.589 —
ln(P Bottled)	**-0.239** **(-9.05)**	**0.230** **(3.17)**	**0.589** **(10.35)**	-0.580 —
ln(x/P)	**0.113** **(17.07)**	**0.334** **(8.23)**	**-0.288** **(-15.13)**	-0.159 —
Hours of Service, Public System	4.90×10^{-4} (1.47)	-0.004 (-1.28)	-7.92×10^{-4} (-1.02)	
Health Problem			**-0.0306** **(-2.21)**	
Potability	**0.027** **(2.72)**	-0.064 (-0.89)	**-0.194** **(-4.20)**	
HH Size	**-0.010** **(-2.04)**	**-0.068** **(-2.37)**	**0.115** **(2.76)**	
Storage Capacity per capita	0.0093 (0.51)	-0.088 (0.80)		
Density	—	**-0.305** **(-1.69)**	**1.198** **(5.76)**	
Adjusted-R^2	0.386	0.172	0.501	

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

Improved potability increases the share of expenditures devoted to publicly supplied water and decreases the share of expenditures devoted to water purchased from treatment shops.

Finally, let us turn to the under-consuming poor. These are households that consume less than 50 lcd per capita from the public system and have annual household incomes less than 550 JOD per capita. We note that, as before, our measure of under consumption is based solely on consumption from the public system, and may be purchasing water from other sources. Results can be found in Table 39 and Table 40 (full results are listed in Tables 40 and 41 in

Annex B). In the probability models, two of the three own-price coefficients are statistically significant but the bottled price has an unexpected sign. Household income does not explain the choice to purchase water from a given source. As hours of public system service increase, household are less likely to purchase water from tanker or treatment shop sources. Improved perceived potability of publicly supplied water decreases the probability that a household will purchase water from a treatment shop.

Table 39 Probability of Purchasing Water, by Source, Poor Households Consuming < 50 lcd per capita (n=214)

	Tanker	Shop	Bottled
Constant	-0.871 (-1.11)	**6.47 (5.19)**	**-18.84 (-2.89)**
ln(P Tanker)	-0.411 (-1.26)		
ln(P Shop)		**-1.535 (-5.16)**	
ln(P Bottled)			**2.578 (2.32)**
Hours of Service, Public System	**-0.009 (-1.72)**	**-0.006 (-1.64)**	-0.007 (-0.76)
Health Problem	0.255 (0.90)	0.154 (0.67)	0.402 (0.68)
Potability	-0.063 (-0.51)	**-0.252 (-2.60)**	0.074 (0.28)
HH Income	1.88×10^{-4} (0.10)	0.005 (1.31)	0.005 (1.31)
HH Size	0.067 (1.16)	0.125 (1.32)	0.125 (1.32)
χ^2, β=0	6.77	**45.25**	**13.25**

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

Table 40CTS AIDS Model for Water Demand, Poor Households Consuming <50lcd per capita (n=214)

	Public	Tanker	Shop	Bottle
Constant	**0.943 (8.67)**	0.005 (0.12)	**0.146 (4.05)**	------
ln(P Public)	**-0.046 (-2.97)**	**0.106 (3.26)**	**0.168 (5.37)**	-0.228 —
ln(P Tanker)	**0.106 (3.26)**	-0.312 (-1.42)	-0.057 (-1.16)	0.263 —
ln(P Shop)	**0.168 (5.37)**	-0.057 (-1.16)	**-0.490 (-4.60)**	0.379 —
ln(P Bottled)	**-0.228 (-6.47)**	0.262 (1.29)	**0.379 (4.95)**	-0.412 —

ln(x/P)	**0.034** **(4.25)**	**0.325** **(4.78)**	**-0.153** **(-7.29)**	-0.206 —
Hours of Service, Public System	**0.0015** **(3.18)**	-0.002 (-0.40)	-0.002 (-1.42)	
Health Problem			-0.028 (-1.58)	
Potability	**0.022** **(2.00)**	-0.059 (-0.56)	-0.050 (-1.23)	
HH Size	-0.006 (-1.09)	**-0.086** **(-2.10)**	0.014 (0.94)	
Per Capita Storage Capacity	-0.011 (-0.29)	-0.096 (-0.28)		
Density	—	-0.287 (-0.55)	**0.672** **(3.77)**	
Adjusted-R^2	0.237	0.129	0.342	

Numbers in bold text indicate statistical significance at α<0.10.
All households connected to public system.

In the water demand system, only two of the three own-price effects are significant with the expected sign; the price of tanker water is significant only at p=0.16. Four of the six cross-price effects are statistically significant. As hours of public service increase and as the perceived probability of the public water increase, the share of expenditures directed to public system water increases.

In general, the results for the various subsamples of the households are consistent. Own price relationships are negative, public water consumption and tanker consumption are substitutes, and shop and bottled water appear to be functions of water quality more than hours of availability. Household perception of potability is strongly related to the consumption of public water rather than tanker and shop water, and health issues are important in choosing shop or bottled water. For every sub-sample, it appears that public water and tanker water are likely substitutes for general household use, while shop and bottled water are used to avoid illness and poor potability.

- *Implications of the results*

The direct implications of our results are as described above. To reiterate our most important findings:

- As expected, the socioeconomic variables collected in the survey are highly correlated, and should not be used in statistical analyses without consideration of colinearity.
- Household size, the existence of a garden and the amount of storage capacity available to the household consistently are significantly positively related to

household total consumption, and sharing a meter is negatively related to consumption.

- Household size and sharing a meter are both significantly positively related to "under-consumption" while the proportion of public water is significantly negatively related to it.
- The probability of reporting an illness is significantly positively related to the number of children in the household and negatively related to household income, while treatment expenditures are just the reverse. That is, larger households with lower incomes were more likely to report water-borne illnesses, but spent a lower amount of money for medical care relative to smaller, higher income households.
- The probability of consuming publicly supplied water increases with the hours of availability of the public system whereas the probability of consuming tanker water decreases as availability increases (Table 33 and Table 37 and Table 39).
- The probability of consuming bottled water increases if the household has experienced an illness believed to be caused by publicly supplied water (Table 33 and Table 37 and Table 39).
- As the potability of water delivered by the public system increases, households are less likely to purchase water from treatment shops (Table 38 and Table 40).
- The share of expenditures allocated to water purchased from the public system will increase as hours of service increases, whereas the share of water purchased from tankers will decrease as hours of service of the public system increases. Given the relatively low price of public water in comparison to the price of tanker water, increasing hours of availability of the public system will increase the *total quantity* of water consumed by households.
- The share of water purchased from water shops and bottled water sources increases if the household has experienced a water-borne illness from consumption of publicly supplied water.

3.3.3 Survey Results and Intervention Analysis

The interventions being considered for improvement of the poor and under-consuming households are as follows:

1. Improved water utility operational systems - including improved information system and modeling for rationing schedule and setting pumping pressure, implementation of assets management system, capacity building and certification program for utility operators, and meters replacements
2. Spilt the households that are connected to one share meter to reduce water payments, and consequently increase public system use

3. Raise water awareness on water issues, water potability of available supplies, and participation in reducing leakages through filing complaints with the utility
4. Restructuring Water Tariff to achieve O&M Cost Recovery and keep cross-subsidy to benefit the poor
5. Improving water storage to address quality and quantity issues, and rehabilitation of plumping systems of poor households
6. Geographically target network rehabilitation and zoning to serve the poor

One of the intervention proposals is to increase the tariffs on high income households to foster conservation of water, and shift those "savings" in water to the under-consuming poor. Using the AIDS analysis for the rich households (the highest 20 percentile of incomes in the sample), we find that a 10% increase in the public water tariff will shift expenditures by the rich from public water to other sources (in particular to tanker and shop water) reducing public water consumption by about 10%. Given our AIDS models, that change would amount to about a 4.6 cubic meter per quarter reduction in the use of public water by rich households, or a total of about 480,000 cubic meters per year.

Other results from our analyses are general in the sense that they are not specifically tied to an intervention. Rather, they identify the critical effects of those interventions. The most important effects afrom any given intervention are:

1. Increase water availability
2. Increase water quality
3. Reduce water-born illness
4. Reducing the number of households who share a meter

Our benefit models (reported below) assume levels of these effects, and indicate that there are significant benefits to the general population of water users and to the poor, under-consuming, and poor under-consuming households. Without specific indications of the impact of the listed interventions, we are unable to quantify the effects of the listed interventions with respect to their effects on poor, under-consuming, and poor under-consuming households.

Some of our model results are not clear. For example, the apparently insignificant impact of increasing household storage capacity in the AIDS model is likely a result of storage capacity being a dependent (endogenous) rather than an independent (exogenous) variable. Our exploratory results indicate that storage capacity is closely related to hours of availability (negatively related), and positively related to household size and income.

There are a number of variables which may or may not impact our results, but we feel that we have identified the most important. The missing meter data caused us to use only the 3rd Quarter of 2008 as our observations on metered water. In so far as 2008 was an "unusual" year with regard to water consumption (and we have no reason to believe that it was or wasn't), our results might be different. The consistency between the exploratory results and the AIDS results suggest that the problem was minimal.

We examined the effects of our AIDS results based on assumed changes due to the MCC/MCA program in Zarqa for both the general sample,for the subsample of poor households, for the under-consuming households, and for the under-consuming poor households in order to provide one means to evaluate interventions. The models for those effects are found in the attached interactive Excel files. Since the share of household expenditures on water is assumed constant, benefits are measured in the changing cost of water to households as they shift among sources. This means that as households consume more (less) public water as a result of a change in a given factor, it will purchase more (less) of that water at a cost savings (increase) based on the comparative prices of the sources. For example, if some attribute such as water quality causes households to shift from, say, shop water to public water, the cost savings from reducing the expensive shop water are used to purchase increasing amounts of the relatively cheap public water. As indicated above, while public water supply restrictions might limit the possibility for households to increase their consumption of public water, the analysis of the impact of various interventions – including increasing available supplies - and the subsequent benefits arising there from requires knowing the direction and magnitude of those shifts.

Prices, or tariffs, are clearly significant in the choice of water sources. One of the proposed interventions is to increase the tariff on rich households. If a 10% increase in tariff is imposed on rich households, the result is a decrease in use of about 480,000 cubic meters per year. If that savings was distributed to under-consuming households, it would mean about a 6.3 cubic meter increase in water availability per year per household. If it were distributed to only the poor under-consuming households, that would mean an increase of about 18.4 cubic meters per year, or about 4.5 cubic meters per quarter. While these data do not equate directly to hours of availability, it seems reasonable to assume that such a change would result in about a 10% increase in hours available for the poor households. Using the Excel files, the estimated benefits to under-consumers would about 90,000 JOD per year, or a net present value of about 722,000 JOD. We do not have the current metered billing totals for poor under-consuming households, but since they are about 1/3 of the under-consumers, the increased availability would likely be about 30%, which would result in about the same total benefits to them as to the poor households.

There were two other sources of benefits to users that we considered: the reduced cost of medical illnesses and the reduced need to treat public water. We assumed that reduced medical illness and potabiity are independent factors, although they probably are not. Thus, the saving on medical expenditures is linked to that factor in the Excel tables, and the savings on water treatment is linked to water potability. The average annual amount spent on water-related illness is approximately 11 JOD. The cost of treatment of public water was reported as 19.91 JOD per year (1.59 JOD per month times 12 months).

It should be noted that, while the cost savings to switching to public water use the same calculations for poor households, the average poor household expenditures on water treatment (1.335 JOD per month, or 16.26 JOD per year) and for medical care (8.40 JOD per year) are below the average savings for the entire sample. Thus, the calculated economic benefits to the poor will be smaller than those for the entire sample for any given set of assumptions.

The Excel models permit the user to make alternative assumptions about the increased availability of water from the public system (hours per week), and the incidence of health problems reported.For our analyses, we assumed first that hours of availability increase, and then that other quality aspects increase, partially because it is clear that availability is a limiting factor on public water consumption and that any estimated shift in water source to public water due to quality changes are not likely without a concomitant increase in public supply. Table 41 presents results from some of these assumptions and Table 42 presents the same information for the poor households. Annual cost savings are assumed to be constant for a 25 year project life, and discounted at 12% (the MCC cut-off rate of return) to obtain a present value. It appears from our results that improving water quality (potability) and reducing the water-supply related illnesses and the costs of treating the public water lead to the largest increase in benefits. However, increasing the availability of water from the public system does result in significant benefits as well and would very likely be linked to water potability and safety. As the tables indicate, the relative share of benefits to the poor is smaller than those to the entire sample (40+% of the benefits compared to 43%+ of the sample). Nonetheless, benefits to the poor households would be significant.

Table 41 Estimated benefits resulting from MCC project affects (entire population using per capita storage capacity)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	475,000	3,751,000

Increase availability, reduce illnesses to 0	2,430,000	19,186,000
Increase water availability, reduce illness, improve potability rating to 4	6,074,000	47,961,000
Increase availability to continuous flow, reduce illness and increase potability	6,973,000	55,057,000

Table 42Estimated benefits to poor households resulting from MCC project affects (usingper capita storage capacityy)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	191,500	1,512,000
Increase availability, reduce illnesses to 0	1,035,300	8,174,600
Increase water availability, reduce illness, improve potability rating to 4	2,500,400	19,742,200
Increase availability to continuous flow, reduce illness and increase potability	2,947,700	23,484,200

Benefit estimation for households consuming less than 50 lcd from the public system, and for the poor households consuming less than 50 lcd are found in Table 43 and Table 44. The benefits to those consuming less that 50 lcd are generally slightly larger than those of the poor. However, it should be kept in mind that poor households are not necessarily under-consumers, nor are under-consumers necessarily poor, as discussed above. The benefits to the poor households who consume less than 50 lcd from the public system are smaller than either the poor along or the under-consumers alone, as should be expected. Since these benefits are aggregate, the smaller numbers of households in the combined category will result in smaller total benefits. Per household benefits, on the other hand, are quite similar.

Table 43Estimated benefits to households consuming less that 50 lcd from the public system (using per capita storage capacity)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	185,150	1,462,000
Increase availability, reduce illnesses to 0	1,098,000	8,671,000

Increase water availability, reduce illness, improve potability rating to 4	2,728,000	21,542,000
Increase availability to continuous flow, reduce illness and increase potability	3,073,000	24.266,000

Table 44Estimated benefits to poor households consuming less than 50 lcd from the public system (using per capita storage capacity)

Assumed affects	Annual benefits (JOD)	Present value of benefits (JOD)
Increase water availability to 84 hours per week	214,000	1,690,000
Increase availability, reduce illnesses to 0	559,000	4,411,000
Increase water availability, reduce illness, improve potability rating to 4	1,151,000	9,086,000
Increase availability to continuous flow, reduce illness and increase potability	1,539,000	12,151,000

5 PRIORITY INVESTMENT ZONES

5.1 CRITERIA FOR PRIORITIZING INVESTMENT ZONES

Through the Inception Report; it was proposed to use the following criteria to categorize neighborhood zones into high priority, intermediate priority & low priority investment zones:

- Income Level/Poverty (Socioeconomic)
- Network Population Density (Socioeconomic)
- Density of Water network breaks (Infrastructure)
- Average Network Age (Infrastructure)
- NRW (Infrastructure)

However and after data cleansing and the correlation analysis, several obstacles appeared that prevent applying the proposed criteria for the analysis which are mainly related to data unavailability and inaccuracy. These major obstacles can be summarized as following:

- NRW is unavailable at Zonal Level
- Water and wastewater networks lengths are unavailable for many zones and there is a doubt of its accuracy for some zones.
- Average network age is unavailable for many zones and the available data don't seem accurate enough to be used for this assessment.
- Water complaints are unavailable for many zones.
- Wastewater complaints are only available for Zarqa district.

Therefore, the study team decided to adopt the following criteria for the PIZ analysis:

- Income Level/Poverty (Socioeconomic)
- Population (Socioeconomic)
- Water and wastewater complaints (Infrastructure)

5.2 *RATIONALE*

The main objective of this assessment is to help MCC identifying the priority zones for the MCC investment in Water & Sewage Networks in Zarqa Governorates through recommending the criteria for priority investment zones and their weights.

5.3 *DATA AVAILABILITY*

Extensive data from different resources has been collected, cleansed & analyzed.

Main data sets and sources include:

- Zarqa billing data from the CIS-X7 in Zarqa Water Administration
- Comprehensive Subscribers Survey (CSS) data from Zarqa Water Administration
- GIS maps for Zarqa water and wastewater networks from Zarqa Water Administration
- Socio-economic and census data of 2004 from DOS
- Complaints data form Zarqa DC Maintenance Management System (DCMMS)
- Administration data from Land and Survey Department.
- Others

DOS census data is available of block level in which Zarqa Governorate in 2004 was divided into 2158 blocks. The size of these blocks makes them unsuitable for priority investment zones analysis therefore a larger zone scale was envisaged and the neighborhood zones was selected as a start then some adjustment is made as described in the next section.

Customers and billing data were extracted from Zarqa CIS-X7 system. The billing information for all Zarqa subscribers sine 1994 till the second quarter of 2009 was obtained. This information included the quarterly billed water amount, the subscription date of water and wastewater service, the subscriber number and COBOSS number.

The subscribers and billing data was not provided spatially because the billing system (CIS-X7) doesn't contain geographical references field for each subscriber. Therefore, there was a need to seek a way to distribute the customers spatially over the neighborhood zones using the GIS. To overcome this major obstacle, the Primary Key (PK number) from the CSS for each water subscriber, which constitutes a geographically reference for each lot of land, was related to each subscriber's record in the CIS-X7. This enabled the option of geographically mapping the customers which is crucial for this assessment. However, around 3 thousands subscribers out of 128 thousands subscribers existing in Zarqa governorates were not spatially distribute since there was no COBOSS number for those subscribers to be used to link them with PK number.

The CSS has data on flat area, subscriber number, number of people using the same meter, sewerage network connection status, meter sealing status, and PK number that will be then linked with their location on the GIS map.

Complaints data was imported from the DCMMS operating in Zarqa Water Administration. These data were distributed over the zones using the GIS. However, wastewater complaints data was not available on the DCMMS data since ZWA doesn't use DCMMS to register wastewater complaints. Therefore, data entry for the available wastewater complaints data for Zarqa district is made. Additionally, water complaints data were only available for Zarqa and Russaifeh districts as the other districts in Zarqa are still not using the DCMMS to register their water complaints.

Water complaints considered related to the water network conditions are damaged installation, water flooding, water blockage, water pollution, leak complaints and no water available to the subscribers complaints (no water reach them). The wastewater complaints considered related to the wastewater conditions are wastewater blockages and overflows.

5.4 ANALYSIS PROCESS

I. Data collection and assembly

Data has been collected from the different sources listed in the previous section. Large amounts of data and maps has been collected that required spatial assembly in a proper way to facilitate the analysis. For this, different software packages and tools have been used for the data assembly as well as for the analysis. These tools include:

- Geographic Information System
- MS Excel
- MS Access

Data related to DOS census data on block level have been aggregated over the neighborhood zone level through appropriate mathematical methods. However, this process faced a major issue with the provided GIS block layer by DOS where many blocks overlapped with each-others and many blocks overlapped and/or intersected with the neighborhood boundaries. Therefore, the GIS blocks Layer had been edited and modified in order to be able assembling the DOS census data on the neighborhood zone level. This process took unforeseen time and efforts.

II. Data cleansing

The quality of the GIS zones layers was good in general. However, there are several issues arose as a result of getting data spatially related from different sources and for different time periods. Such of these issues are:

- Population data obtained from DOS: DOS has provided GIS maps for the blocks used to assemble the census data collected in 2004 and the detailed data for 2004. Since it is more convenient for analysis is to obtain the population data for 2008, DOS has additionally provided us with these data but on a different spatial format and only as a hard copy in detailed tables. This required summing manually the population data for 2008 to match the adopted priority investment zones and then entering them into the GIS database. This is expected to produce some inaccuracy in the population number of some zones.
- Complaints data: the complaints data are mapped based on the complainer's description of the problem location without having a verification process, which results in accurate determination of the complaints location in some cases.
- Socioeconomic conditions: the most recent available socioeconomic data for the study was for 2004 which in some cases does not reflect the current actual conditions on the ground. However, it is difficult to gage to what extend this might affect on the analysis, since in many cases socioeconomic behaviour does not reflect the actual income level. People in rural areas have different style of life than urban areas that might indicate their poor income level while in fact they are not. One of the proper ways to address this issue is the field observations. As an example of such zone in Zarqa is Hai Makka Al-Mukaramah which has socioeconomic condition of 2 on scale of 1 (poorest) to 4 (richest), while on reality this zone is recently becoming an area for villas and separate houses that enjoy an income above the average of Zarqa governorate.
- Linking CIS-X7 data with CSS data: CSS data has been imported repeatedly in order to use the most up-to-date data in our analysis. The CSS data had to be cleansed each time before relating CIS data with it in order to map the subscribers. Initially, uncompleted data was provided by Zarqa Water Administration on November 2009 and the process of mapping the subscribers was repeated again on January 2010.

- Water and wastewater networks:
    - o Water and wastewater networks are crossing zones boundaries, therefore these had to be manually split in order to calculate networks length inside each zone.
    - o Several neighborhood zones have no water and/or wastewater networks since Zarqa Water Administration didn't finish yet digitizing all water and wastewater networks. This resulted in not being able to determine networks lengths inside certain zones.
    - o The age of the networks recorded in the GIS is missing for many parts and the recorded age doesn't seem to have high accuracy.
- Billing and CIS data: the billing and CIS data has some issues such as records duplication which required removing the duplicated records, missing COBOSS numbers that are used to map the subscribers and non-matching fields where some COBOSS numbers in the CIS data did not match with the COBOSS number in the CSS data.

In summary, almost 130,225 records were extracted from Zarqa CIS-X7. However, cleansing the data and removing the duplicates resulted in having 127,077 records. The CSS contained 127,981 records. The matching process of the CIS and CSS data (those are the subscribers that could be geographically distributed over the neighborhood zones) ended up having 124,111 subscribers that then mapped by the GIS and used further in the analysis.

III. Zones identification

For this assessment; Zarqa Governorate has to be divided into zones taking into consideration the zone size, the socioeconomic characteristics, infrastructure conditions and data availability. Initially, the currently used neighborhood zones in Zarqa governorate were selected. Then these zones had been split or adjusted in order to maintain as possible the homogeneity of the socio-economic characteristics and the infrastructure conditions and to obtain reasonable zones sizes. Eventually, most of these zones match the neighborhood zones adapted by Zarqa Municipality except for few which had to be split or adjusted. The following is listing the modification made on the neighborhood zones in order to reach to the adopted ones for the analysis:

- Berain has been further subdivided
- Um Rommaneh has been split into Rajm Al-Shouk, Mehab and Abu El Zeighan

- Rusaifeh 5 neighborhood zones have been replaced by the 24 water distribution zones since they are more convenient in terms of number of inhabitants, size of the zone, socio-economic characteristics and the water system district zones.

Zones identification process ended up having 88 zones with an average population of 9,708 persons per zone. Summary information of the adopted priority investment zones is presented in Table 45.

Table 45: Summary of the adopted priority investment zones

District	No of zones	Population (2008)	Average population per zone	No of total Water Subscribers (2009)	No of total WW Subscribers (2009)	Water Complaints	Sewage Complaints
Zarqa	52	445,583	8,569	71,516	56,624	31,803	4,415
Bireen	8	15,664	1,958	2,733	-	-	-
Azraq	1	7,396	7,396	991	-	-	-
Al_hashmeieh	4	48,829	12,207	6,915	3,021	-	-
Al_Dhulial	3	37,790	12,597	3,309	-	-	-
Russaifeh	20	299,062	14,953	35,377	28,065	16,715	-
All Zones	**88**	**854,325**	**9,708**	**120,841**	**87,710**	**48,518**	**4,415**

Source: WAJ

It is important to address that there are around 3,200 water subscribers located outside the adopted priority investment zones because:

1- The construction of the water network in Al-Sharq city and urban development area are not the responsibility of the Water Authority of Jordan.

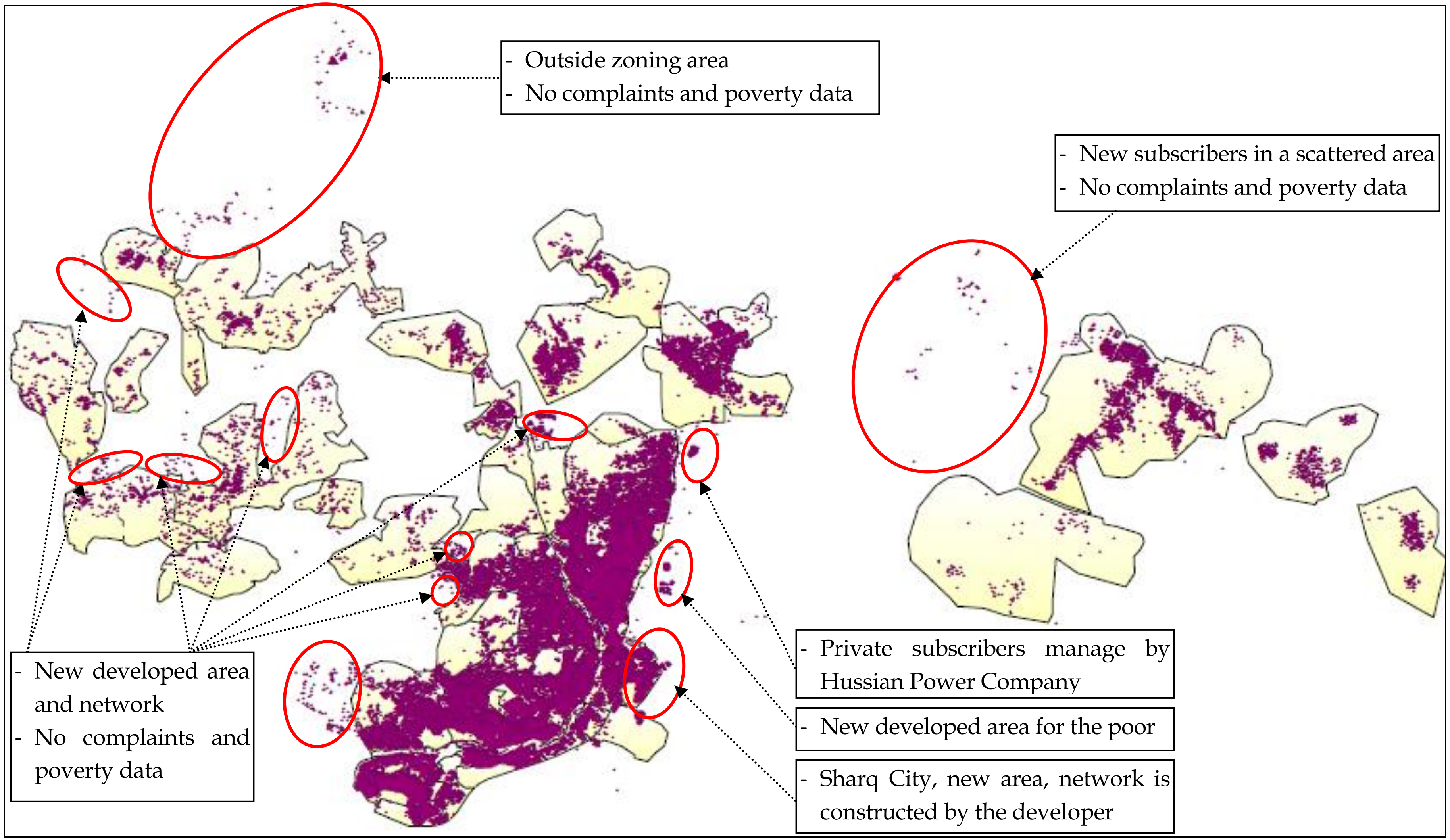
2- There are some subscribers scattered and located outside the zoning area

3- There are some subscribers located around the semi-urban zones that are recently connected to the water network and considered new ones.

4- There are no complaints and poverty data available for some of these subscribers.

Figure 32 shows the locations of those subscribers and illustrates the reason for excluding them.

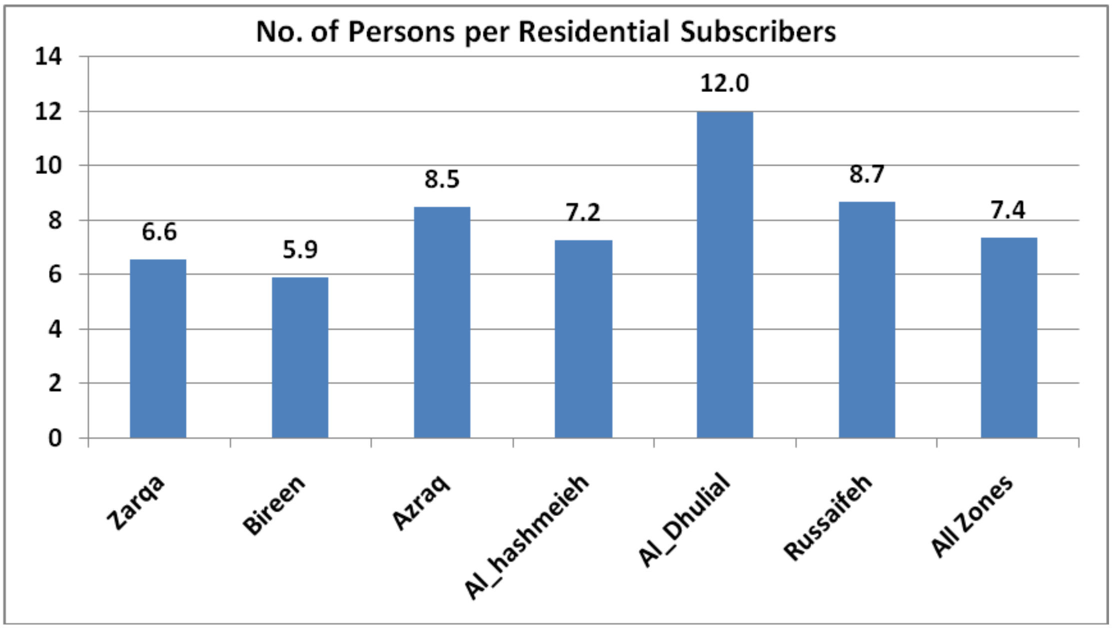
Figure 32: Subscribers located outside the adopted zones for the PIZ analysis



The population density per water meter (subscriber) varies largely between zones and districts. Figure 33 illustrates this variation on district level. The lowest and the highest average number of persons per residential water subscribers are recorded in Bireen and Dhulial districts (5.9 and 12 respectively). It is important to notice that both districts are considered rural areas, which reflects the high variation in living style even on rural areas. Bireen is a mountainous area and characterized by tree farms and low density population. On the other hand, Dhulial is a dense area and majority of people is working on animal production related businesses. Also, the land value and climate is largely different between the both districts, in which Bireen has mild climate and its land value considered high compared to Dhulial.

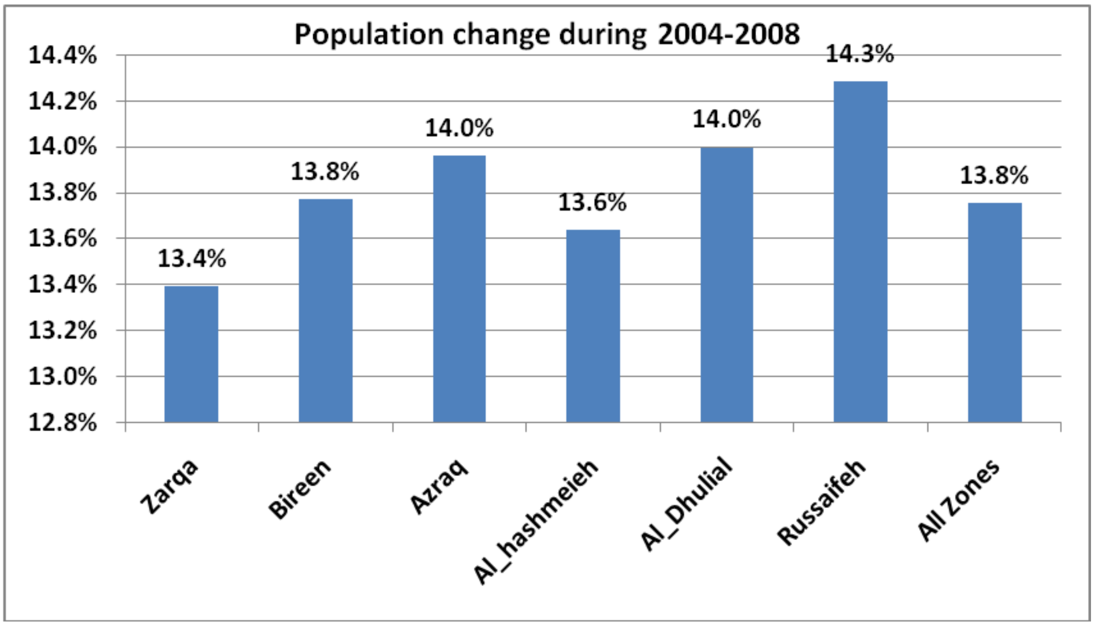
In terms of population growth, there were no significant variations among Zarqa's district as shown in Figure 34. The wastewater service coverage is highest in Zarqa and Russaifeh with around 79% of water subscribers are connected to the wastewater network (see Figure 35). There is no wastewater network in Bireen, Azraq and Dhulial districts. 44% of Hashmeieh district subscribers are connected to the wastewater network. Those are mainly the people living in the main town "Al-Hashmeieh". The surrounding villages are not yet served by any wastewater network as they are scatted and not densely populated.

Figure 33: Average No. of persons per residential water subscribe of Zarqa's districts



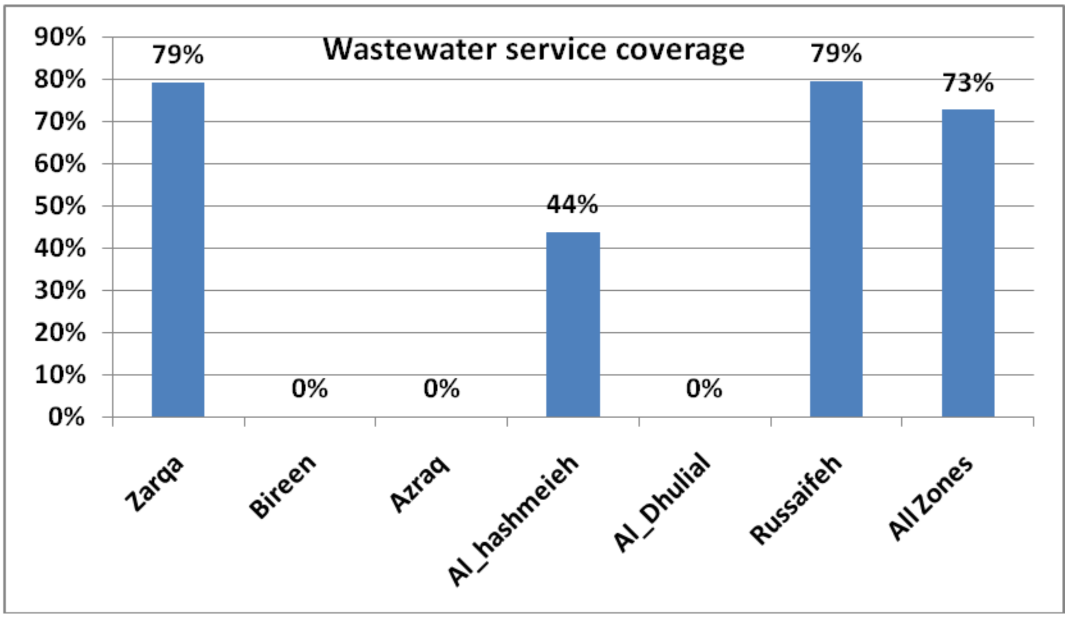
Data source: Zarqa Water Administation, 2009

Figure 34: The percentage change of population during 2004-2008 of Zarqa's districts



Data source: Zarqa Water Administation, 2009

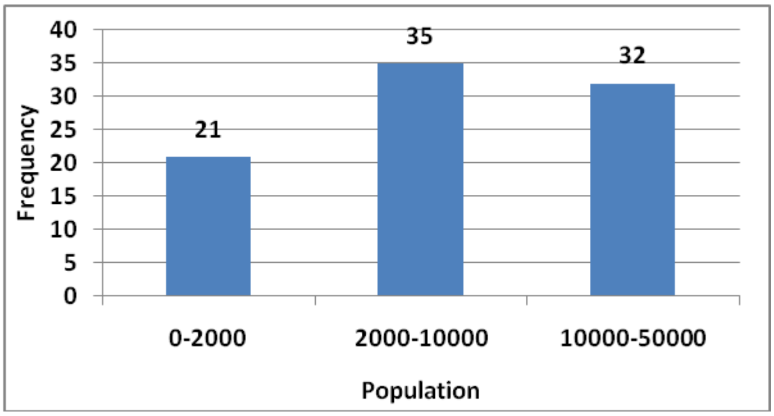
Figure 35: Average wastewater service coverage for Zarqa's districts



Data source: Zarqa Water Administation, 2009

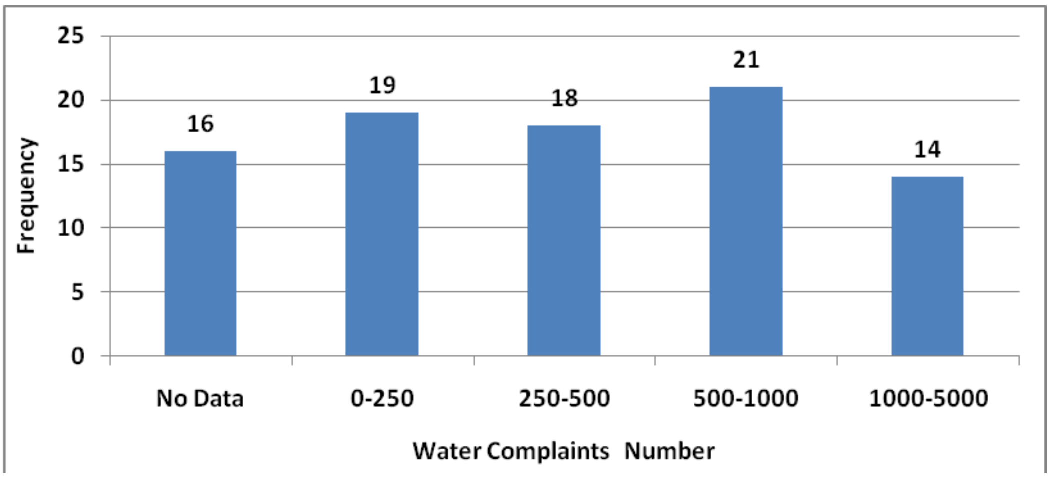
Figure 36 presents the population distribution over the priority investment zones, where 32 zones out of 88 are above the average zone population. Figure 37 and Figure 38 illustrate the variation of water and wastewater complaints over the priority investment zones.

Figure 36: Population distribution over priority investment zones



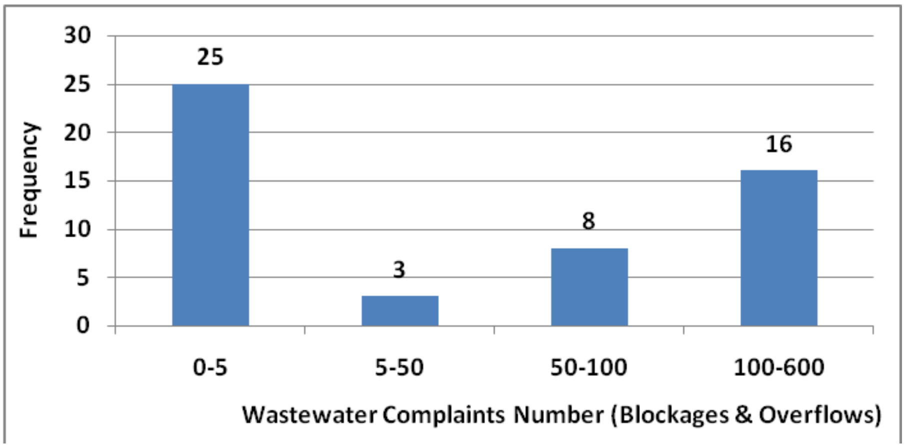
Data source: Zarqa Water Administation, 2009

Figure 37: Water complaints distribution over priority investment zones



Data source: Zarqa Water Administation, 2009

Figure 38: Wastewater complaints distribution over priority investment zones



Data source: Zarqa Water Administation, 2009

IV. Correlation analysis of priority investment criteria

The aim of this analysis is to examine the relationship between the priority investment criteria and check their colinearity. Therefore, the correlation analysis has been performed for all neighbourhood zones except for those listed in Table 46 as following:

Poverty with water complaints density

Multiple R = -0.203

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	977.32850	241.09938	4.05363	0.00014	495.8198	1458.837
X Variable 1	-164.40203	98.34813	-1.67163	0.09940	-360.817	32.01275

Poverty with population density (capita per water subscriber)

Multiple R = -0.205

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	8.1152	0.7140	11.3651	4.3E-17	6.689148	9.541232
X Variable 1	-0.4920	0.2913	-1.6891	0.095989	-1.07369	0.089716

Population density (capita per water subscriber) with water complaints density

Multiple R = -0.301

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	7.5011	0.3021	24.8271	7.07E-35	6.897709	8.14517
X Variable 1	-0.0009	0.0004	-2.5471	0.013239	-0.00159	-0.00019

The results of the correlation analysis clearly illustrate that there is no correlation among the selected criteria where the multiple R for the correlations above were close to zero.

Table 46: Zones excluded for the correlation analysis

ID	Zone name	Reason for excluding
1	Hai Ma'amel At-Toub	Craft zone, non-residential subscribers connected as residential subscribers
3	Hai Al-hashemy	New zone, low number of water complaints is expected
6	Hai Al-herafyeen	Low population, craft zone, non-residential subscribers connected as residential subscribers
53	Hai Al-Masane'e	Large ratio of shared meter, non-residential subscribers connected as residential subscribers

61	Ghrisa _um _alsaleeh	Missing poverty and complaints data
65	Um_Romaneh	Missing poverty and complaints data
91	Abu Al-Zighan	Missing poverty and complaints data
90	Merheb & Um Al fataier	Missing poverty and complaints data
92	Rajm_Alshouk	Missing poverty and complaints data
100	Dogara	Missing poverty and complaints data
72	◌Qaser_Al Hallabat	Missing poverty and complaints data
71	Taffeh	poor, shared meter
66	Al_A'louk	Missing poverty and complaints data
67	Biereen	Missing poverty and complaints data
68	Al_Kamsheh	Missing poverty and complaints data
69	Sarrot	Missing poverty and complaints data
80	Al_Azraq	Get 1st 200 m^3 per quarter for free, high billed is expected, missing complaints data
R10	Phosphate Area	Craft zone, non-residential subscribers connected as residential subscribers

Further correlation analysis is also carried out between the total billed water with each of the priority investment zones on all zones excluding those listed in Table 46 as following:

Poverty with total billed water per capita

Multiple R = 0.00

Population density (capita per water subscription) with total billed water per capita

Multiple R = - 0.8

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	125.2043	5.8200	21.5127	0.0000	113.5907	136.8180
X Variable 1	-8.5938	0.7950	-10.8094	0.0000	-10.1803	-7.0074

Water complaints density with total billed water per capita

Multiple R = 0.46

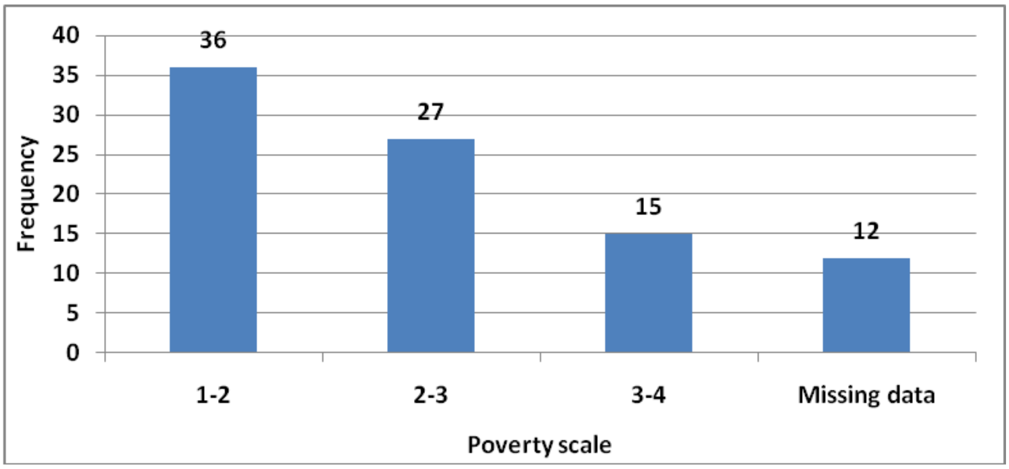
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	55.5419	3.2402	17.1417	0.0000	49.0708	62.0129
X Variable 1	0.0155	0.0038	4.1368	0.0001	0.0080	0.0231

The correlation analysis indicates that poverty rate has no influence on the total billed water per capita. While, there is strong negative influence of the population density on the total billed water per capita, where the person lives in the dense zones consumes less water than less dense zones. This indicates a need to give more weight for the population density. On the other hand, the water complaints are moderately correlated with the total billed water but the coefficient of 0.0155 is insignificant.

V. Priority investment zones analysis

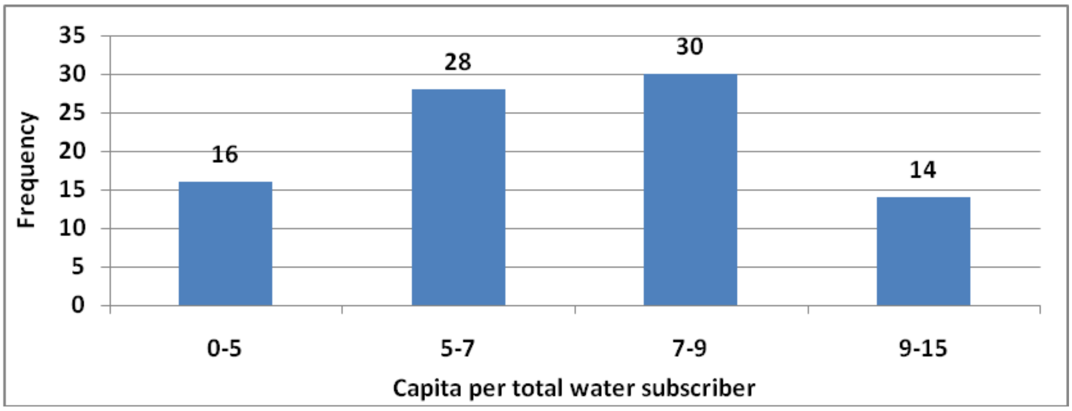
Before carrying out the priority investment zones analysis, the values for each criterion has been grouped as shown in Figure 39 to Figure 43, so as to reduce the influence of the biased data for some zones. Grouping of each criterion has been done based on the density values. The density values for each criterion have been calculated through dividing the absolute values by the number of water and wastewater subscribers for the analysis of the water and wastewater priority investment zones respectively. This provides normalized values that can be used to compare zones without the influence of the zones size.

Figure 39: Poverty scale distribution over priority investment zones



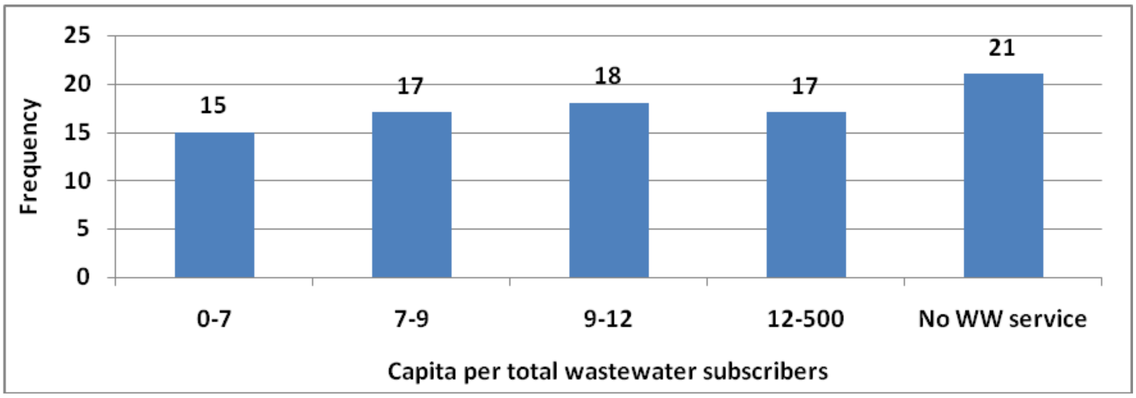
Data source: Zarqa Water Administation, 2009

Figure 40: population density distribution for water priority investment zones



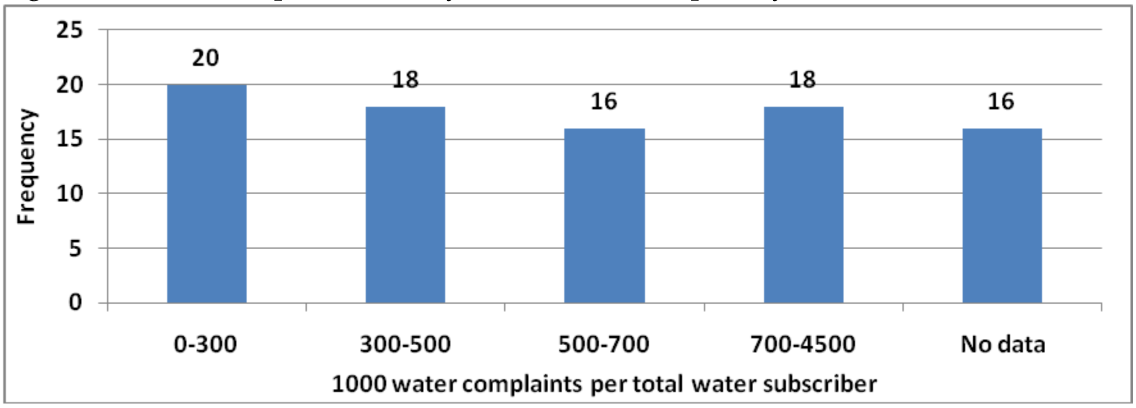
Data source: Zarqa Water Administation, 2009

Figure 41: population density distribution for wastewater priority investment zones



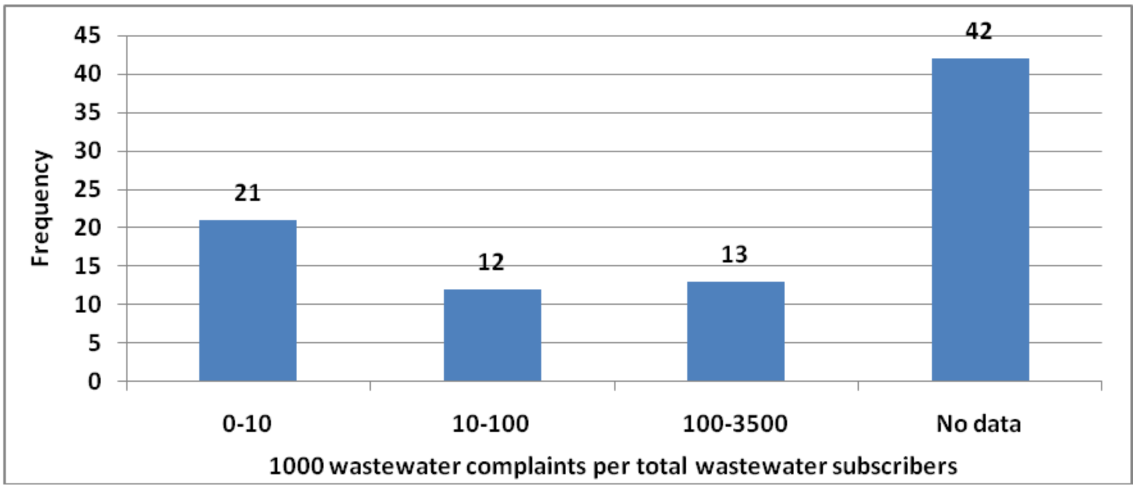
Data source: Zarqa Water Administation, 2009

Figure 42: Water complaints density distribution over priority investment zones



Data source: Zarqa Water Administation, 2009

Figure 43: Wastewater complaints density distribution over priority investment zones



Data source: Zarqa Water Administation, 2009

Each group for each criterion has given a relative classification. For example, the zones with poverty scale of 1 to 2, 2 to 3 and 3 to 4 are considered high, moderate, and low poverty zones respectively. For mathematical estimates these classification are transferred to weights that can be scaled up and down based on the overall weight given to each criterion. The given weights for each criterion groups are shown in Table 47.

Table 47: Weights for each criterion groups

Poverty			Population density			Water complaints density		
Range	**Frequency**	**Weight**	**Range**	**Frequency**	**Weight**	**Range**	**Frequency**	**Weight**
1-2	36	3	0-5	16	1	0-300	20	1
2-3	27	2	5-7	28	2	300-500	18	2
3-4	15	1	7-9	30	3	500-700	16	3
			9-15	14	4	700-4500	18	4

5.5 *RESULTS OF ANALYSIS FOR DIFFERENT SCENARIOS*

Different scenarios have been developed by applying different weights for each criterion. The aim of conducting these different scenarios is to understand how the priority for each zone is changing throughout the different scenarios. The final goal is to identify the zones that are ranked as high priority overall the scenarios. These high priority zones and classifications should then be considered by the consultants who are working on the feasibilities of the water and wastewater networks. Eventually, the zones with high poverty scale, high population density, and high water complaints density are expected to be always high priority investment zones whatever the scenario was. Table 47 is summarizing the carried out scenarios.

Table 48: Weights applied for the priority investments zones scenarios

Scenario No	Weight value		
	Poverty	**Complaints**	**Population**
I	5	4	3
II	3	5	2
III	5	5	2
IV	2	5	2
V	2	5	4
VI	2	5	3

The results of water priority investment zones analysis are presented in **Error! Reference source not found.** and **Error! Reference source not found.**. Priority investment zones are classified into five categories (High, Above Moderate, Moderate, Below Moderate and Low priority investment zones in addition to a category for the zones that are missing data. As shown in **Error! Reference source not found.**, the zones that are almost identified as high priority investment zones throughout the different scenarios are classified as high priority investment zones. The zones that are identified 2 to 4 times as high priority investment zones while the remaining are moderate are classified as above moderate priority investment zones, and so on.

Similarly, the wastewater priority investment zones are identified but categorized as High, Moderate and Low as shown in **Error! Reference source not found.**. Zones that do not have wastewater service are considered high priority investment zones. However, cost effectiveness should be assessed by the Consultant carrying out the wastewater network feasibility and design study.

Table 49: Summary results of the water priority investment zones analysis

Zone ID	Zone Name	District	Poverty	Water Complaints	Pop.	Scenario weights (Poverty, complaints, population)						Priority Investments Zones
						5,4,3	5,5,2	3,5,2	2,5,4	2,5,3	2,5,2	
1	Hai Ma'amel At-Toub	Zarqa	High	High	High	High	High	High	High	High	High	High
5	Hai Al-Hashemeyah Al-Janoubi	Zarqa	Mod	High	Mod	High	High	High	High	High	High	High
18	Hai Al-Jneeneh	Zarqa	High	High	Mod	High	High	High	High	High	High	High
20	Hai Az-Zawahreh	Zarqa	Mod	Mod	Mod	High	High	High	High	High	High	High
22	Hai Al-Ghwaireyeh	Zarqa	High	Mod	Mod	High	High	High	High	High	High	High
24	Hai Nassar	Zarqa	High	High	Mod	High	High	High	High	High	High	High
28	Hai An-Nuzha	Zarqa	Mod	High	Mod	High	High	High	High	High	High	High
31	Hai Al-Ahmad	Zarqa	High	High	Mod	High	High	High	High	High	High	High
32	Hai Al-qamar	Zarqa	High	High	Mod	High	High	High	High	High	High	High
52	Hai Aljundi	Zarqa	High	High	High	High	High	High	High	High	High	High
53	Hai Al-Masane'e	Zarqa	High	High	High	High	High	High	High	High	High	High
54	Hai Awajan	Zarqa	High	High	Mod	High	High	High	High	High	High	High
R2	Qadesiah	Russaifeh	Mod	Mod	Mod	High	High	High	High	High	High	High
R7	Awagan	Russaifeh	Mod	Mod	High	High	High	High	High	High	High	High
R13	Northern Mountain	Russaifeh	Mod	High	High	High	High	High	High	High	High	High
6	Hai Al-herafyeen	Zarqa	Mod	High	Low	High	High	High	Mod	High	High	High
7	Hai Shoumar	Zarqa	High	High	Low	High	High	High	Mod	High	High	High
9	Hai Ma'asoum Ash-Shamali	Zarqa	Mod	Mod	Mod	High	Mod	High	High	High	High	High
41	Hai MAkka Al-MUkaramah	Zarqa	Mod	High	Low	High	High	High	Mod	High	High	High
10	Hai Al-Eskaan	Zarqa	Low	High	Mod	Mod	Mod	High	High	High	High	Above Mod
R6	Dahereah	Russaifeh	Mod	Mod	High	Mod	Mod	High	High	High	High	Above Mod

Zone ID	Zone Name	District	Poverty	Water Complaints	Pop.	Scenario weights (Poverty, complaints, population)						Priority Investments Zones
						5,4,3	5,5,2	3,5,2	2,5,4	2,5,3	2,5,2	
3	Hai Al-hashemy	Zarqa	High	Mod	High	High	High	Mod	High	Mod	Mod	Above Mod
21	Hai Al-Jaber	Zarqa	Mod	High	Low	Mod	High	High	Mod	Mod	High	Above Mod
33	Hai Al-Madenah Al-Monawarah	Zarqa	High	Mod	Low	High	High	High	Mod	Mod	Mod	Above Mod
42	thawra	Zarqa	Mod	High	Low	Mod	High	High	Mod	Mod	High	Above Mod
51	Haii Al-Ameer Talal	Zarqa	High	Mod	High	High	High	Mod	High	Mod	Mod	Above Mod
12	Hai Ibn Sina	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	High	High	Mod	Above Mod
40	Hai Janna'a	Zarqa	High	Mod	Mod	High	High	Mod	Mod	Mod	Mod	Above Mod
R1	Rasheed	Russaifeh	Mod	Mod	Mod	Mod	Mod	Mod	High	High	Mod	Above Mod
R22	Hussien District	Russaifeh	Mod	Mod	Mod	Mod	Mod	Mod	High	High	Mod	Above Mod
R9	Arateqa	Russaifeh	Mod	Mod	Mod	Mod	Mod	Mod	High	Mod	Mod	Mod
R17	Prince Fuisel Mountain	Russaifeh	High	Mod	High	High	Mod	Mod	Mod	Mod	Mod	Mod
4	Hai Al-Batrawi	Zarqa	Low	High	Low	Low	Mod	Mod	Mod	Mod	High	Mod
15	Hai Al-Ameer Mohammad	Zarqa	High	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
17	Hai Ash-Shyoukh	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
25	Hai Qurtuba	Zarqa	High	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
38	Hai Al-Jabal Al-Abyadh	Zarqa	High	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
44	Hai Al-Ameera Rahmeh	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
46	Hai Al-Falah	Zarqa	High	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
50	Hai Al-Ameer Hasan	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
R3	Tatweer Hadari	Russaifeh	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
R11	Lower Rasheed	Russaifeh	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
R5	Razi	Russaifeh	Low	Mod	Mod	Low	Mod	Mod	Mod	Mod	Mod	Mod
R4	Prince Talal Housing	Russaifeh	Low	Mod	Mod	Low	Low	Mod	Mod	Mod	Mod	Below Mod

Zone ID	Zone Name	District	Poverty	Water Complaints	Pop.	Scenario weights (Poverty, complaints, population)						Priority Investments Zones
						5,4,3	5,5,2	3,5,2	2,5,4	2,5,3	2,5,2	
R20	Msherfah	Russaifeh	Low	Mod	Mod	Low	Low	Mod	Mod	Mod	Mod	Below Mod
R24	Western Msherfah	Russaifeh	High	Low	High	Mod	Mod	Low	Mod	Mod	Low	Below Mod
2	Hai Al Bustan	Zarqa	High	Low	Mod	Mod	Mod	Mod	Low	Low	Low	Below Mod
35	Al Jabal Al Abyad	Zarqa	High	Low	High	Mod	Low	Low	Mod	Mod	Low	Below Mod
45	Hai Tareq Bin Zeyad	Zarqa	Low	Mod	Low	Low	Low	Mod	Low	Mod	Mod	Below Mod
27	Hai Al-Hussain	Zarqa	Mod	Mod	Mod	Low	Low	Mod	Low	Low	Mod	Below Mod
39	Hai Um Bayadhah	Zarqa	High	Low	Mod	Mod	Mod	Low	Low	Low	Low	Below Mod
R19	Huteen Camp	Russaifeh	Mod	Low	High	Mod	Low	Low	Mod	Low	Low	Below Mod
34	Hai Al-Ameer Hamzah	Zarqa	High	Low	Mod	Mod	Low	Low	Low	Low	Low	Low
37	Ja'nna_camb	Zarqa	High	Low	Mod	Mod	Low	Low	Low	Low	Low	Low
43	Hai Al-Dwaik	Zarqa	High	Low	Low	Low	Mod	Low	Low	Low	Low	Low
47	Hai Ath-Thoura Al-Arabiyah Al-Kubrah	Zarqa	Mod	Mod	Mod	Low	Low	Low	Low	Low	Mod	Low
48	Al Thawra 2	Zarqa	Mod	Mod	Mod	Low	Low	Low	Low	Low	Mod	Low
R10	Phosphate Area	Russaifeh	High	Low	Low	Low	Mod	Low	Low	Low	Low	Low
8	Hai Al-zarqa'a Al-Jadedah	Zarqa	Low	Mod	Low	Low	Low	Low	Low	Low	Low	Low
11	Hai Barrakh	Zarqa	Mod	Mod	Mod	Low	Low	Low	Low	Low	Low	Low
13	Hai Ramzi	Zarqa	Mod	Low	Mod	Low	Low	Low	Low	Low	Low	Low
14	Hai Ma'asoum Al-Janoubi	Zarqa	Mod	Low	Mod	Low	Low	Low	Low	Low	Low	Low
16	HAi Al-Ameera Haya	Zarqa	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
19	Hai Al-Basateen	Zarqa	Low	Mod	Mod	Low	Low	Low	Low	Low	Low	Low
23	Hai Al-Almmer Shaker	Zarqa	Mod	Low	Mod	Low	Low	Low	Low	Low	Low	Low
26	Hai An-Naser	Zarqa	Low	Low	Mod	Low	Low	Low	Low	Low	Low	Low
30	Hai Al-Wasat At-Tejari	Zarqa	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

Zone ID	Zone Name	District	Poverty	Water Complaints	Pop.	Scenario weights (Poverty, complaints, population)						Priority Investments Zones
						5,4,3	5,5,2	3,5,2	2,5,4	2,5,3	2,5,2	
36	Hai Adh-Dhubbat	Zarqa	Mod	Low	Mod	Low	Low	Low	Low	Low	Low	Low
R8	gunde	Russaifeh	Low	Low	Mod	Low	Low	Low	Low	Low	Low	Low
R14	Fakhora	Russaifeh	Mod	Low	Mod	Low	Low	Low	Low	Low	Low	Low
R16	Hashem Housing	Russaifeh	Mod	Low	Mod	Low	Low	Low	Low	Low	Low	Low
R18	Nakab	Russaifeh	Mod	Low	Low	Low	Low	Low	Low	Low	Low	Low
65	Um_Romaneh	Bireen	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
91	Abu Al-Zighan	Bireen	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
90	Merheb & Um Al fataier	Bireen	MD	MD	Low	MD	MD	MD	MD	MD	MD	MD
92	Rajm_Alshouk	Bireen	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
66	Al_A'louk	Bireen	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
67	Biereen	Bireen	MD	MD	Low	MD	MD	MD	MD	MD	MD	MD
68	Al_Kamsheh	Bireen	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
69	Sarrot	Bireen	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
80	Al_Azraq	Azraq	High	MD	Mod	MD	MD	MD	MD	MD	MD	MD
60	Al_Hashmeieh	Hashmeieh	Low	MD	Mod	MD	MD	MD	MD	MD	MD	MD
61	GHrisa _um _alsaleeh	Hashmeieh	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
63	Al_Sukhneh	Hashmeieh	Mod	MD	Mod	MD	MD	MD	MD	MD	MD	MD
100	Dogara	Hashmeieh	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
72	́Qaser_Al Hallabat	Dhulial	MD	MD	Mod	MD	MD	MD	MD	MD	MD	MD
71	Taffeh	Dhulial	MD	MD	High	MD	MD	MD	MD	MD	MD	MD
70	Al_Dhulil	Dhulial	High	MD	High	MD	MD	MD	MD	MD	MD	MD

Moderate: Mod *MD: Missing Data*

Figure 44: Recommended water priority investments zones map

Table 50: Summary results of the wastewater priority investment zones analysis

Zone ID	Zone Name	District	Poverty	Pop.	WW Complaints	Scenario weights (Poverty, complaints, population)						Priority Investments Zones
						5,4,3	3,5,2	5,5,2	2,5,2	2,5,4	2,5,3	
3	Hai Al-hashemy	Zarqa	High	High	Mod	high	high	high	high	high	high	High
15	Hai Al-Ameer Mohammad	Zarqa	High	Mod	Mod	high	high	high	high	high	high	High
20	Hai Az-Zawahreh	Zarqa	Mod	Mod	Mod	high	high	high	high	high	high	High
22	Hai Al-Ghwaireyeh	Zarqa	High	Mod	Mod	high	high	high	high	high	high	High
25	Hai Qurtuba	Zarqa	High	High	Low	high	high	high	high	high	high	High
32	Hai Al-qamar	Zarqa	High	High	Low	high	high	high	high	high	high	High
33	Hai Al-Madenah Al-Monawarah	Zarqa	High	High	Low	high	high	high	high	high	high	High
38	Hai Al-Jabal Al-Abyadh	Zarqa	High	Mod	Mod	high	high	high	high	high	high	High
39	Hai Um Bayadhah	Zarqa	High	High	Low	high	high	high	high	high	high	High
40	Hai Janna'a	Zarqa	High	Mod	Mod	high	high	high	high	high	high	High
43	Hai Al-Dwaik	Zarqa	High	High	Low	high	high	high	high	high	high	High
46	Hai Al-Falah	Zarqa	High	High	Low	high	high	high	high	high	high	High
52	Hai Aljundi	Zarqa	High	High	Mod	high	high	high	high	high	high	High
53	Hai Al-Masane'e	Zarqa	High	High	Mod	high	high	high	high	high	high	High
54	Hai Awajan	Zarqa	High	Mod	Mod	high	high	high	high	high	high	High
4	Hai Al-Batrawi	Zarqa	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
5	Hai Al-Hashemeyah Al-Janoubi	Zarqa	Mod	Mod	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod
9	Hai Ma'asoum Ash-Shamali	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
12	Hai Ibn Sina	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
21	Hai Al-Jaber	Zarqa	Mod	High	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod
27	Hai Al-Hussain	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
28	Hai An-Nuzha	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
34	Hai Al-Ameer Hamzah	Zarqa	High	Mod	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod
35	Al Jabal Al Abyad	Zarqa	High	High	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod
37	Ja'nna_camb	Zarqa	High	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
41	Hai MAkka Al-MUkaramah	Zarqa	Mod	High	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod
44	Hai Al-Ameera Rahmeh	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
50	Hai Al-Ameer Hasan	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
51	Haii Al-Ameer Talal	Zarqa	High	Mod	Low	Mod	Mod	Mod	Mod	Mod	Mod	Mod
16	HAi Al-Ameera Haya	Zarqa	Low	High	Low	low	Mod	low	Mod	Mod	Mod	Mod
17	Hai Ash-Shyoukh	Zarqa	Mod	Mod	Low	Mod	low	Mod	low	low	low	Low
6	Hai Al-herafyeen	Zarqa	Mod	Low	Low	low	low	low	low	low	low	Low
8	Hai Al-zarqa'a Al-Jadedah	Zarqa	Low	Low	Mod	low	low	low	low	low	low	Low
10	Hai Al-Eskaan	Zarqa	Low	Low	Mod	low	low	low	low	low	low	Low
11	Hai Barrakh	Zarqa	Mod	Low	Low	low	low	low	low	low	low	Low
13	Hai Ramzi	Zarqa	Mod	Mod	Mod	low	low	low	low	low	low	Low
14	Hai Ma'asoum Al-Janoubi	Zarqa	Mod	Mod	Low	low	low	low	low	low	low	Low
19	Hai Al-Basateen	Zarqa	Low	Low	Low	low	low	low	low	low	low	Low
23	Hai Al-Almmer Shaker	Zarqa	Mod	Low	Mod	low	low	low	low	low	low	Low
26	Hai An-Naser	Zarqa	Low	Low	Low	low	low	low	low	low	low	Low
30	Hai Al-Wasat At-Tejari	Zarqa	Low	Low	Mod	low	low	low	low	low	low	Low
36	Hai Adh-Dhubbat	Zarqa	Mod	Low	Mod	low	low	low	low	low	low	Low
42	thawra	Zarqa	Mod	Low	Low	low	low	low	low	low	low	Low
45	Hai Tareq Bin Zeyad	Zarqa	Low	Low	Mod	low	low	low	low	low	low	Low
47	Hai Ath-Thoura Al-Arabiyah Al-Kubrah	Zarqa	Mod	Low	Mod	low	low	low	low	low	low	Low
48	Al Thawra 2	Zarqa	Mod	Mod	Low	low	low	low	low	low	low	Low
1	Hai Ma'amel At-Toub	Zarqa	High	High	High	No S	No S	No S	No S	No S	No S	High
2	Hai Al Bustan	Zarqa	High	High	High	No S	No S	No S	No S	No S	No S	High
7	Hai Shoumar	Zarqa	High	High	High	No S	No S	No S	No S	No S	No S	High
18	Hai Al-Jneeneh	Zarqa	High	High	High	No S	No S	No S	No S	No S	No S	High
24	Hai Nassar	Zarqa	High	High	High	No S	No S	No S	No S	No S	No S	High
31	Hai Al-Ahmad	Zarqa	High	High	High	No S	No S	No S	No S	No S	No S	High
65	Um_Romaneh	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
91	Abu Al-Zighan	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
90	Merheb & Um Al fataier	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
92	Rajm_Alshouk	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
66	Al_A'louk	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
67	Biereen	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
68	Al_Kamsheh	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
69	Sarrot	Bireen	MD	High	High	No S	No S	No S	No S	No S	No S	High
80	Al_Azraq	Azraq	High	High	High	No S	No S	No S	No S	No S	No S	High
61	GHrisa _um _alsaleeh	Hashmeieh	MD	High	High	No S	No S	No S	No S	No S	No S	High
63	Al_Sukhneh	Hashmeieh	Mod	High	High	No S	No S	No S	No S	No S	No S	High

100	Dogara	Hashmeieh	MD	High	High	No S	No S	No S	No S	No S	No S	High
72	óQaser_Al Hallabat	Al_Dhulial	MD	High	High	No S	No S	No S	No S	No S	No S	High
71	Taffeh	Al_Dhulial	MD	High	High	No S	No S	No S	No S	No S	No S	High
70	Al_Dhulil	Al_Dhulial	High	High	High	No S	No S	No S	No S	No S	No S	High
60	Al_Hashmeieh	Hashmeieh	Low	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R1	Rasheed	Russaifeh	Mod	High	MD	MD	MD	MD	MD	MD	MD	MD
R2	Qadesiah	Russaifeh	Mod	High	MD	MD	MD	MD	MD	MD	MD	MD
R3	Tatweer Hadari	Russaifeh	Low	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R4	Prince Talal Housing	Russaifeh	Low	Low	MD	MD	MD	MD	MD	MD	MD	MD
R5	Razi	Russaifeh	Low	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R6	Dahereah	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R7	Awagan	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R8	gunde	Russaifeh	Low	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R9	Arateqa	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R10	Phosphate Area	Russaifeh	High	Low	MD	MD	MD	MD	MD	MD	MD	MD
R11	Lower Rasheed	Russaifeh	Mod	High	MD	MD	MD	MD	MD	MD	MD	MD
R13	Northern Mountain	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R14	Fakhora	Russaifeh	Mod	High	MD	MD	MD	MD	MD	MD	MD	MD
R16	Hashem Housing	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R17	Prince Fuisel Mountain	Russaifeh	High	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R18	Nakab	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R19	Huteen Camp	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R20	Msherfah	Russaifeh	Low	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R22	Hussien District	Russaifeh	Mod	Mod	MD	MD	MD	MD	MD	MD	MD	MD
R24	Western Msherfah	Russaifeh	High	Mod	MD	MD	MD	MD	MD	MD	MD	MD

Moderate: Mod   *MD: Missing Data*   *NO S: No wastewater service*

Figure 45: Scenario I of water high priority investment zones

5.6 *RECOMMENDATIONS FOR PRIORITY INVESTMENT ZONES*

- Population density should be given the highest weight follow by the water complaints then poverty. However, the analysis showed that whatever weights are given for the criterion, the priority investment zones almost do not change.
- The consultant carry out the water network feasibility and design study has to identify further criteria to address more accurately the water networks condition such as the pipeline type, age of the network, pipeline sizing, water gravity distribution verses water pressurized distribution, etc.
- Zones that do not have wastewater service are required further investigation by the Consultant carrying out the wastewater network feasibility and design study, where expanding wastewater service is considered a priority but cost effectiveness of the expansion should be assessed in compassion to other investment options.
- Water and wastewater priority investment zones presented in Table 54 and Table 55 respectively are recommended to be considered by the feasibility and design consultant.
- In order to maximize the benefits from each dollar spent on rehabilitating water and wastewater network, it is essential to select the investments that benefit more people for the same amount of fund. Therefore, the costs should also be normalized by the number of water and wastewater subscribers for each sector in order to make accurate comparisons between various criteria.

6 *INTERVENTIONS ANALYSIS*

This chapter presents the interventions that might possibly enhance the share of benefits accruing to the poor from increases of urban water supplies and assesses their efficacy. The interventions are grouped into policy, institutional and management, infrastructure investments, and targeted household interventions. A set of criteria is used to evaluate these interventions, and the cost effectiveness of the selected interventions is carried out.

The potential interventions that are examined include:

Policy interventions

1. Reallocation of fresh groundwater supplies from agriculture to municipal users
2. Restructuring the water tariff to achieve O&M Cost Recovery and keep cross-subsidy to benefit the poor
3. Substituting fresh water supplies in the Jordan Valley with suitable water quality from treated wastewater in Amman and Zarqa, release Jordan Valley water to municipal users in Middle Gov.
4. Implementing the appropriate PPP option for Zarqa Water Utility, and support the transition from WAJ owned utility into a water company
5. Providing regulatory and incentive tools for water harvesting
6. Providing regulatory and incentive tools for grey water reuse

Utility Management and Operational Interventions

7. Improving water utility operational systems - including improved information system and modeling for rationing schedule and setting pumping pressure, implementation of assets management system, capacity building and certification program for utility operators, and meters replacements
8. Splitting the households that are connected to one shared meter to reduce tariff, and consequently increase public system use

9. Raising water awareness on water issues, water potability of available supplies, and participation in reducing leakages through filing complaints with the utility

Infrastructure Investment Interventions

10. Rehabilitation of water wells to increase productivity
11. Expansion and rehabilitation of water supply system to increase water availability and improve water quality
12. Expansion of wastewater collection and treatment system to enable wastewater reuse and release fresh waters to drinking supplies
13. Geographically targeting the network rehabilitation and zoning in poor areas

Household Interventions

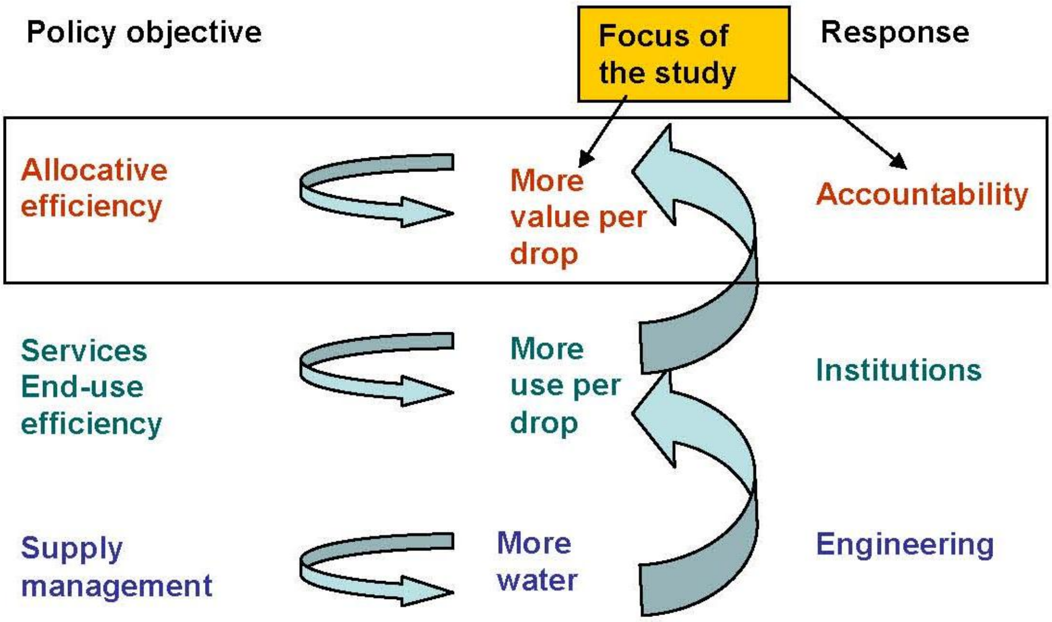
14. Improving water storage to address quality and quantity issues, and rehabilitation of plumping systems of poor households
15. Subsidizing the implement water harvesting in semi-urban and rural areas
16. Implementing grey water collection and reuse in semi urban and rural areas

6.1 SCREENING CRITERIA

The criteria applied for screening the interventions are:

Addressing key factors of under-consumption	The analysis has clearly shown that under-consumption of network water is highly related to water potability, and water availability. Therefore, interventions that address these two factors will be prioritized.
Improving utility efficiency and services delivery capacity	International and local experiences have shown that enhanced utility operations significantly improve water delivery to customers, increase utility ability to finance needed investments, and contributes to increased confidence in the public systems, and the willingness to participate in demand management effort.
Financial Costs	Water infrastructure investments and the technical complexity are key limitations of ability to implement any interventions. The technical complexity is addressed here, given that cost of complex technical interventions are higher.

Political and Social Constraints	The level of support or opposition of intervention is an important criterion. Very often, expensive and complex technical solutions are selected if political and social opposition of other interventions push in that direction. Experiences in Jordan and elsewhere suggest that governance systems usually address interventions in the following order: supply management, system efficiency and allocative efficiency.
Extent of the Intervention Impact	Some interventions are more appropriate in specific conditions and environments. The choice of centralized and decentralized water and wastewater solutions is related to these conditions and environments.
Ongoing and implementation plans of the government and donors/funding agencies	This serves as an exclusion criterion if a set of the potential interventions are already funded or considered by others.



Source: World Bank 2006

6.2 *ASSESSMENT OF INTERVENTIONS*

The interventions were discussed with utility managers, WAJ water department, OMS project, Mercy Corps, MCA Jordan, and others to understand the ongoing support related to the intervention, the level of complexity in implementation, and how the interventions will affect water share to poor households, and overall utility operations. **Table 51**below summarizes the intervention assessment against the criteria, and illustrate the set of short-listed interventions to be assessed for cost effectiveness. The interventions that are already likely to be considered by the MCC program, government, and other donor projects will not assessed further. The interventions that have low or limited geographic impact on increasing water availability and potability to the poor are also not taken further into the short-list.

Table 51Interventions Assessment

#	Intervention	Criteria for Short-listing Interventions						Short-list
		Address under-consumption key factor	Improving utility efficiency	Financial Costs	Political and Social Constraints	Extent of the Intervention Impact	Ongoing and implementation projects and plans	
	Policy Level							
1	Reallocation of fresh groundwater supplies from agriculture to municipal users	High – Increase water availability	NA	To be assessed	High – agricultur e users	Middle region andZarqaGover	Addressed through various donors and government projects	
2	Restructuring water tariff to achieve O&M Cost Recovery and keep cross-subsidy to benefit the poor	moderate	High	Low	moderate	Zarqa Governorate	The government is considering tariff increases to support utilities	✓
3	Substitute fresh water supplies in the Jordan Valley with suitable water quality from treated wastewater in Amman and Zarqa, release Jordan Valley water to municipal users in Middle Gov.	High – Increase water availability	NA	Moderate, with the existing of infrastructu re	Moderate to high	Middle region andZarqa Gove	Addressed through various donors and government projects	
4	Implement the appropriate PPP option for Zarqa Water Utility	Moderate to High – increase water availability and potability	High	Relatively low	Low to moderate	Zarqa Governorate	The WAJ PMU is preparing for PPP – corporatization and Management Contract	
5	Provide regulatory and incentive tools for water harvesting	low	low	Relatively higher than connecting to network	low	Limited to semi urban and rural areas		
6	Provide regulatory and incentive tools for grey water reuse	low	low	Relatively high costs	low	Limited		

		Criteria for Short-listing Interventions						Short-list
#	Intervention	Address under-consumption key factor	Improving utility efficiency	Financial Costs	Political and Social Constraints	Extent of the Intervention Impact	Ongoing and implementation projects and plans	
	Utility Management and Operational Interventions							
7	Improved water utility operational systems: • Metering • Assets Management • SCADA Operations • Capacity building and training	Moderate to High	High	Relatively low	Low to moderate	Zarqa Governorate	No addressed by MCC project or the Management Contract	✓
8	Spilt the households that are connected to one share meter to reduce tariff, and consequently increase public system use	Moderate	Moderate	low	low	Zarqa Governorate	Not Addressed	✓
9	Raise water awareness on water issues, water potability of available supplies, and participation in reducing leakages through filing complaints with the utility	Moderate	low	low	low	Zarqa Governorate	Some IDARA initaives, MWI Awareness Unit Programs	✓
	Infrastructure Investment Interventions							
10	Rehabilitation of water wells to increase productivity	Low	Moderate	high	low	Zarqa Governorate	MCC program	
11	Expansion and rehabilitation of water supply system to increase water availability and improve water quality	High	High	High	Low	Zarqa Governorate	MCC Program	
12	Expansion of wastewater collection and treatment system to enable wastewater reuse and release fresh waters to drinking supplies	moderate	moderate	high	Low to moderate	Zarqa Gov	MCC Program	
13	Geographically target network rehabilitation and zoning to serve the poor	High	low	Low to moderate	low	Target areas		✓

#	Intervention	Criteria for Short-listing Interventions						Short-list
		Address under-consumption key factor	Improving utility efficiency	Financial Costs	Political and Social Constraints	Extent of the Intervention Impact	Ongoing and implementation projects and plans	
	Household Interventions							
14	Improving water storage to address quality and quantity issues, and rehabilitation of plumping systems of poor households	High	NA	low	NA	Poor areas in Zarqa Gov	Mercy Corp Program	✓
15	Subsidize and implement water harvesting in semi-urban and rural areas	low	NA	low	NA	Poor rural areas – low % of Zarqa	Mercy Corp Program	
16	Implement grey water collection and reuse in semi urban and rural areas	Limited	NA	low	NA	Limited to semi urban and rural areas	Mercy Corp Program	

6.3 *COST EFFECTIVENESS ANALYSIS OF SHORTLISTED INTERVENTIONS*

The short-listed interventions are:

1. **Improved water utility operational systems** - including improved information system and modelling for rationing schedule and setting pumping pressure, implementation of assets management system, capacity building and certification program for utility operators, and meters replacements.
2. **Splitting the households that are connected to one shared meter** to reduce water payments, and consequently increase public system use.
3. **Awareness program on water issues, water potability of available supplies, and participation in reducing leakages** through filing complaints with the utility.
4. **Restructuring water tariff** to achieve O&M cost recovery and keep cross-subsidy to benefit the poor.
5. **Improving water storage to address quality and quantity issues**, and rehabilitation of plumping systems of poor households.
6. **Geographically targeting the network rehabilitation and zoning** in poor areas.

These interventions were discussed with MCA-Jordan and MCC to prioritize the interventions programs and estimate the cost effectiveness. The planned actions by the Government of Jordan and the MCC, and how they intersect and/or overlap with these interventions have been considered in packaging the interventions and scoping them.

The discussions on these interventions is summarized below:

- **Intervention 1- Zarqa Utility Operational System** – improving the water utility operations is being considered through a corporatization and a management contract program to provide the appropriate tools and the right set of incentives to improve performance and increase efficiency. The design of this PPP program for Zarqa Water Utility including scope, program budget, feasibility and enablers for success is not completed. Experiences have shown that PPP programs require investments in systems and operational improvements to be improve efficiencies and achieve targets.

It was agreed to analyze intervention 1 and estimate the cost effectiveness to be considered in the design and scoping of the PPP program for Zarqa.

- **Intervention 2 – Splitting households that are connected to a shared water meter –** this intervention is built around designing a voluntary mechanisms for the poor households sharing a water meter (one subscription number) and have high consumption rates which place them in the upper water tariff blocks and therefore increase water payments to the public water system. If these households are connected to the wastewater network, wastewater tariff will be in the higher blocks as well.The intention of the progressive water tariff is to ensure poor households can consume adequatequantities of water given their budgets. Therefore, the high tariff created from shared meters may contribute to under consumption.

  The issue of poor householdsaccess to wastewater connections is being addressed by the World Bank's "Jordan Water and Wastewater Output-Based Aid Study" and therefore the effect of exapanding access to wastewater connections was not considered in this study.

  The joint decision was to carry out the analysis on splitting shared water meters, but only limit it to the water connections.

- **Interventions 3 and 5 – Awareness program on water issues and Improving water storage to address quality and quantity issues -**the main objective and benefit ofthese two interventions is to improve water potability and water potability perception at the household level, to advance the use of the cheaper public water system, particularly by the poor. The implementation of the interventions' components requires the participation of various stakeholders, community based organizations, women organizations, public figures, and utility management and operational teams. Because of the overlap in objective and actors involved, the agreement was to combine the two interventions.

  The intervention "Household Infrastructure and Knowledge Improvement" will be considered in the cost effectiveness analysis.

- **Intervention 4 - Restructuring water tariff to achieve O&M cost recovery and keep cross-subsidy to benefit the poor -** Restructuring water tariff to achieve O&M cost recovery and keep cross-subsidy to benefit the poor.

  Water tariff mechanisms are one regulatory tool that could be applied to reduce water demand of high consumers, and redistribute the water savings to low water consumers. The water tariff in Jordan addresses policy issues of cross subsidy between different users groups and among the residential water users to provide subsidy to the low consumers. However, the tariff does not specifically target poor based on geographic location, land use zoning, or household areas, or household facilities—it only targets based on quantities on water consumed.

  This intervention already is being considered by the government of Jordan and the Ministry of Water and Irrigation. The details of the policy consideration of tariff restructuring are not known, and therefore could not be analyzed here. These policy considerations may include: geographic location, user group, level of consumption, landuse and municipal zoning, household size and infrastructure. A targeted subsidy to poor consumers could be designed considering some of these policy aspects.

  The Data from 2004, 2005, and 2006 show that 16% of residential subscribers consume more than 60m3/cycle and that they consume about 37% of residential water. Assuming increased water tariff by 40% for consumers who consume above 60m3/cycle, then the water consumption will decrease by 20%. The elasticity table is presented below, and elasticities are calculated using an econometric model for each group.

Groups	Demand Reduction Ratio for various	Increase in price 20%	Increase in price 25%	Increase in price 30%	Increase in price 35%	Increase in price 40%
All Households		20%	20.6%	23.8%	26.6%	29.4%
Rich households		17%	20%	23.1%	26%	28.6%
Under-consuming households (less than 50l/c/d)		18.7%	20.8%	24%	27.1%	29.8%

The quantity of water consumed by big consumers (more than 10m3/c/quarter) is about 36.6% of the total consumption 17 MCM/year, equivalent to 6.232 MCM/year. The increased tariff to the big consumers will result in 1.25 MCM water saving, which will be made available to the system.

The survey sample suggest that 62.1% of the high income (>1050 JOD per capita per year), consume more than 10 m3 /c/quarter which or more than 111 l/c/day, and that 22% of high income consume more than 222 l/c/day or 20 m3/c/quarter.

It was agreed that this intervention will not be analyzed any further, as it is being considered by the Government of Jordan.

- **Intervention 6 – Geographic targeting in poor neighbourhoods and zones -** As discussed in Chapter Five, "Priority Investment Zones,"the neighbourhoods in Zarqa governorate were prioritized according to poverty, complaints density, and population density. In order to improve water availability (duration and frequency of service), poor neighbourhood zones came out as high assuming the nature of the rehabilitation directly improves duration and frequency of service. The MCC water supply system project (P1-B) scope includes hydraulic analysis of the system, modeling, and restructuring the network to work according to pressure zones. The pressure zones may not coincide with the priority neighbourhood zones, however, giving attention to restructuring the network in the priority investment zones by the P1-B team, will provide immediate benefits to the poor.

Out of the 86 neighbourhood zones, we recommend that high priority is given to the 30 zones listed inbelow

Table 52and Table 53. These zones are all located in Zarqa and Russaifeh.

Table 52 High Priority investment zones

Zone Name	District	poverty	Compls	Pop.	W543	W552	W352	W254	W253	W252
Hai Ma'amel At-Toub	Zarqa	High	High	High	High	High	High	High	High	High
Hai Al-Hashemeyah Al-Janoubi	Zarqa	Mod	High	Mod	High	High	High	High	High	High
Hai Al-Jneeneh	Zarqa	High	High	Mod	High	High	High	High	High	High
Hai Az-Zawahreh	Zarqa	Mod	Mod	Mod	High	High	High	High	High	High
Hai Al-Ghwaireyeh	Zarqa	High	Mod	Mod	High	High	High	High	High	High
Hai Nassar	Zarqa	High	High	Mod	High	High	High	High	High	High
Hai An-Nuzha	Zarqa	Mod	High	Mod	High	High	High	High	High	High
Hai Al-Ahmad	Zarqa	High	High	Mod	High	High	High	High	High	High
Hai Al-qamar	Zarqa	High	High	Mod	High	High	High	High	High	High
Hai Aljundi	Zarqa	High	High	High	High	High	High	High	High	High
Hai Al-Masane'e	Zarqa	High	High	High	High	High	High	High	High	High
Hai Awajan	Zarqa	High	High	Mod	High	High	High	High	High	High
Qadesiah	Russaifeh	Mod	Mod	Mod	High	High	High	High	High	High
Awagan	Russaifeh	Mod	Mod	High	High	High	High	High	High	High
Northern Mountain	Russaifeh	Mod	High	High	High	High	High	High	High	High
Hai Al-herafyeen	Zarqa	Mod	High	Low	High	High	High	Mod	High	High
Hai Shoumar	Zarqa	High	High	Low	High	High	High	Mod	High	High
Hai Ma'asoum Ash-Shamali	Zarqa	Mod	Mod	Mod	High	Mod	High	High	High	High
Hai MAkka Al-MUkaramah	Zarqa	Mod	High	Low	High	High	High	Mod	High	High

Table 53High/Moderate Priority Investment Zones

Zone Name	District	poverty	Compls	Pop.	W543	W552	W352	W254	W253	W252
Hai Al-Eskaan	Zarqa	Low	High	Mod	Mod	Mod	High	High	High	High
Dahereah	Russaifeh	Mod	Mod	High	Mod	Mod	High	High	High	High
Hai Al-hashemy	Zarqa	High	Mod	High	High	High	Mod	High	Mod	Mod
Hai Al-Jaber	Zarqa	Mod	High	Low	Mod	High	High	Mod	Mod	High
Hai Al-Madenah Al-Monawarah	Zarqa	High	Mod	Low	High	High	High	Mod	Mod	Mod
thawra	Zarqa	Mod	High	Low	Mod	High	High	Mod	Mod	High
Haii Al-Ameer Talal	Zarqa	High	Mod	High	High	High	Mod	High	Mod	Mod
Hai Ibn Sina	Zarqa	Mod	Mod	Mod	Mod	Mod	Mod	High	High	Mod
Hai Janna'a	Zarqa	High	Mod	Mod	High	High	Mod	Mod	Mod	Mod
Rasheed	Russaifeh	Mod	Mod	Mod	Mod	Mod	Mod	High	High	Mod
Hussien District	Russaifeh	Mod	Mod	Mod	Mod	Mod	Mod	High	High	Mod

6.3.1 *Intervention One*

Improved water utility operational systems including improved information system and modelling for rationing schedule and setting pumping pressure, and implementation of assets management system and capacity building and certification program for utility operators.

<u>*Rationale:*</u>

The benefits of the extending the water services and rehabilitation of the system will not provide the anticipated benefits unless the utility is equipped with operational systems to control water distribution, set up the required pressures according to the designed zoning, and monitor water operations. SCADA systems will provide timely data on water distribution, pressures, and enable operators to control water supply. Assets management system provides understanding of the modus operandi of the water network, identifies problems requiring remedial work to enable proper asset operation and to improve overall zoning and circulation, and improve service delivery & customer service. System metering will enable the utility to understand spatial distribution of water losses, and manage water operations to reduce NRW.

<u>*Cost estimation of the Intervention:*</u>

The cost items of the intervention and the source of the estimate are listed below:

- 3 M for SCADA system – Discussion with the PMU at WAJ
- 1.0 M for Assets Management – Implementation of Assets Management systems in medium scale cities, and discussing with IT director at Miyahuna
- 1.0 M for Capacity Building – training of number of staff in IT, O&M, GIS, facilities operators
- Installing house connections meters 3.2 M JOD to replace about 80,000 meters at 40 JOD/meter

Total cost of the intervention is 8.2 million JOD, and 3 years implementation time.

<u>*Direct Benefits to the Poor:*</u>

- Increased water availability

- Enable the utility to operate the system to increase supply frequency and duration in poor areas

Estimations of Benefits

The water billing data in Zarqa shows that water billing for the under consumers has increased with the increased bulk supply and increased residential billing.Table 54below shows that water billing to the 60% of the consumers at the bottom of sclaehas increased from 4,535,887 m3 in 2001 to 6,297,009 in 2008. The increase of additional billing shows that 40% of additional water is allocated to consumers of less than 50 l/c/d. The table shows that increases in residential billing and billing of under water consumers are correlated to available supplies.

Gradual reduction of NRW realized from operational improvements, water system infrastructure investments, and improved enabling environment efficiency (PPP) will increase residential water billing and under consumers water billing. As shown in Table 55,if the NRW is reduced from its existing levels to 30%, the residential water billing will go up from the existing levels of 57 l/c/d to an average of 76 l/c/d with the same bulk water supplies to Zarqa at 44.8 MCM per year. Assuming 40% of additional water will be allocated to under-consumers, the additional water billing to the under-consumers will be about 3.6 MCM.

Table 54Historic residential billing and under consumers billing – fixing the % of 2008 consumption to consumers of less than 50 l/c/d

Year	Bulk supply	Total billing (m3)	NRW Quantity	NRW %	Total Residential billing (m3)	% of Residential Billing	60% of Pop (Pop consuming less than 50 l/c/d based on 2008 billing)	Total billing for 60% of Pop	incremental billing to 60% of people	incremental billing to residential consumers	% of increment billing of 60% to the total Res. billing
2001	32,729,644	14,718,575	18,011,069	55%	13,766,855	94%	60%	4,535,887			
2002	34,412,052	15,217,373	19,194,679	56%	14,365,053	94%	60%	4,728,658	192,772	598,198	32%
2003	36,965,882	17,934,637	19,031,245	51%	15,049,690	84%	60%	5,121,356	392,698	684,637	57%
2004	37,687,744	18,163,850	19,523,894	52%	13,740,246	76%	60%	4,531,520	(589,836)	(1,309,444)	45%
2005	38,447,913	18,402,572	20,045,341	52%	15,826,219	86%	60%	5,114,815	583,295	2,085,973	28%
2006	40,324,912	19,798,903	20,526,009	51%	16,987,443	86%	60%	5,781,273	666,458	1,161,224	57%
2007	44,630,332	20,920,160	23,710,172	53%	17,677,420	84%	60%	6,057,444	276,172	689,977	40%
2008	44,836,509	19,898,994	24,937,515	56%	18,221,621	92%	60%	6,297,009	239,564	544,201	44%

Table 55NRW Reduction and Projection of residential billing and low consumers billing (less than 50 l/c/d)

Bulk Supply with 2008 as base year numbers	NRW	Total billing	NRW Q in m3	Res Billing	Population (2% annual growth rate from 2008)	lpcd residential billed water	Increase in Res Billing from 2008 numbers based on 87% res billing to total billing	additional water to under consumers based on 40% allocation to under consumers
44,836,509	56%	19,898,994.00	24,937,515	18,221,621.00	871,600.00	57		
44,836,509	50%	22,418,254.50	22,418,255	19,503,881.42	889,032.00	60	1,282,260.42	512,904.17
44,836,509	45%	24,660,079.95	20,176,429	21,454,269.56	906,812.64	65	3,232,648.56	1,293,059.42
44,836,509	40%	26,901,905.40	17,934,604	23,404,657.70	924,948.89	69	5,183,036.70	2,073,214.68
44,836,509	37%	28,247,000.67	16,589,508	24,574,890.58	943,447.87	71	6,353,269.58	2,541,307.83
44,836,509	33%	30,040,461.03	14,796,048	26,135,201.10	962,316.83	74	7,913,580.10	3,165,432.04
44,836,509	30%	31,385,556.30	13,450,953	27,305,433.98	981,563.16	76	9,083,812.98	3,633,525.19

With the absence of engineering studies at this time, it is hard to estimate the water availability hours from the reduced NRW to enable us to apply the economic models to estimate the benefits. However,Table 56below show water availability improvement of different scenarios and corresponding benefits to the under-consumers, and Zarqa water subscribers.

Table 56 Benefits estimates to under-consumers and all Zarqa consumers

Model Parameters	Under-consumers	All Customers
	Annual Benefits	Annual Benefits
Reduce illness to zero, increase potability to 4, increase availability to 60 hrs	2,629,775.24	5,816,736
Reduce illness to zero, increase potability to 4, increase availability to 72 hrs	2,679,060.21	5,937,689
Reduce illness to zero, increase potability to 4, increase availability to 84 hrs	2,728,345.18	6,058,642
Reduce illness to zero, increase potability to 4, increase availability to 96 hrs	2,777,630.14	6,179,595

Reducing NRW from existing levels of 56% to 30% will increase billing by 9 MCM/year, and assuming that operational systems improvement is responsible for 20% of NRW reduction, then the benefits from operational improvements will contribute additional billing of 1.8 MCM/year to Zarqa Subscribers. The additional actual consumption will be considerably lower than billing- possibly as low as 0.90 MCM/year. However this is a substantial additional water supply to the under-consumers, and the cheapest second available option is tanker water at a unit price of 3.8 JOD/m3.

Indirect Benefits to all Subscribers and to the Utility

- Increase water availability to Zarqa Subscribers
- Improve utility performance and cost recovery
- Enhanced maintenance program from available data from SCADA, Assets Management, and Billing.
- Targeted improvements in supply conditions:
    - **Increase water availability to Zarqa Subscribers**

      Reducing NRW from existing levels of 56% to 30% will increase billing by 9 MCM/year, and assuming that operational systems improvement is responsible for 20% of NRW reduction, then the benefits from operational improvements will contribute additional billing of 1.8 MCM/year to Zarqa Subscribers. The additional actual consumption will be considerably lower than billing- possibly as low as 0.90 MCM/year. However this is a substantial additional water supply to the under-consumers, and the cheapest second available option is tanker water at a unit price of 3.8 JOD/m3.

- **Improve utility performance and cost recovery**

  The increased water billing from operational improvement is estimated at 20% of NRW reduction – 1.8 MCM/year. At an average water price of 0.238 JD/ cubic meter, the additional revenues to the utilities will increase by 428,000 JD at the same tariff structure. Given that average price will go up with the increased billing, and assuming average price of 0.3 JD/m3, the additional water revenues will increase by 540,000 JD/year.

  The NRW water reduction is the cheapest water source, the marginal costs of developing additional water supplies in Jordan are relatively high with the associated treatment and conveyance costs.

  The marginal costs of developing new water supplies are very high in Jordan due to high treatment and conveyance costs. At a marginal price of 0.8JD/m3, the potential savings from improving water utility operations are estimated at 1,800,000 JD.

- **Enhanced maintenance program from available data from SCADA, Assets Management, and Billing**

  Other benefits include: protect the water network and increase the expected life of the water system, reduce the need for developing additional water supplies at higher marginal costs, improve operations and customers' confidence.

- **Targeted improvements in supply conditions**

  The implementation and operations of water systems will provide operators with means to operate the system at zones level including monitoring water supply, pressures, billing, etc. the operators will be able to adjust water operations to target certain zones by increasing availability – duration and pressure – to meet demands.

Conclusions and Cost Effectiveness

The operational systems improvement is essential to realize the benefits from water infrastructure investment and to maintain these investments. Experiences from different water utilities have shown positive results from implementation of these systems.

The cost effectiveness of this operational improvement program is:

Program	Cost	Effect	Cost effectiveness Ratio
Operational improvement	8.2 Million	1.36 million (360000*3.8 JD)	6.02

6.3.2 *Intervention Two*

Splitting the households that are connected to one shared meter to reduce water payment, and consequently increase public system use.

<u>Rationale:</u>

The CCS survey revealed that about 25% of the customers' connection has 2 or more residences connected to the same meter. The DOS survey numbers show about 39% of surveyed houses share water connections with 2 or more houses. This may have an implication on the household payments for public systems water, given the nature of water tariff in Jordan.

From DOS survey, the poor with multiple households (204 of them) average 2.81 households per meter with the following distribution:

Household connected sharing one meter	Household reporting
2	100
3	68
4	19
5	8
6	3
7	4
	202

We were able to link subscription data with survey data for 154 of the 204 poor households sharing meters. For poor households connected to a shared meter, the consumption analysis is summarized below:

Meter consumption	Number	Percent	Average household number/connection
<20	9	5.8	2.67
20+-40	32	20.8	2.56
40+-60	39	25.3	2.51
60+-80	33	21.4	2.61
>80+	41	26.6	3.24
	154	100%	Average: 2.75

As illustrated above, about 26.6% (> 80m3) of the subscribers will see reduction in the water bills, but will have additional fixed fee costs and subscription costs.

Cost of the Intervention:

For this intervention, we will only consider the poor subscribers who are high consumers (more than 80 m3/cycle). Considering that the subscription cost at 150 JD, and based on an average 3.2 households connecting to the same meter, the additional subscription fees will be 330 JD/household connection sharing one meter.

With 25% of subscribers sharing one meter, and 26.6% of them have consumption levels above 80m3/cycle, it is estimated that 8,446 are potential beneficiaries. Of those, the eligible poor will about 40% according to the survey results. The cost effectiveness analysis for this intervention will consider the benefits and costs associated with one meter that has 3.2 households connected to it. The cost associated with splitting these households and providing them with WAJ subscription is (3.2 households – 1 existing subscription) * 150 = 330 JD

Direct Benefits to the under-consumers:

About 26.6% of the poor are potential beneficiaries of reduced water tariff. Table 57below show the average water tariff at different blocks

Table 57 Water Consumption within different blocks and average water price

Block	No. of bills Water	% of water bills	Cum % of water bills	Water billed (m3)	Cum Water billed (m3)	Water Billed (lpcd)	Water charge (JD)	average m3 price
0-10	28,274	7%	7%	183,483	183,483	9	96,621	0.527
11-20	107,072	25%	31%	1,974,322	2,157,805	26	368,135	0.186
21-30	75,270	17%	49%	1,971,254	4,129,059	37	406,378	0.206
31-40	66,992	16%	64%	2,409,812	6,538,871	51	410,807	0.170
41-50	50,401	12%	76%	2,306,387	8,845,258	65	468,379	0.203
51-60	34,431	8%	84%	1,910,062	10,755,320	79	437,439	0.229
61-70	23,207	5%	89%	1,517,692	12,273,012	93	395,688	0.261
71-80	15,095	4%	93%	1,137,570	13,410,582	107	336,995	0.296
81-90	9,712	2%	95%	828,356	14,238,938	121	275,640	0.333
91-100	6,597	2%	97%	630,440	14,869,378	135	232,215	0.368
101-110	3,890	1%	98%	409,353	15,278,731	149	166,852	0.408
111-120	2,609	1%	98%	300,643	15,579,374	163	133,607	0.444
121-130	1,788	0%	99%	223,816	15,803,190	177	108,166	0.483
131-140	1,124	0%	99%	151,925	15,955,115	191	77,720	0.512
141-150	829	0%	99%	120,606	16,075,721	206	63,842	0.529
151->	3,797	1%	100%	911,722	16,987,443	340	576,626	0.632
Total	**431,088**	**100%**		**16,987,443**		**56**	**4,555,113**	**0.268**

The benefits of installing the meter are estimated as follows:

Assuming average water consumption of 101 – 110m3/ billing cycle for 3.2 households who are connected to a shared meter, the average water price will go down from 0.408 JD/m3 to 0.17 JD/ m3. The total water bill per cycle for the combined 3.2 households will come down from 42.84 JD households to 17.85 JD. The annual water bill will be reduced by about 100 JD.

For each individual household, the bill will come down by about 7.8 JD/cycle, and the annual bill will come down by about 30 JD.

Potentially, there are 26.6% of poor customers sharing one meter who could benefit from reduced water rates. With 25% estimated customers have more than one household connecting to a shared meter; the potential beneficiaries are estimated 8446 customers. Those customers could benefit of 100 JD reduction in water tariff on yearly basis, resulting in 844,600 JD saving to those customers.

Conclusions and Cost Effectiveness

Program	Cost	Effect	Cost effectiveness Ratio
Splitting meters of high consumers but poor	330 JD	100 JD	3.3

It should be noted here, the wastewater connection costs are not calculated as part of this intervention. These could have a direct implication on the cost analysis of this intervention. The legal consideration need to be examined thoroughly to ensure compliance with WAJ Law and regulations, and achieve equality among beneficiaries.

6.3.3 Intervention Three

Household Infrastructure and Knowledge Improvement

Rationale:

Customers in Jordan are generally aware of the water scarcity, but are not aware of: 1. the role they can play in management of water in Jordan, 2. The water quality associated issues from the public system. USAID, GTZ, and other donors have been supported programs to raise awareness of water issues, water advocacy, and taking a proactive role in monitoring and reporting losses.

In most of the focus groups conducted by the "water Management Program of the Middle Governorates" for KfW, participants reported that are not happy with the public system water quality. In the DOS survey, the sample revealed that customers are dissatisfied with water quality (color, potability, taste, and purity). It is evident that people do not carry out a proper cleaning and maintenance program to their household facilities, and may not be aware of the household systems impact on water potability. WAJ carries out a water quality sampling and testing at different levels of the systems – production system, main systems, and tertiary systems. Unless water quality deteriorates in the main system due to rotation and intermittent supplies, it is believed that storage associated infrastructure and maintenance is responsible for water quality deterioration.

People's awareness of qualities of different supplies, and how the change of quality would affect their consumption patterns is relatively low. In DOS survey, when people are asked how the change of public system water quality, the responses came as follows:

776 65.9%)	No change in consumption from other sources
263 (22.3%)	Would reduce consumption from other sources a little
102 (8.7%)	Would reduce consumption from other sources a lot

From similar experiences in Jordan and elsewhere, increasing the level of participation of water users in system management, will increase transparency and efficiency of the system.

The elements of this intervention:

1. Awareness program on water conservation and water potability, and filing complaints
2. Capacity building for community NGO's and advocacy training
3. Capacity building for household systems installation and maintenance

4. Financing the upgrading of household infrastructure to increase potability
5. Providing subsidy for water saving devices

The program could be design to include three components:

1. Household infrastructure revolving fund
2. Awareness program for behavioural change
3. Technical assistance, capacity building, and training

Cost of the Intervention:

Component 1 – household infrastructure

Assuming that percentage of under-consumers poor is (226/1177) 19.2%, and that 50% of these household need support to improve their household water storage and plumping systems at an average investment of 250 JOD, then the total needed investment is about 3.94 million JD. Water saving devices could be also added to this program. It is envisioned that the program will extend over 5 years, and initial funding of **1.5 million JD** will cover about 15500 houses with an average of 3000 house a year. The community NGO's will be responsible for managing the program and will be trained on funds disbursements and management.

Component 2 – awareness program

For an effective program to address behaviour change, a long-term awareness campaign should be designed and implemented. The involvement of community based organizations, community leaders, schools, and women NGO's is essential. The estimated cost for a five-year program is about 1 million JD, which includes organizing demonstration sites, implementation of awareness campaigns, and production of material.

The awareness program will also focus increasing the role of community organizations and individuals in management of the system, leakage reduction program, and filing of complaints with the utility.

The budget for the program is **1 million JD**.

Component 3 – technical assistance and training

This will include training of plumbers on systems installation, water saving devices installation, and water quality protection within the households. It will also include training of NGO's on funds management, advocacy, and awareness programs.

The budget for the program is **<u>0.4 million JD</u>**.

Program management – this will include fees for overall management of program, financial management and support to its 3 components.

<u>Direct Benefits to the under-consumers:</u>

- Increase water availability through reducing household systems losses
- Improve water potability and the perception of water potability from the public system
- Increase water availability through reducing household systems losses
- Improve water utility operations (leakage reduction, service improvement)

<u>Estimations of Benefits</u>

Benefits	Methodology
Improve water potability with the HH and the perception of water potability from the public system	Potability issues and perceptions are related to water quality from the system, conditions of water systems at household, and incidents of water pollution. Assuming that 10% of potability benefits will come from awareness of water quality issues, and customers action to improve household water systems.
Increase water availability through reducing household systems losses	The IDARA Project has estimated that Amman household losses at 4% after the water tank. There are not estimates of water losses from storage. The 4% is considered within the international standards No estimates are made in Zarqa. For this analysis, this benefit is not considered.
Improve water utility operations (leakage reduction, service improvement)	Experiences show that participatory approaches increase efficiencies and reduce losses. Reduction of NRW will be further enhanced by increased customers participation.

From the poor under-consumers model, the benefits of improving water potability to 4 and reduce illness are estimated at 936,735 JD annually. Assuming that benefits from this intervention will contribute to 40% of the total benefits, then it is estimated that this intervention benefits are estimated at 375,000 JOD/year.

Decreasing NRW and water leakage will increase water supplies and improve availability. As shown in intervention 1 analysis, NRW reduction will result in increased water billing. Assuming that 3% of NRW reduction will come from awareness and advocacy, then the benefits will contribute additional billing to the under-consumers of 108,000 m3/year. The additional actual consumption will be lower than billing- possibly as low as 54,000 m3/year.

However this is a substantial additional water supply to the under-consumers, and the cheapest second available option is tanker water at a unit price of 3.8 JOD/m3. Therefore the benefits are 205,200 (54,000 *3.8JD).

Indirect Benefits to the Utility

- Increase participation will increase utility efficiency and responsive to customers needs and improve services
- Support the utility in its initiatives of demand management and efficiency improvement.
- Reduction of water illegal use.

Conclusions and Cost Effectiveness

The cost effectiveness of this program is:

Program	Cost	Effect	Cost effectiveness Ratio
Household Infrastructure and Knowledge Management	3.5 Million	580,000	6.03

6.4 *Recommended Intervention*

A summary of the interventions cost effectiveness is presented in the table below:

Intervention	Cost Effectiveness
Utility Operations Improvement	6
Splitting High Consumers HH Sharing One Meter	3
Household Infrastructure and Knowledge Improvement	6

As discussed earlier, as the government of Jordan is preparing for a corporatization and management contract program for Zarqa Water Authority, the Utility Operations Improvement intervention should be considered as part of that program. The indirect benefits of this program go beyond the identified benefits to the poor and include systems' maintenance and sustainability of the investment, and providing the tools to operate the systems according to the envisioned design and international best practices. Therefore, we strongly recommend incorporating this intervention in the corporatization and management contract program.

The Splitting High Consumers Household Sharing One Meter intervention was analyzed for household sharing a water meter, and showed big potential. However, the legal and institutional aspects of splitting theses households will have to be considered further in addition to the wastewater connection fees. The access to water and wastewater connections by poor households is being addressed by the World Bank's "Jordan Water and Wastewater Output-Based Aid Study" and we recommend to be considered for further analysis by the World Bank team.

The Household Infrastructure and Knowledge Management intervention has several benefits.It addresses water potability and reduction of illnesses. It can target poor areas and under consumers that will be renovated so the benefits of MCC investment are fully realized in these areas. It builds awareness around potability and leakage reduction, and participatory approaches to improve utility efficiency. The indirect benefits of this intervention, particularly related top awareness and capacity building components provide benefits that are beyond the direct benefits to the poor identified in the cost effectiveness analysis. We recommend this intervention for phase 2 and program design.

7 MONITORING PLAN

7.1 REVIEW OF MONITORING PLAN

7.2 RECOMMENDATIONS