Faculty of Graduate Studies
Water and Environmental Engineering Masters Program

MSc. Thesis

Drivers and Barriers of House Onsite Grey Water Treatment and Reuse in Palestinian Rural Areas

المحفزات والمعيقات للمحطات المنزلية لمعالجة المياه الرمادية في المناطق الريفية الفلسطينية

Master's Thesis Submitted By
Rehab A. Thaher
Student number
1075196

Supervisor
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This thesis was prepared under the main supervision of Dr. Nidal Mahmoud and has been approved by all members of the examination committee**.**

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ABSTRACT

Wastewater management in Palestinian rural communities is highly neglected, where they still depend on cesspits. In the last fifteen years, house onsite wastewater management systems have been blooming over the West Bank in rural areas. Some of these projects were not successful, and there is a waste of funds and efforts, but some others are still operational very successfully. The aim of this research is to assess the impacts and social acceptance of onsite GWTPs on the environment, health, society (from beneficiaries' perception), to find out the drivers and barriers of implementing GWTPs, success and failure lessons. Applied methodology consisted of two parts, two workshops and two questionnaires, the first questionnaire targeted the households served with GWTPs, and the other one targeted the owners of cesspits.

Reuse of treated grey water in irrigation was the main incentive for applying GWTPs as stated by 88.0% of beneficiaries. The second incentive is the saving of cesspit discharge frequency and its financial consequences as stated by 71.3%. 72.5% of the beneficiaries stated that they had a water shortage before providing GWTPs; and the GWTPs contribute to solve it. Availability of fund was an important driver, as stated of 70.7% of the interviewers. Education level has an impact on GWTPs acceptance, 73% of not educated beneficiaries are satisfied, and (58.8%) of educated people. Islamic religion considered a driver; as the majority of people (70%) accept reuse of treated grey water in irrigation. Women play a major role on GWTPs management; 68.9% of the treatment systems are running by men side by side with women (fathers and mothers), and 24% is running completely by women. The majority of GWTP's beneficiaries (70.4%) are satisfied of GWTPs. Little efforts are required for operation and maintenance, with only an average 0.4 working hour per week.

The findings show that 13% of the total constructed treatment plants were not operated. The most important barrier as mentioned by 66.5% is odour emission and insect's infestation. 25.1% of the implementing agency never monitor or check the treatment plants, and 59.3% of them monitor and check the plants only at the first 2-3 months, followed by inadequate beneficiaries' experience in operation and maintenance. A health concern of crop quality irrigated by treated grey water was another barrier as well.

For people who still depend on cesspits, 75.7 % of interviewed people complained from high disturbance and intensive odour emission during discharge of the cesspits. The results show that the average number for emptying the cesspit per year before construction of onsite GWTP was 6.9, where the people pay 6% out of their monthly income on cesspit's emptying, which decreased to 4.1 after providing onsite GWTPs. 55.4% of the interviewers accept construction of onsite GWTPs supported by external funding. Water shortage is a main driver for providing GWTPs, 71.2% of cesspits owners accept using of treated grey water in irrigation. The majority of people (74.8%) prefer sewerage networks for wastewater management, 15.5% of people prefer onsite GWTPs, and 9.5% prefer cesspits.

From “Logistic Regression” analysis, the following variables were considered significant for acceptance of onsite GWTPs, garden availability, utilization of untreated grey water for irrigation, preference of central wastewater network for sanitation system, acceptance of separation of house piping system, knowledge of sanitation systems.

House onsite grey water management systems is acceptable in rural communities, therefore, a more proper system is required to handle the wastewater and replace cesspits and its harmful implications on environment, ground water and public health.

الخلاصة

إن إدارة الصرف الصحي مهملة بشكل كبير في المناطق الريفية الفلسطينية، والتي مازالت تعتمد على الحفر الامتصاصية. لقد انتشرت محطات المعالجة المنزلية للمياه العادمة الرمادية بشكل كبير في المناطق الريفية في الضفة الغربية في السنوات الخمسة عشر الأخيرة، بعض هذه المشاريع فشلت مما تسبب بضياع الجهود والأموال المخصصة لذلك، وبعض هذه المشاريع مازالت تعمل بنجاح. يهدف هذا البحث إلى تقييم محطات المعالجة الرمادية كنظام غير تقليدي لإدارة المياه العادمة الرمادية وتأثيراته على النواحي البيئية والصحية والاجتماعية من ناحية فهم ومعتقدات المستفيدين، كما هدف إلى معرفة المحفزات والمعيقات لتطبيق هذه الأنظمة في المناطق الريفية و دروس النجاح والفشل. المنهجية المطبقة في هذا البحث تتكون من ورشتي عمل لتضمينها قبل تحضير الاستبيان، ونوعين من الاستبيان، الاستبيان الأول الذي استهدف أصحاب محطات المعالجة الرمادية ، والثاني استهدف أصحاب الحفر الامتصاصية.

إعادة استخدام المياه المعالجة للأغراض الزراعية كان أهم حافز لتطبيق هذه الأنظمة، حيث أن 88% من المستفيدين من محطات المعالجة أشاروا إلى ذلك، الحافز الثاني تضمن تقليل عدد مرات نضح الحفر الامتصاصية وتبعاتها الاقتصادية والذي أشار له 71.3% من المستفيدين. 72% من المستفيدين أشاروا إلى نقص المياه قبل إنشاء محطات المعالجة، وأن محطات المعالجة قد ساهمت بحل مشكلة نقص المياه. توفر التمويل لإنشاء المحطات اعتبر حافزا مهما من قبل 70.7% من المستفيدين. مستوى التعليم كان له تأثير على تقبل المحطات، 73% من غير المتعلمين كانوا راضيين، و 58.8% من المتعلمين لم يكونوا راضيين عن أداء المحطات. الدين الإسلامي اعتبر أيضا حافزا للمحطات وإعادة استخدام المياه المعالجة والذي أشار له الأغلبية بنسبة 70%. تلعب النساء دورا مهما في إدارة أنظمة المعالجة المنزلية، 68.9% من المحطات تتم إدارتها من قبل الرجال جنبا إلى جنب مع النساء، و 24% من المحطات تتم إدارتها من قبل النساء بشكل كلي. إن المستفيدين راضيين عن أداء محطات المعالجة بنسبة 70.4%، تشغيل وصيانة المحطات تحتاج إلى جهود قليلة من قبل المستفيدين، حيث أنها تحتاج إلى 0.4 ساعة أسبوعيا.

أشارت النتائج إلى أن 13% من المحطات لا تعمل بشكل نهائي. وقد تم تقييم المعيقات لتطبيق هذه الأنظمة، والتي كانت من أهمها انتشار الرائحة الكريهة وانتشار الحشرات، نقص متابعة ومراقبة النظام من قبل الجهات المنفذة، كما أشارت النتائج إلى أن 25.1% من الجهات المنفذة لم تقم بفحص ومراقبة الأنظمة. 59.3% من المحطات تمت رماقبتها فقط من 2-3 اشهر بعد الانتهاء من انشائها. فشل المحطات كان أيضا بسبب عدم وجود خبرة كافية لدى المستفيدين لإدارة وتشغيل النظام، تبعتها قلق المستفيدين من المخاطر الصحية ونوعية المياه المعالجة وإعادة استخدامها في الزراعة.

أما بالنسبة لأصحاب الحفر الامتصاصية المستخدمة كنظام لإدارة المياه العادمة، 75.5% كان لديهم انزعاج كبير من النضح المستمر وانبعاث الرائحة الكريهة أثناء عملية النضح، وأشارت النتائج إلى أن معدل نضح الحفرة الامتصاصية قبل إنشاء محطة المعالجة كانت 6.9 في السنة، تقلصت هذه النسبة إلى 4.1 في السنة بعد إنشاء محطات المعالجة . أما من ناحية تقبلهم لأنظمة صرف صحي جديدة فان أكثر من النصف بنسبة 55.4% تقبلوا يناء محطات معالجة بحيث أن تكون ممولة من جهات أخرى. قلة المياه هي الحافز الأكبر لإنشاء محطات المعالجة لمنزلية، حيث أن الغالبية من أصحاب الحفر الامتصاصية بنسبة 71.1% تقبلوا إعادة استخدام المياه المعالجة الرمادية للأغراض الزراعية. وتجدر الإشارة إلى أن 74.8% من المجتمع الريفي الفلسطيني يفضلون شبكات الصرف الصحي كاختيار أول للتخلص من المياه العادمة المنزلية، وبنسبة 15.5% يفضلون محطات المعالجة الرمادية، و 9.5% يفضلون الحفر الامتصاصية.

من خلال تحليل الانحدار اللوجستي لتقبل انشاء محطات معالجة المياه الرمادية تم ايجاد المتغيرات المهمة التالية والتي تشمل، توفر حديقة منزلية، استخدام المياه الرمادية غير المعالجة في الزراعة، تفضيل شبكة صرف الصحي كنظام لادارة المياه العادمة المنزلية، تقبل الفصل لخطوط الصرف الصحي المنزلية، المعرفة بانظمة معالجة المياه العادة الرمادية.

إن محطات المعالجة الرمادية مقبولة من قبل مستخدمي الحفر الامتصاصية في المناطق الريفية، لذلك فان أنظمة صرف صحي أخرى يجب تبنيها للحيلولة دون استخدام الحفر الامتصاصية وتأثيراتها السلبية على البيئة، المياه الجوفية والصحة العامة.

DEDICATION

To my family

To my husband

To my all friends

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LIST OF ABBREVIATIONS

AWC: Arab Water Council

EQA: Environmental Quality Authority

FoEW: Friends of Environment and Water

GDP: Gross Domestic Product

GNDI: Gross National Disposable Income

GNI: Gross National Income

GW: Grey Water

GWTP: Grey Water Treatment Plant

HWE: House of Water and Environment

IEWS: Institute of Environment and Water and Studies

l/c.d: Liters per Capita per Day

M^3: Cubic meter

MAS: Palestinian Economic Policy Research Institute

MCM: Million cubic meters

MENA: Middle East and North Africa

MoPAD: Ministry of Planning and Administrative Development

MoPIC: Ministry of Planning and International Cooperation

NGOs: Non Governmental Organizations

OPT: Occupied Palestinian Territories

PCBS: Palestinian Central Bureau of Statistics

PSI: Palestinian Standard Institute

PWA: Palestinian Water Authority

UNRWA: United Nations Relief and Works Agency for Palestine Refugees

WB: World Bank

WBG: West Bank and Gaza

WHO: World Health organization

WWTPs: Wastewater Treatment Plants

LIST OF DEFENITIONS

Cesspit: a pit in which night soil and other refuse is stored, constructed with either tight or porous walls*.

Household: One person or a group of persons with or without a household relationship, who live in the same housing unit, share meals and make joint provision of food and other essentials of living*.

Rural: Any locality whose population is less than 4,000 persons or whose population varies from 4,000 to 9,999 persons.*.

Target People: The owners of the onsite GWTPs distributed in the rural areas in the West Bank.

**: Palestinian Central Bureau of Statistics, 2009[a].*

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Chapter One

INTRODUCTION

1.1 Background

Palestine is among the countries with the scarcest renewable water resources per capita due to both natural and artificial constrains, amounting to around 70 cubic meters per capita per year for all purposes (PWA, 2009). This is far below the per capita water resources available in other countries in the Middle East and the World. At present, water demand exceeds the available water supply. The gap between water supply and water demand is growing due to population growth, a higher standard of living, and the need to expand irrigated agriculture and industrialization (PWA, 2009). The WHO minimal standard for daily water consumption for direct human consumptive and hygiene needs is 100 liter/person/day (Chenoweth, 2008).

The results of the PCBS (2009) showed that 88.4% of the households in the Palestinian Territory live in housing units connected to water network. This indicate that the percentage of the households in the Occupied Palestinian Territory living in housing units connected to water network have increased comparing with 84.8% in 1999. Environmental statistics in the household sector are an important instrument for making decisions, planning, and drawing up strategies for the environment (PCBS, 2009[a]).

In reference to sewage networks, they have been absent from every agenda and have not been developed. They also lack operational plans linked with a clear strategic vision needed for development. The development of the wastewater treatment systems in Palestine has not exceeded the establishment of a few main projects, such as the water treatment plants in Northern Gaza, Gaza City and Al Bireh in addition to a few minor projects executed by civil organizations (even though they lack a strategic vision). Most refugee camps in the West Bank are served by sewage networks which implemented by United Nations Relief and

Works Agency for Palestine Refugees (UNRWA). In Gaza Strip there are no sanitation services in all camps except Jabalya camp (PWA, 2010[a]).

1.2 Problem Statement

In the last fifteen years, house onsite grey water management systems have bloomed over all the West Bank in the rural communities, justified by lack of adequate wastewater services and driven by the business opportunity for the supporting NGOs funded by donors. Some of those projects were not successful, but some others are still operational very successfully. The drivers and barriers of providing onsite grey water treatment plants from beneficiaries' view are not reasons of implementing such management in the rural communities, as these reasons were not investigated to assess these systems.

1.3 Research Questions

Some of the questions which this research aims to answer are:

- What are the perceptions of people regarding onsite GWTPs?
- What are the main drivers for onsite GWTPs implementation in the West Bank?
- What are the main barriers for onsite GWTPs implementation in the West Bank?

1.4 Justifications

- On the national level, there is a necessity and crucial need for providing a reliable and sustainable grey water management in all governorates especially in the rural communities, since the development of the water treatment system in Palestine has not go exceeded the establishment of a few main centralized projects. Some efforts have been done by NGOs for providing onsite GWTPs distributed in several communities in the rural communities in the West Bank. Also lack of socio-economic studies linked with a clear vision needed for the development of wastewater sector in rural communities hold back the required progress in this sector.

- Onsite wastewater systems are often undervalued when compared to other projects due to improper assessment to quantify benefits and constrains of these projects. The demand and uses of treated grey water depends mainly on the acceptance of grey water.

1.5 Research Objectives

The goal of the study was to reveal the extent to which, in the context of providing onsite GWTPs as unconventional wastewater management in the rural communities in Palestine, local population's perceptions, and acceptance of such type of wastewater management. The outputs of this research will lead to better planning and investment in the water and wastewater sector, as well as contribution of introducing wastewater policy notes and guide involved authorities working in this field.

The objectives of this research are to assess at the household level;

1- The impacts of house onsite source separated wastewater management systems on the environment, health and socio-culture (from beneficiaries' perception),
2- The drivers and barriers of implementing those non conventional wastewater systems in rural communities,
3- Drivers and barriers of implementing onsite GWTP for people who still depend on cesspits for wastewater management
4- Success and failure lessons of the onsite management systems.

1.6 Thesis Outline

This research thesis comprises five chapters. Chapter one provides an Introduction, Chapter two presents the Literature Review, Chapter three describes Methodology, Chapter four discusses the Results and Discussions, and the last chapter is Chapter five which presents the Conclusions and Recommendations, followed by five annexes; cesspit's questionnaire, onsite GWTPs questionnaire, list of attendees, photos of onsite GWTPs and logistic regression analysis.

Chapter Two

LITERATURE REVIEW

2.1 Introduction

A growing number of studies on wastewater address socioeconomic and political issues associated with its use for agriculture. Japan, North America and Australia rank globally highest in decentralized grey water management. In areas with low population densities, such as throughout North America and Australia, grey water reuse is common practice due to water scarcity and lack of centralized treatment facilities. Since grey water is a reflection of household activities, its main characteristics strongly depend on factors such as cultural habits, living standard, household demography, type of household chemicals used etc. In Cyprus, a study on grey water reuse indicates a 36% reduction in water bills when household grey water is reused. The generated amount of grey water greatly varies as a function of the dynamics of the household. It's influenced by factors such as existing water supply systems, and infrastructure, number of household members, age distribution, lifestyle characteristics, typical water usage patterns etc. Most system failures are caused by inappropriate operation and maintenance, sometimes also resulting from a lack of system understanding by the owners (Sandec, 2006).

Framers and common public of the MENA countries have limited knowledge and unclear perceptions towards wastewater reuse and the prevailing water shortage. Many people believe that Islamic religion prohibits reuse of treated wastewater. On the contrary, Islamic religion supports water demand initiatives as well as reuse of treated wastewater that does not have negative impacts on public health. Joint efforts are needed from governmental, non-governmental, academic, and aid institutions on developing appropriate educational and awareness programs and initiatives that improve public knowledge and perceptions (Abu-Madi and Al-Sa'ed, 2009).

A decentralized system employs a combination of onsite and/or cluster systems and is used to treat and dispose of wastewater from dwellings and businesses close to the source. Decentralized wastewater systems allow for flexibility in wastewater management, and different parts of the 10 system may be combined into "treatment trains," or a series of processes to meet treatment goals, overcome site conditions, and to address environmental protection requirements. Managed decentralized wastewater systems are viable, long-term alternatives to centralized wastewater treatment facilities, particularly in small and rural communities where they are often most cost-effective. These systems already serve a quarter of the population in the U.S. and half the population in some states. They should be considered in any evaluation of wastewater management options for small and mid-sized communities (Pipeline, 2000).

2.2 Water and Sanitation Conditions in Palestine

Palestine is among the countries with the scarcest renewable Palestinian environment, its all elements have suffered and for a long time during the Israeli military occupation, many pressures and impacts includes: aggression, destruction, unfair use, neglect, and lack of appropriate management resulting in a deterioration of these various elements of the environment including water, land, soil, air, sand and biodiversity. There are potential risks of wastewater on public health and the environment, there is a need to establish a wastewater collection systems in rural areas and the completion of those in cities, there is a need to plan the establishment of wastewater treatment plants and re-use systems, there is no assessment of the quality and quantity of wastewater that Israeli settlements discharges into the Palestinian territories (EQA, 2010).

Palestine is an area of profound water scarcity, and in addition to those living in Gaza, those living in area ‘C’ face the most acute water scarcity. Domestic water availability averages 50 litres per capita per day (World Bank, 2009). Half the daily recommended level by the WHO (100 litres), a sixth of the amount used by Israelis (300 litres) (Amnesty, 2009).

The issue of water is considered to be a basic and vital component of the social, economical and political fabric of Palestine. The water source in Palestine is composed of renewable groundwater, which is estimated at a capacity of 785 – 825 MCM and streams in valleys estimated at 215 MCM. In addition to that is the Jordan River whose annual discharge is estimated at 1320 MCM upon its entrance to the Tiberias Lake. Palestinians citizens currently require 182 MCM of water for drinking annually. Water consumption in 2008 was recorded at only 94 MCM. The agricultural sector consumes an estimated total of 123 MCM annually.
It is expected that by the end of 2013. Palestinian citizens will require 200 MCM of water annually. However, the negative impact is still noticeable as far as inequality in the sharing of joint water resources (between Palestine and Israel) as well as the lack of freedom to exploit, develop and manage these sources. The inability to rehabilitate and manage the necessary infrastructure needed for wastewater services is also another issue. These issues negatively effect economic and social development in Palestine (PWA, 2010[a]).

Sewerage networks were used by 52.1% of households in Palestine, and 35.5% depend also on sewerage networks in the West Bank for wastewater disposal. Cesspits were used by 45.5% of households. When comparing the results of the year 2009 with the year 1999, we note that the percentage of households in the Occupied Palestinian Territories that used wastewater network increased since 1999 from 39.3% up to 52.1%. The situation of sanitation in the rural communities is very poor, where the communities still depend on cesspits as a main method of wastewater disposal, the cost of emptying cesspits have more burden on their poor domestic economy, where as the cost of emptying 1 m^3 of waste water is up to ten Shekels (2.8$) (PCBS, 2009[a]).

Estimated quantities of wastewater produced in Palestine reaches 106 MCM annually; 50 MCM in the West Bank and 56 MCM in Gaza Strip, in addition to 39 MCM discharge annually from nearby settlement to the open environment in the West Bank, only 10% of the total produced wastewater is treated using WWTPs. Most major cities served by wastewater networks such as Hebron and Nablus and Gaza and Beit Hanoun, Jenin, Tulkarem, Ramallah and Al Bireh. While remained some large cities still without networks such as Jericho in the West Bank and Khan Younis in Gaza Strip (PWA, 2010[a]).

2.3 Wastewater Reuse

Water reuse can be planned through specifically designed projects to treat, store, convey and distribute treated wastewater for irrigation. Examples of planned reuse can be found in Tunisia. Indirect reuse can also be planned as in Jordan and Morocco where treated wastewater is discharged into open watercourses. Wherever available, farmers prefer to rely on freshwater, which is usually very cheap and socially acceptable. But if no other source of water is available especially in arid and semiarid regions such as the case in the Middle East, farmers throughout the region would be encouraged to use wastewater for irrigation (EMWATER, 2004).

Recycling wastewater for food production is less common than using wastewater for municipal uses, golf courses, or wetlands. Yet, it is common in poorer countries of the world where water is simply unavailable or where the economic incentive to reuse is substantial. It is estimated that 20 million farmers worldwide use untreated or partially treated wastewater (WHO, 2008).

The theoretical advantages of wastewater are several: It is available for 365 days a year, it comes in reliable and predictable quantities, quantities are not normally reduced during a drought, and the price is negotiable - it can be made available cheaply. In the case of the West Bank and Gaza, an added advantage is that it would be additional to existing allocations outlined in Article 40. There is potential up to half the quantity of M&I supply could theoretically be reused (up to 40-50 MCM). However, although it is Palestinian policy to promote reuse, attempts so far have not been conclusive (World Bank, 2009).

Oron et al. (1999) identified two basic requirements for utilization of wastewater as a solution for water shortage problems whilst minimizing the health and environmental risks: (i) the need for comprehensive wastewater collection systems, and (ii) the need for well-operated wastewater treatment facilities.

The most important barriers for reuse of reclaimed wastewater in the MENA region, the reuse of reclaimed wastewater are often recognized after the design and implementation of treatment plants. Due to low tariffs of irrigation water, farmers are not attracted to replace freshwater with reclaimed wastewater, framers and common public of the MENA countries have limited knowledge and unclear perceptions towards wastewater reuse and the prevailing water shortage (Abu-Madi and Al-Sa'ed, 2009).

Palestine has its own standard "The sixth draft of treated wastewater standard", which has been prepared by a special technical committee. The main components of standard are as elaborated in Table (2-1), the standard consists of a combination of factors that influence the use treated wastewater in several purposes, and reclaimed wastewater is classified into 4 groups as shown in the Table (2-1) below.

Table 2-1 Reclaimed wastewater classification, (Sixth draft of treated wastewater standard)

Class		Water Quality Parameters		
		BOD5	**TSS**	**Faecal coliforms**
Class A	High quality	20 mg/l,	30 mg/l,	200 MPN/100 ml.
Class B	Good quality	20 mg/l,	30 mg/l,	1000 MPN/100 ml
Class C	Medium quality	40 mg/l,	50 mg/l,	1000 MPN/100 ml
Class D	Low quality	60 mg/l,	90 mg/l,	1000 MPN/100 ml

Source: Palestinian Standards Institute *(PSI, 2010).*

2.4 Grey Water

All waste produced in the home except toilet waste (urine and faeces) is called grey water. Grey water from washing dishes, showers, sinks and laundry comprises the largest part of residential wastewater. The composition of grey water varies greatly and reflects the lifestyle of the residents and the choice of household chemicals for washing-up, laundry etc. Characteristic of grey water is that it often contains high concentrations of easily degradable organic material, i.e. fat, oil and other organic substances from cooking, residues from soap and tensides from detergents. Treated grey water can thus be expected to have a much better hygiene quality than any kind of mixed wastewater. Clogging from fats is a potential risk in grey water systems that must always be considered, especially when the pipe system is enlarged and water cools in the ground (Ridderstolpe, 2004).

Indoor domestic water demand (excluding garden irrigation and other external uses) in developed countries usually range between 100 and 180L/d per capita, comprising 30-70% of total urban water demand. Beside minor quantities, most consumed water is transformed into wastewater. This can be classified into two major categories:

1- Grey water, originating from all household water generating appliance except toilets, comprising 60-70% of the in-house water demand.
2- Black water: originating from toilets, comprising 30-40% of the in-house water demand. (Friedler and Hadari, 2005).

The generated amount of grey water greatly varies as a function of the dynamics of the household. Its influence by factors such as existing water supply systems, and infrastructure, number of household members, age distribution, life style characteristics, typical water usage patterns etc. Reuse of treated grey water in irrigation can significantly contribute to reducing water bills and increasing food security. Grey water reuse is especially recommended in areas facing water stress such as the Middle East and Sub-Saharan Africa. Most system failures are caused by inappropriate operation and maintenance, sometimes also resulting from a lack of system understanding by the owners (Sandec, 2006).

Grey water contains impurities and micro-organisms derived from household and personal cleaning activities. While bathroom and laundry water are relatively benign, kitchen water often deserves special attention since it is loaded with organic matter from food wastes. Grey water is distinct from black water (from the toilet or urinal) as there are fewer health and environmental risks associated with its use. If used wisely and appropriately, GW – including its separation, containment and use – can be a simple home-based water-demand management strategy that has benefits at the household level as it can be considered as an alternative water resource to optimize productivity (Redwood, 2007). Grey water thus does not contain the same elevated level of pathogens (WHO, 2006).

Grey water should be regarded as a valuable resource and not as a waste. Despite the described inadequate grey water management risks, grey water has, nevertheless, a great potential to reduce the water stress currently faced by regions in the world. Reuse of grey water for irrigating home gardens or agricultural land is widespread, especially in regions with water scarcity or high water prices such as the Middle East, parts of Africa and Latin America. Grey water is thus perceived and recognized as a valuable resource (Sandec, 2006). Grey water, in contrast to common perception, may be quite polluted, and thus may pose health risks and negative aesthetics (i.e., offensive odour and colour) and environmental effects (Diaper et al., 2001).

Onsite grey water reuse is a feasible solution for decreasing overall urban water demand, not only from an environmental standpoint, but also from economic profitability under typical conditions (Friedler and Hadari, 2005). One strategy may be to encourage more on-site sanitation rather than expensive transport of sewerage to centralized treatment plants: this strategy has been successful in Dakar, Senegal, at the cost of about 400 US$ per household (World Bank, 2005).

A series of projects on grey water treatment and reuse have been implemented in Jordan, Lebanon and Palestine. The projects explored water management techniques, simple technological innovations and creative agricultural practices for grey water reuse at the household level. Households used the recycled water to irrigate crops with associated economic and social benefits. Officials monitored the quality of the grey water used for irrigation over time and concluded that the system met WHO's standard for restricted irrigation (AWC, 2006).

Photo 2-1 Reuse scheme by treated grey water in Palestine, Al Qubeba- Jerusalem, 2011

2.5 Grey Water Practices in Palestine

Substantial efforts have been made by Palestinian governmental and non governmental institutions to improve sanitation services through centralized and onsite wastewater treatment facilities. Nevertheless, there are major obstacles reflective of the current sanitation situation, the low population densities and spatial expansion in rural, pre-urban, urban communities, and the long distances from potential centralized wastewater disposal systems, and limited funding is a major obstacle for the development and maintenance of water and wastewater services, as well as some side effects of the Israeli occupation hinder the construction of wastewater treatment plants by Palestinians. The Palestinian in-situations, therefore, try to adopt on-site solutions that are environmentally sound and opt for the treatment and use of household wastewater (Abu Madi et al., 2010).

Palestine is highly water-stressed area, with water supply levels below international standards. At present, only a few small-scale wastewater reuse practices are found in Palestine. However, these are limited in scope and are carried out in an unsatisfactory manner. In addition, the majority of the existing wastewater treatment plants are overloaded and pose serious environmental and health problems. This situation on the ground is further compounded by the existing weak institutional capacity for wastewater reuse, an incomplete legal framework, very low cost recovery and the continued political conflict (World Bank, 2004).

Most of onsite GWTPs, which were constructed in Palestinian rural areas especially those constructed for a group of people, stopped its operations after the funded projects terminated (no identifications for ownership). No monitoring systems were available for the treatment plants although those systems were used for the irrigation. Socio-culture acceptance and public awareness are needed, institutional capacity on the field of the on-site treatment system is important. The perception of the public opinions towards wastewater reuse is still suspicious; generally grey wastewater reuse is more acceptable than black water reuse (Ahmad et al., 2009).

Photo 2-2 Onsite grey water treatment plant, Duara AlQare'- Ramallh, 2011

Most system failures are caused by inappropriate operation and maintenance, sometimes also resulting from a lack of system understanding by the owners. Therefore, simple systems requiring minimal operation and maintenance should be prioritized, and beneficiaries trained on appropriate system management. Their involvement in the planning and implementation process is crucial to raising awareness and improving system understanding (Sandec, 2006).

Generally, wastewater treatment and reuse projects are associated with many obstacles, which are mainly political, financial, social, institutional and technical. Also, the Palestinians have not developed an integrated vision for the reuse issues. These include the political side, institutional, potential and locations of wastewater reuse, awareness, marketing and tariff setting. Political reasons and public acceptance could be considered the main factors affecting the wastewater reuse in agriculture. To ease social constraints, efforts have been increased toward the development of integrated public awareness programs, which highly assist towards establishing a new perception of wastewater. The re-use of treated wastewater in agricultural production in Palestine is still on the pilot scale and the Palestinians lack the proper experience in using this resource in a safe and sound way. Nevertheless, wastewater in Palestine has a high reuse potential. New recycling techniques should be employed to make use of the wastewater discharged. It is important to emphasize the vitality of water reuse to the Palestinian water sector since recycling the wastewater will lower the burden and pressure on the water resources (FoEW and HWE, 2008).

Under the prevailing conditions of the Israeli occupation and restrictions on the implementation of centralized wastewater treatment plants, GW treatment and use could be a potential partial solution for water shortage and wastewater-associated problems in Palestinian rural and peri-urban areas. (Abu Madi et al., 2010).

2.5.1 Jordanian Experience of GWTPs

Grey water is a vital and sustainable water resource that should receive considerable attention when targeting wastewater management in small communities. Grey water treatment and use for irrigation could be an effective water-demand management strategy for small clusters in Jordan. However, the practices and habits of the community highly affect both GW generation rates and GW quality, particularly in terms of microbial and organic contents. Current practices of grey water use need to be improved, taking into consideration health aspects. it was found that two treatment technologies can be used to treat GW generated in small rural communities in the Badia of Jordan. These are: 1) septic tank followed by intermittent sand filter (ISF); 2) septic tank followed by an up-flow anaerobic sludge blanket (UASB). Reclaimed water from the systems investigated could be used for restricted irrigation. On a family level, it can be said that GW use can contribute somehow to improving food security (olive fruit and olive oil) and enhance the household income (Suleiman et al., 2010).

From Jordanian experience of GWTPs and its reuse, a scientific research concluded that a direct positive impact that resulted from having more than 110 households in Al-Amer villages in Karak governorate practicing grey water use was the significant reduction of the need for additional domestic water supply during summer months. Grey water treatment units were well accepted by the majority of households of Al-Amer villages. One objective of the study was to enhance the design and construction of the four-barrel and CT units so as to obtain GW effluent of a quality suitable for restricted irrigation. The use of grey water for garden irrigation has the following benefits: It saves freshwater that would be otherwise used for irrigation. This is a benefit to the householder, although it is substitutionary since grey water can be used only once. It reduces the quantities of black water that need to be discharged and treated at the central wastewater treatment plant. A direct positive impact that resulted from having more than 110 households in Al-Amer villages practicing grey water use was the significant reduction of the need for additional domestic water supply during summer months. With water scarcity considered a high priority in Jordan, one can say that the Karak project was a model and clear example for the implementation of Integrated Water Resource Management (IWRM) and water demand management (WDM) principles. Impacts of GW use for irrigation on the environment must be monitored and evaluated so that better understanding of constraints are identified and assessed. Health impacts of GW use on farmers and consumers of products irrigated with GW must be identified through sound epidemiological studies (Bino et al., 2010).

2.6 Previous Studies on Grey Water Practices in Palestine

Many studies were reviewed the implemented onsite grey water projects in terms of social, technical and economical aspects. In this regard, a specific study reveals that all of the farmers interviewed believed that the construction of onsite GWTPs have improved their social relationship with their neighbors as the problems of bad smells, insects and cesspit flooding have been solved. 98.2% of the benefited households stated that the established GWTP have improved their environmental conditions and assisted in greening their home gardens even during, the analysis indicated that 64.3 % of the farmers said that the treated grey wastewater which was produced from the GWTP is sufficient to irrigate 500 m^2 of their home gardens, while 35.7 % of them used additional water to irrigate their land as the cultivated area was larger than 500 m^2, and there is low domestic water availability due to water scarcity, especially during warm seasons (ACDI/VOCA and ARIJ, 2009).

A technical research reviewed onsite wastewater systems in the West Bank. More than 50 percent of the respondents were against having new onsite treatment systems and favored centralized wastewater treatment options, as only 18 percent showed willingness to participate partially in construction costs. Finally, the social and economical aspects have an equal status in technical and financial issues. Existing onsite wastewater systems in small Palestinian communities are unsustainable as they were mainly constructed based on the low-cost alternative, which was not necessarily the most appropriate solution. Respondents were aware of the impacts of poor sanitation services and had major fears as to pollution problems adversely affecting their health. In addition, they had doubts about projects liability and were not ready to pay for on-site sanitation facilities. Sustainable development incorporates social, economical and environmental factors into the evaluation and selection of wastewater management options (Al-Sa’ed and Mubarak, 2006).

A technical research prepared by (Burnat and Shtayye, 2009) on onsite GWTPs implemented in Qebya village in Palestine. Results showed that by following the installation of onsite GWTPs units, 60% of respondents reported that the treatment units had a positive impact on reducing the cost of mosquito control, increasing the availability of irrigation water leading to an increase in cultivated area. 49% of the households believed that irrigating with treated wastewater improved the growth of the plants. Respondents also reported an improvement in social relationships with neighbors, due to reduced odors and the lower frequency of cesspit emptying. The project has positively impacted women on two levels. First, since in most households the woman is responsible for water and cesspit management, being able to use GW reduces the amount of time spent on water management, allowing women to pay more attention to their families and gardens. Second, since the late arrival of pump trucks often causes cesspits to overflow and strain relationships with neighbors, reducing the load on the cesspits is an advantage of the GW use project.

In social-cultural aspects and acceptance of adopting new onsite sanitation technologies, results showed that household status (income, education and occupation) has an impact on water consumption rates. It was also clear that most (75%) of the respondents have rejected wastewater reuse for agricultural applications. This rejection stems from socio-cultural considerations, where 55 percent of the interviewed people were even against the establishment of new onsite facilities. Against our technical advice, 85 percent of the respondents agreed on having a centralized wastewater management facility, as their financial share will be minimal due to donor countries financial and technical support. With regard technical issues, the same study revealed that the existing onsite wastewater systems in small Palestinian communities are unsustainable as they were mainly constructed based on the low-cost alternative, which was not necessarily the most appropriate solution. Respondents were aware of the impacts of poor sanitation services and had major fears as to pollution problems adversely affecting their health. In addition, they had doubts about projects liability and were not ready to pay for on-site sanitation facilities. Regarding reuse options, most of the respondents were in favor of using treated grey wastewater and equally rejected the use of mixed treated effluent for agricultural irrigation. More than 50 percent of the respondents were against having new onsite treatment systems and favored centralized wastewater treatment options (Al-Sa’ed and Mubarak, 2006).

Abu Madi et al. (2010) indicated in their research which was conducted in Western Ramallah towns and villages, those onsite GWTPs systems are superior to traditional cesspits in terms of construction costs, operation and maintenance costs, contribution to households’ water consumption and expenditure reduction. In addition, the ratio of direct benefits to costs of GWTPs is high even without considering the indirect benefits. Nevertheless, the public perceptions were positive only towards externally-funded GWS and negative towards self-funded ones. The negative perceptions were attributed to refusal to restructure their internal piping systems to separate black water from GW; refusal to use the reclaimed GW in garden irrigation; availability of external funding; unaffordable construction costs.

2.7 Description of House Onsite Grey Water Treatment Plant

The house fixtures installations were changed to separate the grey and black wastewater streams. The black wastewater (from toilet) is discharged into existing cesspit. The grey wastewater (from shower, kitchen sinks and washing machine) is conveyed to the house onsite grey water treatment plant (GWTP).

The onsite GWTP consists of an anaerobic treatment step followed by an aerobic multi layer filter (sand, coal, gravel) as shown in photo (2-3). The an aerobic step is comprised of a septic tank followed by a two stage up- flow gravel filter. The septic tank receives the grey wastewater from the house through a 2-inch or 4-inches diameter PVC pipe. The raw grey wastewater flows through a bar screen to the first compartment which the septic tank by means of a T shaped PVC inlet. The T shaped PVC inlet has one end directed upward (subjected to the atmospheric pressure) and the other end goes down to the bottom of the septic tank at a level of about 30 cm from the bottom of the reactor.

Photo 2-3 Onsite grey water treatment plant components, Qatanna-Jerusalem, 2010

Accumulation of grease occurs by installing a T-shaped pipe at the outlet, at same level of the inlet. The second and third compartments are up flow gravel filters. The fourth is a balancing tank for holding the pre-treated effluent where a submersible pump is installed. The pump lifts the water to a multi-layer aerobic filter, and after them effluent is collected in a storage tank from where it is discharged into the irrigation network of the house garden.

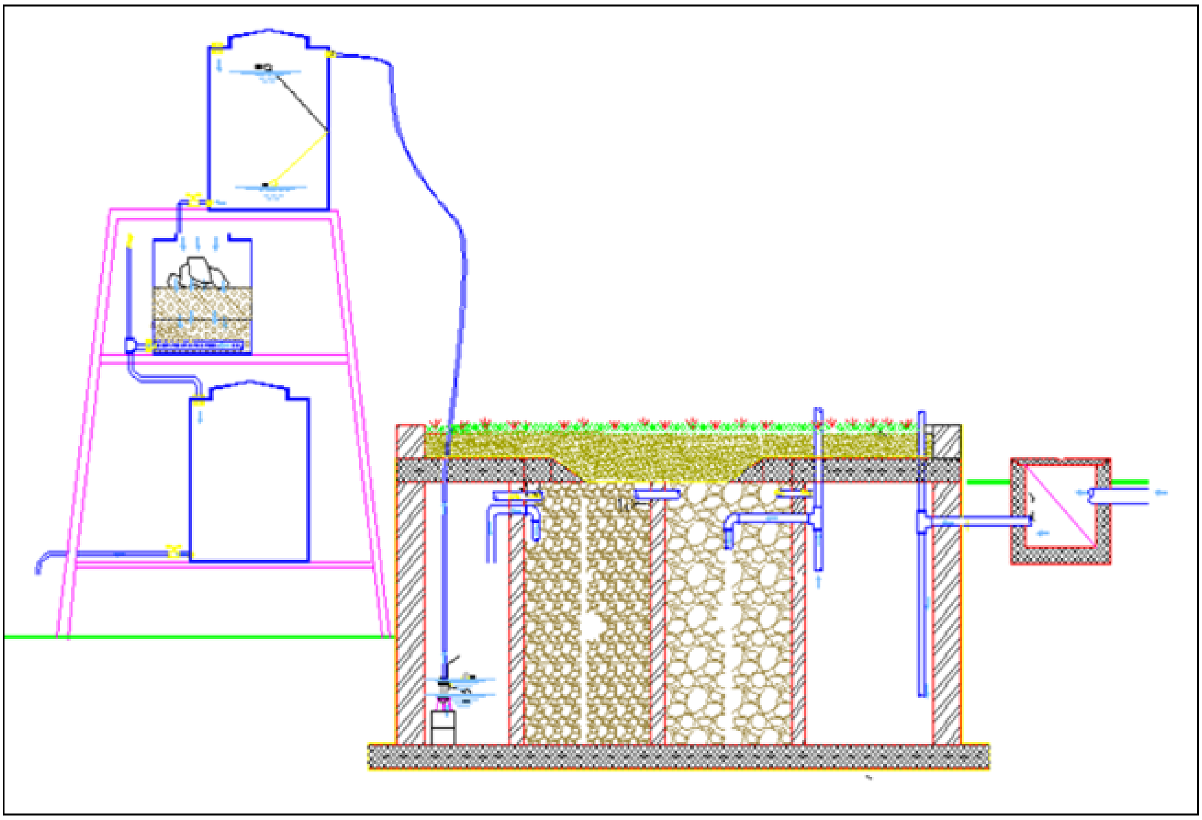


Figure 2-4   Illustration of onsite grey water treatment plant (Burnat and shtayye, 2009)

The intended design hydraulic retention time of the septic tank is 1.5 to 2 days. The up-flow gravel filter is designed as gravity loaded system. It works at maximum flow during day hours and zero flow during night hours. The gravel filter media are mainly hard crushed stones or washed wadi gravel of hard limestone of 3 cm diameter in the first gravel filter and 0.7 cm in the second stage gravel filter. The top of the filter was left without concrete cover, instead it was covered with a thin layer of soil and planted with flowers. This is mainly to make the upper part of the filter functioning as a bio-filter to oxidize the emitted mal odorous compounds. In this line, the headspaces of the septic tank and the balancing tank were connected by a tube underneath the upper part of the filter in order to enhance odor removal. Meshes were provided to the tubes going upward and exposed to atmosphere in-order to prohibit mosquito entrance to the system and subsequent growth propagation. The treatment plants have been constructed with concrete or/and bricks. A schematic diagram of the GWTP is presented in figure.

Photo 2-5 Onsite grey water treatment plant after finishing works, Jifna-Ramallh, 2010

Treatment efficiency of onsite GWTPs

Table (2-2) shows the range of results from water quality testing of 30 triplicate samples of grey water before and after treatment in the units. Untreated Grey water in Qebia village in the West Bank was found to be heavily polluted with bio-degradable matter, with COD levels varying from 1,390 to 2,400 mg/l, and therefore requiring treatment before use. The efficiency of the installed treatment systems was high, reducing COD levels to 58–266 mg/l, levels which meet the WHO standards for grey water use. The faecal coliform counts were reduced by two orders of magnitude, from a range of 1–37×104 to 0–1×102 cfu/100 ml. Projects quality results were compared with the Palestinian Standards of treated wastewater 742-2003.

Table 2-2 Characteristics of untreated grey water from Qebia Project

Parameter	GW influent	GW effluent	WHO/FAO guidelines	Fruiting Trees PSI for onsite units
Dissolved oxygen mg/l (DO)	0	0.5-2.0		>0.5
pH	6.60–6.86	6.70-7.79	6.5–8.4[b]	6-9
Biological Oxygen Demand mg/l (BOD)	941 -997	21-121	20[c]	60 (3 barriers)
Chemical Oxygen Demand mg/l (COD)	1391 -2405	58-266		150
Ammonium as N mg/l (NH4 +-N)	25 -45	12-48		-
Nitrate mg/l (NO3-)	0 1.3	13-36	9.5-518.5[b]	50
Total Suspended Solids mg/l (TSS)	36-396	4-24	20[c]	90 (3 barriers)
Total Dissolved Solids mg/l (TDS)	483-515	465-849	450-2000[b]	1500
Faecal coliforms cfu/100 ml	1x104-37x104	0-1x102	200[a]	□1000
Total coliforms cfu/100 ml	1x109-5x109	2x102-10x102	1000[c]	

a WHO 1989 guidelines for public parks and crops likely to be eaten uncooked
b FAO guideline for water quality for irrigation
c WHO/AFESD Consultation, limit for vegetables likely to be eaten uncooked
Ref: (Burnat and shtayye, 2009)

Projects quality results for onsite treatment units and collective systems compared to Palestinian standards shows that: For onsite treatment units fruiting trees could be irrigated with the effluent from treatment plants generating effluent with COD, BOD and TSS values less than 150, 60 and 90 mg/l respectively but with 3 barriers (Burnat and shtayye, 2009).

Chapter Three

METHODOLOGY

3.1 Study Area

The study area was selected in different rural communities in the West Bank in eight governorates namely (Ramallah, Jerusalem, Betlehem, Hebron, Jenin, Tubas, Tulkarem, Nablus). Study area was selected according to availability of onsite GWTPs distributed mostly at all governorates of the West Bank as mentioned in Table (3-1).

Table 3-1 Distribution of GWTPs in the West Bank

Governorate	**Total number of WWTPs**	**Percentage**
Ramallah	130	27
Jerusalem	16	3
Betlehem	15	4
Hebron	148	31
Jenin	151	31
Salfeet	10	2
Tulkarem	6	1
Nablus	6	1
Total	482	100%

Source: (PWA,2010[b])

The target area covers the following communities in rural areas as illustrated in Table (3-2) and following Fig. (3-1):

Table 3-2 Population of the study area

Governorate	Community	No. of population
Ramallah	'Ein Siniya	668
	Jifna	1613
	Dura al Qar'	2723
	Beit Sira	2584
	Kharbatha al Misbah	4898
Jerusalem	Beit 'Anan	3589
	Al Qubeiba	2860
	Qatanna	5,823
Hebron	Beit Kahil	6361
	Taffuh	10330
	Yatta	47446
	Bet Ommar	2800
	As Samu'	19154
	Bani Na'im	19578
Jenin	Al Judeida	4,649
	Jaba'	8,333
	Telfit	234
	Raba	3,086
Tulkarem	Beit Lid	4,956
Nablus	Talfit	2781
Betlehem	Dar Salah	3253
Tubas	Tayasir	2,385

Source: (PCBS, 2009[b])

Figure 3-1 Study area, (MoPAD, 2011)

3.2 Geographic Area

Palestine has unusual characteristics of great variation in terrain within a small area, from the coastal plain to the central mountain ridge ending with Al- Ghor at the Jordan valley, where the lowest point on earth is located at the Dead Sea. The total area of Palestine (land and water surface) is 26986 km^2. Borders of Palestine are with Jordan, Syria, Lebanon and Egypt (Abu-Sitta, 2010). The total area of the West Bank is 5650 km^2, and Gaza strip is 365 km^2, areas of redeployment divided into area A which is 17.71%, area B is 21.29%, area C is 61% (MoPIC, 2000). According to current administrative divisions, the Palestinian Territory is divided into two geographic regions: West Bank and Gaza Strip, as shown in Fig. (3-2).

1. West Bank is divided into 11 Governorates (Jenin, Tubas, Tulkarm, Nablus, Qalqiliya, Salfit, Ramallah & Al-Bireh, Jericho & AlAghwar, Jerusalem, Bethlehem, and Hebron).

2. Gaza Strip is divided into 5 Governorates (North Gaza, Gaza, Deir Al-Balah, Khan Yunis, Rafah**)** (PCBS, 2009[c]).

Fig. 3-2 West Bank and Gaza Strip (MoPAD, 2011)

The Census findings show that the number of persons in the West Bank housing units totals 2,279,452, findings show that 221,060 of the occupied housing units of the West Bank are of apartment type, the figure constitutes 53.2% of the total occupied housing units. Moreover, the number of occupied housing units of house type is 178,924 or 43.2% of the total number of occupied housing units. In The West Bank, urban area housing units are 288,289 with total of 1,565,772 persons, in the rural area, the housing units are 103,742 with total of 591,023 persons, in camps the housing Units are 22,462 with total of 122,657 persons (PCBS, 2009[c]).

3.3 Demographic and Social Characteristics of the Population

The percentage of population distributed per localities in the West Bank based on the type of locality is distribution as 68.6% in urban communities, 25.88% in rural communities, and 5.4% in camps. The unemployment rate in the West bank is 14.3% of both males and females (MAS, 2009).

Population age structure of the West Bank society is still a society of young people, according to the findings. The number of the people aged 0-14 years in the West Bank totals 920,649 or 40.3% of the total West Bank population. The population density reaches 416/km^2. There are 90,780 illiterates in the West Bank in the age group of 15 years and over (they constitute 7.0% of the total of the Palestinian population of the same age group in the West Bank). Illiteracy is more prevalent among females than males since there were 21,815 illiterate males or 3.3% of the total number of illiterate West Bank population aged 15 years and over and 68,965 illiterate females or 10.7% of the total number of illiterate West Bank population of the same age group. The highest concentration of illiteracy was at rural areas 9.1% followed by refugee camps 7.3% and urban areas 6.1% *(*PCBS, 2009[d]).

PCBS defined some characteristics of the population in the West Bank, these are:

1. A young age structure.
2. High fertility.
3. Comparatively, low mortality.
4. Low labor force participations rates.
5. A population growth rate nearly 4 percent every year.

According to PCBS statistics the growth rates in the West Bank during 1997 – 2015 will be as per Table (3-3):

Table 3-3 Growth rates in the West Bank

Year	2000	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Growth Rate	4.1	3.4	3.3	3.2	3.1	3.0	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.4

Source: PCBS, 2005

3.4 Economic Situation

Palestine is placed in the lower middle-income group of countries in terms of the Human Development Index (ranked 110 out of 182 countries in 2009). According to UNDP/Program of Assistance to the Palestinian people, the ongoing Israeli occupation (with its restrictions on labour, trade and financial/investment flows) and prolonged economic contraction are undermining human development goals. Following the end of the Second Intifada in February 2005, The uncertainty in the political situation poses challenges in achieving progress until 2015; the cut-off date for most MDG based national strategies, but recent trends (2009) show a sharp deterioration. 48% of Palestinians in the West Bank now live below the poverty line, which rises to 68% in southern Gaza and 72% in northern Gaza. Most Palestinian families derive their incomes from a variety of sources, including labour/direct livelihoods, but also small side-businesses (markets) (UNDP/PAPP, 2011).

Unconnected households are paying one sixth of their income or more for tanker water. It is estimated that there are 25 MCM of untreated sewage discharged to the environment each year at over 350 locations in the West Bank. The inequality in access to water between Israelis and Palestinians is striking. Palestinian consumption in the oPt is about 70 litres a day per person whereas Israeli daily per capita consumption, at about 300 litres, is about four times as much. In some rural communities. Palestinians survive on far less than even the average 70 litres, in some cases barely 20 litres per day, the minimum amount recommended by the WHO for emergency situations response (World Bank, 2009).

The contribution of the most prominent economic activities of the Gross Domestic Product at constant prices during 2008, 2009 reflect the service nature of the Palestinian economy. The service sector provided the highest contribution to the GDP followed by industrial activities. The activities of the financial intermediation registered the lowest contribution to the GDP in the year 2009 (PCBS, 2011).

Table 3-4 Percentage contribution to GDP in the Palestinian Territory by economic activity at constant prices: 2004 is the base year

Economic Activity	**2008**	**2009**
Agriculture and fishing	5.9	5.6
Mining, manufacturing, electr and water	15.6	14.3
Construction	6.4	7.4
Wholesale and retail trade	10.2	10.3
Transport, Storage and Communications	7.1	7.3
Financial intermediation	5.7	5.1
Services	20.7	21.2
Public administration and defense	14.0	14.5
Other *	14.4	14.5
Total	**100**	**100**

(*): Include Public owned enterprise, Household with employed persons, Custom duties and VAT on imports

Source: PCBS, 2011

3.5 Questionnaires

Questionnaires were distributed at a household level at the research area in rural communities; two types of questionnaires were developed for this study,

1. The first questionnaire which is the core of this research was designed to owners “beneficiaries” of onsite GWTP,
2. The second questionnaire was designed to people who depend on cesspits for wastewater management,

Both questionnaires were distributed at the rural communities in the West Bank. The selected sites were visited and checked visually, this includes all collection wastewater system, irrigation system, where beneficiaries from onsite GWTP were interviewed over the system performance, perception and different aspects. Questionnaires were applied at the household level targeted the respondents in the research sites.

3.5.1 Questionnaire Building

For the purpose of questionnaire building two workshops were conducted to find out the main issues and significant aspects for the target beneficiaries, which reflected and covered in the two questionnaires, and to find out the concerns of the farmers and the owners of the treatment units, in addition to meet those people who depend on cesspits, as well as meeting and interviews with decision makers and sanitary experts as follows:

- **Inception Workshop**

Prior to questionnaires building, an inception workshop was arranged to gather the owners of GWTPs and cesspits’ users to reveal the concerns, opinions, views of the local community about their sanitation systems.

The workshop was held at Bet Inan village which located to the North West of Jerusalem city, the workshop targeted the farmers and the owners of on-site GWTPs in Bet Inan and neighboring villages namely Qatana and Al Qbeba. Public invitations were distributed in the public places, village councils, and mosques. 27 persons (22 males and 5 females) attended the workshop, 10 persons have GWTPs and the rest still depend on cesspits. Open discussion and simple card method are the tools which applied in the workshop. Each person was asked to write his/her concerns, positive and negative aspects of the treatment units or who use cesspit for wastewater management. The workshop revealed negative and positive beneficiaries concerns of the onsite GWTPs.

- **Professional Workshop**

It was targeting the key persons who work in water and sanitation sectors. The workshop was held at Birzeit University, gathering academic people, professionals who work in water and sanitation, and other interested people such as academic students in water and sanitation field, MSc. Students (Please refer to Annex 3).

- **Meetings and interviews**

For the sake of building the questionnaire several meetings were conducted for many non-governmental organizations (NGOs), scientific and technical groups, professional and other associations working in water management and related environmental issues in Palestine, such as Palestinian Hydrology Group (PHG), Palestinian Agricultural Relief Committee (PARC), Applied Research Institute Jerusalem (ARIJ), Palestine Consultancy Group of East Jerusalem (PCG), Institute of environment and Water Studies (IEWS) –Birzeit University, Centre for Environmental and Occupational Health Sciences at Bir Zeit University (CEOHS), Water and Environmental Studies Institute at An-Najah National University (WESI) and Water and Soil Environmental Research Unit at Bethlehem University (WSERU).

3.5.2 Questionnaires Structure

Based on the results of workshops, meetings and interviews with key persons who work on water and sanitation field, the concerns and findings were reflected in building the questions to have more elaboration from the view and perception of the respondents.

Onsite GWTP questionnaire focused on the following issues:

- Is the sanitation system socially and culturally acceptable to the community?
- Is the system affordable with respect to capital and annual running costs?
- Which type of waste management is it preferable: centralized or decentralized?
- Do you have benefits of wastewater separation; grey and black wastewaters?
- Would you be willing to buy vegetables irrigated with treated grey effluent?
- Is it safe for you to have an onsite treatment system?
- What are the drivers and barriers of implementing a house onsite source separated sanitation system?

The questionnaire consisted of the following main headings:

- Family Structure such as (family size, job, income)
- General information regarding the treatment plant such as (type of treatment, date of construction)
- Monitoring of the treatment plant from side of the implementing agency such as (inspection of the treatment efficiency, quality analysis of treated grey water)
- User comfort and acceptance of the sanitation system such as (satisfaction about the GWTP, reasons for acceptance of GWTP, type of irrigated palnts)
- Current Status of the sanitation system such as (system failure, operation, maintenance, financial aspects, system's management)

- Aesthetic concerns and the treatment plants impact such as (bad smell, disturbance, insects infestation)
- The impact of the sanitation system on health (type of diseases, bad impact on health)
- Drivers and barriers, social and managerial aspects, financial aspects, monitoring of the plants, confidence of applied systems.

Cesspit questionnaire focused on the following issues:

- The current situation of sanitation system
- Problems from utilizing cesspit
- Availability of water for domestic use and for irrigation
- Knowledge and acceptance of onsite GWTP
- Preferred systems for irrigation

The questionnaire consisted of the following main headings:

- Family Structure
- General information with regard water availability and cost
- The current situation of applied sanitation system
- Agriculture practices and satisfaction of sanitation system, acceptance, drivers and barriers of applying onsite GWTP.

3.6 Sample Description

3.6.1 Sample Size Calculations

This calculation is based on the Normal distribution using software program ***"Sample size calculator Raosoft, Inc.,2004"***

Sample size calculations of onsite GWTPs:

- E: The margin of error is the error that you can tolerate which equals 5%,
- C: The confidence level is the uncertainty you can tolerate which equals 90%,
- r: Response distribution equals 50% (assumed by SPSS program).

- N: Population size (total number of onsite GWTPs in the West Bank)
- n: Sample size
- Z(c/100): critical value for confidence level

The sample size n and margin of error E are given by:

1- A 90% degree confidence corresponds to $\alpha = 0.1$, then $\alpha/2 = 0.05$

From Normal distribution curve : the region to the right of Z is 0.5 to 0.05 or 0.45

From table of standard normal Z distribution, Z value = 0.0169

The critical value = Z(C/100)
= 0.0169 (90/100)
= 0.0152

To find X:
$X= Z(c/100)^2 * r *(100-r)$
$X = 0.0169 (90-100)^2 (0.5) (100-0.5)$
X = 0.679

2- E = Sqrt **(**(N-n) x /n(N-1)**)**

0.05 = Sqrt **(**(482-n) 0.679/n(482-1)**)**

n = 174 onsite GWTPs.

- *The same process was calculated to the sample size of cesspits, which equals 485.*

3.6.2 Sample Size Distribution

The total number of onsite WWTPs in the West Bank is 638 units, out of these units (156) are total WWTPs which means grey and black wastewater, while the total number of the onsite GWTPs in the West Bank is around 482 units distributed in Ramallah, Bet-lehem, Jenin, Salfeet, Hebron, Nablus and Tulkarem (PWA,2010).

- **GWTPs beneficiaries' questionnaire**

185 questionnaires were distributed at household level in 18 communities in the West Bank, recovery is 89.2% where (166 questionnaires) were filled, the questionnaire targeted the people who get benefit from GWTPs as per Table (3-5).

Table 3-5 Covered GWTPs in the West Bank

Governorate	Community	No. of GWTP	Percent	Total percent
Jenin	Raba	9	5.4	23.4
	Jaba'	9	5.4	
	Judaida	21	12.6	
Betlehem	Dar Salah	4	2.4	2.4
Hebron	As Samu'	7	4.2	22.8
	Bani Na'im	2	1.2	
	Yatta	29	17.4	
Tulkarem	Beit Lid	7	4.2	4.2
Tubas	Tayaseir	10	6	6
Nablus	Talfit	6	3.6	3.5
Ramallah	'Ein Siniya	4	2.4	33.5
	Jifna	5	3	
	Dura al Qar'	12	7.2	
	Beit Sira	9	5.4	
	Kharbatha al Misbah	12	7.2	
	Qibya	13	8.4	
Jerusalem	Beit 'Anan	4	2.4	4.2
	Qatanna	3	1.8	
Total		**166**		**100%**

- **Cesspit's owner questionnaires**

485 questionnaires were distributed at household level in 19 communities in the rural areas in the West Bank, but the recovery is 95.9% where (465 questionnaires) were filled in the

following Governorates, Jenin, Betlehem, Hebron, Tulkarem, Tubas, Nablus, Ramallah, Jerusalem who depend on cesspits for wastewater management as per Table (3-6).

Table 3-6 Covered cesspits in the West Bank

Governorate	**Community**	**No. of Cesspits**	**Total of Cesspits**	**Percentage (%)**
Ramallah	'Ein Siniya	10	101	21.7
	Jifna	17		
	Dura al Qar'	17		
	Beit Sira	25		
	Kharbatha al Misbah	22		
	Qibya	10		
Jerusalem	Beit 'Anan	11	19	4.1
	Al Qubeiba	2		
	Qatanna	6		
Betlehem	Dar Salah	14	13	2.8
Hebron	Beit Kahil	20	169	36.3
	Taffuh	18		
	Yatta	70		
	Bet Ommar	21		
	As Samu'	20		
	Bani Na'im	20		
Jenin	Al Judeida	63	116	24.9
	Jaba'	20		
	Telfit	7		
	Raba	26		
Tulkarem	Beit Lid	15	15	3.2
Nablus	Talfit	7	7	1.5
Tubas	Tayaseir	25	25	5.5
Total			**465**	**100%**

3.6.3 Field Works

Field works started in 20-12-2010 to 30-2-2011; the field workers were distributed to the selected rural communities in the different governorates. Both questionnaires were distributed by six staff consisted of two specialized staff who work in this field, and 4 well trained MSc. Students specialized in Water and Environment Engineering, the students had been trained on field survey, questionnaire's filling and statistical issues.

3.6.4 Data Analysis

Data processing stage includes all the stages after the fieldwork such as: editing, coding, data entry, electronic editing, and then data organized in such a way to prepare required analysis and to obtain results. The analysis was made by using SPSS (SPSS Version 12).

Chapter Four

RESULTS AND DISCUSSION

Results of this research were concluded upon the applied methodology from different resources including, inception workshop, professional workshop, onsite GWTPs' questionnaire and cesspit's questionnaire.

4.1 Workshops

Inception workshop

The workshop reveals the following incentives of the onsite GWTP in order of priority:

1- New water source for irrigation

2- Maintain food security

3- Financial saving for not emptying the cesspits

4- Optimal use of fresh water by saving fresh water for domestic use

5- Promoting agriculture by fining new source of water

6- Job opportunity and generation of new income

The workshop reveals the following negative concerns of the onsite GWTP in order of priority:

1- Health concerns and doubt of the crop quality irrigated by treated grey water,

2- Lack of monitoring and evaluation process after the end of construction units,

3- Improper maintenance and operation of units, and lack of training beneficiaries,

4- Bad smell and insects infestation,

5- Financial burden for maintenance and change of the pump,

6- Construction mistakes in the implementation of the treatment units especially the leakage.

Professional workshop

The main results concluded from the workshop:

1- Grey water is a valuable source of water which need proper management,
2- grey water is new unconventional source of water,
3- Understanding and investigation of people perception and concerns is the first step for grey WWTPs construction,
4- Grey water projects should be conducted in parallel with public awareness,
5- Monitoring and evaluation especially after completion the phase of construction is a must for the implementing agency,
6- Reuse practices should be conducted within monitored and controlled systems.

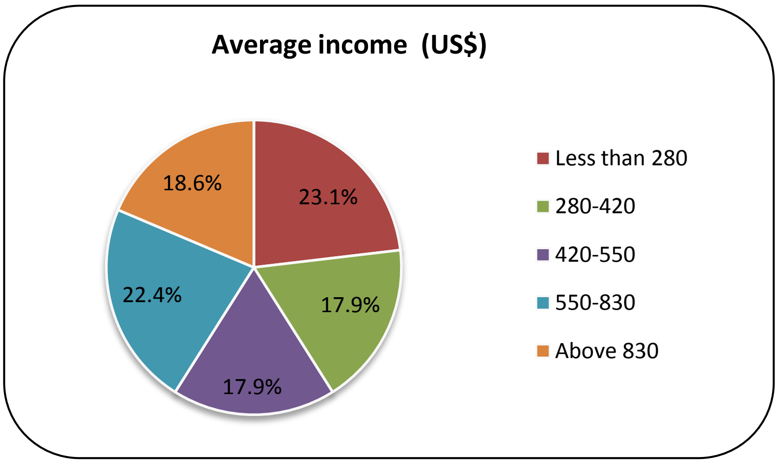
The results concluded from this workshop was very general regarding acceptance of onsite GWTPs, but it gives the main concerns of GWTPs application in rural communities

4.2 Onsite GWTP Questionnaire

4.2.1 General Information on Families and Houses

The survey results revealed that the average family size in the study area is 9.3 which is considered a large family size, the average number of children per household is 4.1, range between (1-16 years), while the average family size in the West Bank is 5.5 person (PCBS, 2010). Most of the GWTPs served one household, in which 76.5% of the treatment plants connected to one household, 14.2% served two families and 9.2% served three to four households. The average income of the onsite GWTP's owners are ranged from 280 up to 830 US$ as illustrated in the following Chart (4-1), while the last official Palestinian statistics reveal that 47.2% of population in the West bank are below the national poorness standard, as their average income is less than 580 US$ (PCBS, 2011).

Chart 4-1 Average income



The job of the interviewers varied between public works, worker in Palestine or in Israel, Farmer, trader and others.

Table 4-1 Type of beneficiaries' job

Type of job	Percent
Public works	16.8
Worker in Israel	17.4
Worker in Palestine	26.3
Farmer	6.0
Wholesaler	7.8
Others (teacher, driver,..)	25.7
Total	**100**

4.2.2 General Information of Onsite GWTPs

The treatment plants which are distributed in the rural communities have been constructed over the last fifteen years, with 99.3% of them were constructed over the last ten years. All of them were constructed by local or international NGOs supported by external donors.

The findings showed that 13% of the total constructed treatment plants were not operated any more, due to many reasons including first, strong bad odour emission and its impacts on the owners and neighbors, second; it's not effective in the treatment process as stated by beneficiaries, third; some of them change the function of the plant to replace it with cistern since its construction, and because they are not well trained in operation and maintenance.

The data revealed that 25.1% of the implementing agency never monitor or check the treatment plants, and 59.3% of them monitor and check the plants only at the first phase (2-3 months as per beneficiaries) after completion of construction, only 11.4% of them monitor and operate the plants by regular visits and giving support to ensure the performance of the plants. This finding was also pointed by (Ahmad et al., 2009), stated that most onsite GWTPs stopped its operations after the funded projects terminated. No monitoring systems were available for the treatment plants although those systems were used for the irrigation. Moreover (Sandec, 2006) mentioned that most system failures are caused by inappropriate operation and maintenance, sometimes also resulting from a lack of system understanding by the owners. Therefore beneficiaries must be trained on appropriate system management, their involvement in the planning and implementation process is crucial to raising awareness and improving system understanding.

The GWTPs questionnaire also covered inspection of the treatment systems and testing the quality of treated water by sampling and analysis of the products and treated water. Findings showed that 61.7% of the implementing agency in no way inspect or monitor the quality of treated water, 26.9% of them monitor the quality and performance of the plants in the first period after implementation, and 7.2% of them on regular basis range between (1-2 times per month) check and monitor the plants. This explains that there is no reliable or continuous monitoring system of the plants from side of the implementing agency. Then these tasks were shifted directly to the owners without adequate knowledge and experience of system's monitoring and evaluation. The results showed that 48.8% of system's owners were not satisfied from organization's behavior after the end of the project, this high percent shows the limited role and responsibility of the implementing agency which negatively affect the sustainability of these treatment plants.

At the same context the beneficiaries stated that the implementing agency makes many mistakes through planning and construction process including; construction mistakes and improper finishing works, lack of monitoring and supervision, inappropriate site selection of the treatment plant, improper design and capacity, leakage from the treatment plant, lack of consultation with communities representatives and the feasibility of the project.

4.2.3 Water and Sanitation Household Conditions

Providing of treatment plants require availability of space area surrounding home, as 95% of household respondents have a garden, the average area of garden is between 100 -500 m^2, as well as 79% of houses have a rain water harvesting systems. Treatment plants affect irrigation and saving of fresh water, as 51.5% of the interviewers used the fresh water from water network in irrigation before construction of GWTP, but this percent considerably decrease after construction of treatment plant; which reach 15% of beneficiaries still use network water source in irrigation after construction of onsite GWTP, and 30% of them use water network from time to time. As stated before, most of rural communities facing chronic water shortage, where 72.5% of the beneficiaries stated that they had a water shortage before construction of the treatment plants, and onsite GWTPs contribute for solving water shortage; 35.3% of beneficiaries stated that the GWTP contribute to solving the water shortage, as well as 44.3% stated that GWTP contribute partially of solving water shortage, since they started to use treated water for purposes of irrigation, consequently they save fresh water.

The effect of providing an unconventional source of water (treated grey water) in a way or another affect positively on the cultivated area and productivity, as the average planted area before establishing of GWTP is 153m^2, while the average planted area after establishing of

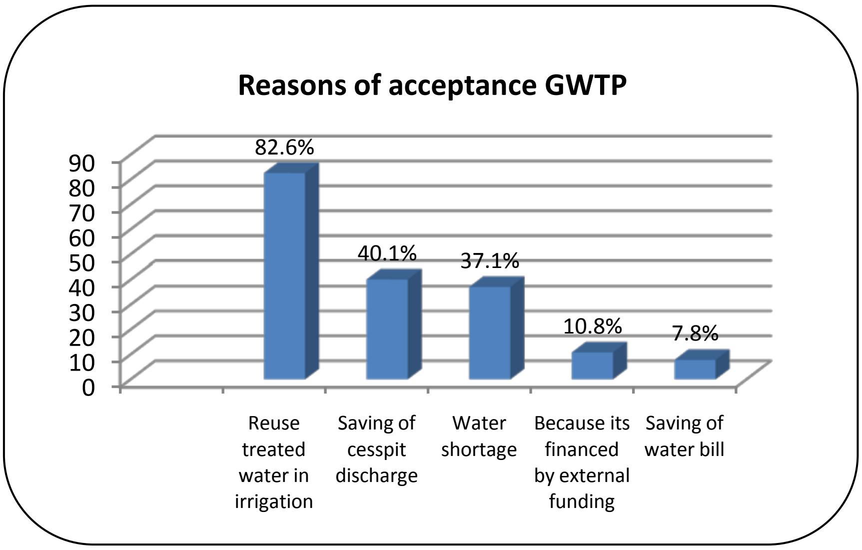
GWTP is 156 m^2, the difference is not significant but the agriculture practices became more efficient and productive, the quantity and quality of fruits are much increase. This result pointed out in other research stated that, reuse of treated grey water in irrigation can significantly contribute to reducing water bills and increasing food security (Sandec,2006).

Findings revealed that there are two types of agriculture, the majority of the interviewers (77.8%) stated that they use treated water in open agriculture, and 15.6% of them use treated water in green house. The percentage of families that use treated grey water in irrigating fruit trees, vegetables, flowers and fodders are respectively 71.9, 44.3, 4.8 and 1.2%. The produced fruits are mainly used for household consumption (77.4%); around 10% gifted to relatives, neighbors and friends, and 7.5% is usually sold in the market. This shows that the application of source separated house onsite grey water management system have encouraged the use of treated grey water in agriculture which have consequently resulted in improving the food security.

4.2.4 Reasons for Acceptance GWTPs

The reasons for acceptance GWTPs to replace the previous sanitation system “cesspits” were different from many different aspects. The highest percent (82.6%) of beneficiaries accept to have the treatment units because of their willingness to reuse treated water in irrigation and agricultural purposes, and the least percent goes for saving of water bill, as illustrated in Chart (4-2).

Chart 4-2 Reasons for accepting GWTPs



The above chart explains that the majority of beneficiaries accept to have these systems for agriculture, and they are in favor to use the treated grey water in irrigation without any restrictions. This result comes in harmony with results of other research by (Adilah, 2011) that stated, the reuse option that has the most potential to be adopted is the home garden irrigation, with the type of crops to be planted and irrigated by the effluent is the fruit trees and flowers. Saving of cesspit discharge is another important reason for accepting GWTP, as only black wastewater goes to cesspit. Water shortage is also a reason for accepting GWTP as the majority have a water shortage especially in the summer. The least percent is saving of water bill because providing GWTP doesn't have much effect on utilization of fresh water, because they were not used to make agricultural practices before construction GWTPs.

Acceptance of providing GWTPs for reuse in irrigation is varied according to many reasons as mentioned in Table (4-2):

Table 4-2 Acceptance of providing GWTPs for reuse in irrigation

Independent value	Acceptance of GWTPs Asymp. Sig. (2-sided) Value	Status
Age	0.526	Not significant
Governorate	0.002	Significant
Number of households	0.433	Not significant
Family size	0.0135	Significant
Job	0.00	Significant
Age of responsible person for managing GWTP	0.501	Not significant
Education level of whom responsible of GWTP	0.00	Significant
Suffering of water before construction of GWTPs	0.003	Significant
frequency of cesspit's emptying before providing GWTP	0.002	Significant
Level of noise	0.32	Not significant
Garden availability	0.00	Significant
Owner's satisfaction of cesspit's	0.001	Significant

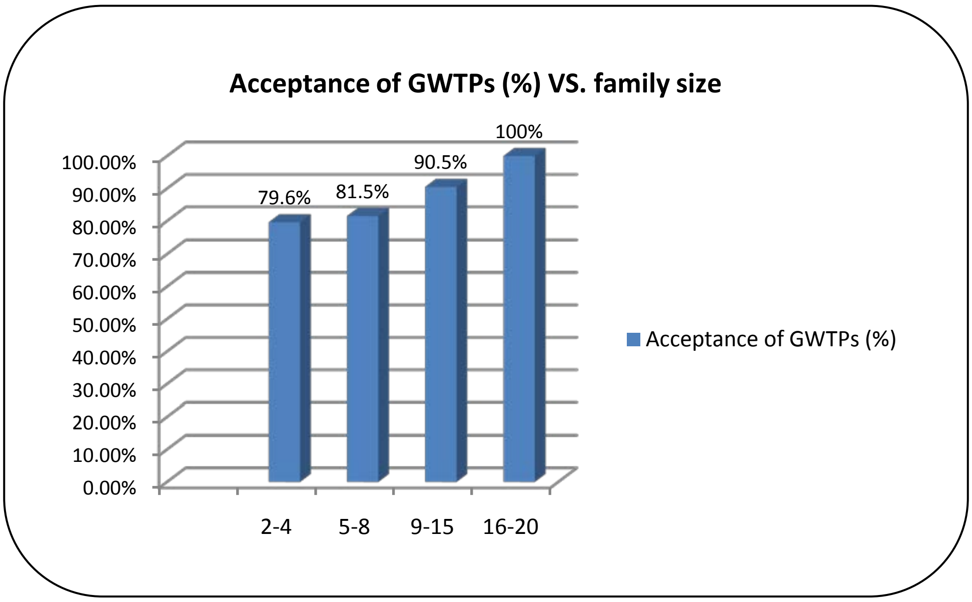
1- Governorate: from the results of Table (4-3), it appears that the percent of acceptance have closed values between all governorates, which shows that onsite GWTPs in the West Bank is acceptable to be applied for purpose of reuse in irrigation.

Table 4-3 Acceptance of GWTPs for reuse in irrigation per Governorate

Governorate	Acceptance of GWTPs (%)
Betlehem	83.3
Ramallah	68.1
Jerusalem	100
Hebron	85.7
Nablus	100
Tulakarem	85.7
Jenin	82.1
Tubas	100

2- Family size: from Chart 4-3 it's noticed that the acceptance of GWTP for reuse in irrigation is different per the number of family size, where the percent increase with large families.

Chart 4-3 Acceptances of GWTPs for reuse in irrigation per family size



3- Job: acceptance of GWTPs was different from people who have different jobs as per Table (4-4), where the high percent goes to the workers and farmers (who have the less income), while employee or wholesaler have less interest to have GWTPs.

Table 4-4 Acceptance of GWTPs for reuse in irrigation versus job

Job	Acceptance of GWTPs (%)
Worker	85
Employee	78.6
Farmer	90
Wholesaler	80%

4- Education level: 87.7% of not educated people accept GWTPs for reuse in agriculture, but less percent (81.2%) of educated people accept, this emphasize that educated people have more concerns regarding quality of treated water.

5- Suffering of water before construction of GWTPs: 85.6% of people who were suffering from water shortage accept construction of GWTPs for reuse in irrigation, while less percent (75.6%) of people who have no problems with water shortage.

6- Garden availability: 86.1% of people who have a home garden would be willing reuse treated grey water in irrigation, however 22% of those who don't have a home garden were not able to reuse in irrigation

7- Frequency of cesspit's emptying before providing GWTP: Acceptance of reuse in irrigation depend on discharge of cesspits per year, 76.2% of people who empty cesspits 1-3 times per year accept reuse in agriculture, while 88.3% of people who discharge their cesspits more than 4 times per year accept reuse in agriculture.

8- Owner's satisfaction of cesspits: 73.9% of people who are satisfied of applying cesspits accept reuse in irrigation, while more percent (87.4%) of people who are not satisfied accept providing onsite GWTPs for purpose of reuse in irrigation.

4.2.5 Invisibility and User Comfort of GWTPs

People's satisfaction with the applied GWTPs was very promising, as the majority of GWTP's beneficiaries showed that 70.4% are satisfied with the applied sanitation systems, and they had got benefits. Whereas 29.6% of beneficiaries were not satisfied due to many reasons including; odour emission, worries about the quality of treated water, the treatment is not efficient as required, worries about the performance of the newly introduced system, seepage and construction faults, insects infestation, additional burden for operation and maintenance,

Regarding confidence in the treated grey water quality for the purpose of plants irrigation, results showed that more than a half 57.5% of the interviews' were confident of treated grey water quality, 32.3% were suspect the quality, and 4.8% were unconfident of the quality.

Regarding acceptance of reuse of treated grey water in Islamic religion, 70% accept reuse of treated grey water in irrigation and 24% do not accept. This result considered as a driver for adopting such systems especially in the rural communities, since religion is very important issue must be considered to ensure the success and feasibility of any new technology. This result is compliance of what mentioned by (Abu-Madi and Al-Sa'ed, 2009), that Islamic religion supports water demand initiatives as well as reuse of treated wastewater that does not have negative impacts on public health. Therefore, many efforts should be targeted to improve public knowledge and perceptions in this regard.

84.4% of the interviewers were not shame of reuse treated grey water in irrigation. These results promote the application of grey water management in rural communities since they found it acceptable. 55.7% of beneficiaries recommend the system to be applied for other non served houses, where 31.1% recommend the system with some technical modifications (such as providing of odor systems, additional purification at the last phase of treatment) in order to establish more reliable grey water systems.

4.2.6 Satisfaction of Onsite GWTPs

There is a relation between satisfaction and reasons for accepting GWTPs. The majority of GWTP's beneficiaries (70.4%) are satisfied of the applied sanitation systems, (69.6%) of satisfied beneficiaries accepted onsite GWTP to reuse the treated effluent in irrigation. 68.5% accepted it to have benefit of reduction of cesspit discharge frequency. 71.2% of them accepted the onsite GWTPs because of water shortage. 69.2% accept it for the purpose of saving in water bill, and only 61.1% accept GWTPs because its financed by external donor.

There are many reasons for not satisfaction of onsite GWTP including; odour emission, inefficient treatment, inadequate water quality and its suitability for irrigation, insects infestation, pollution of the surrounded area and soil, construction faults and leakage.

4.2.7 Education Level in Relation with Satisfaction

Education level has a clear impact on many aspects regarding acceptance of GWTPs including; satisfaction of GWTPs, confidence of effluent quality ad reuse options.

- Education level of responsible people of GWTPs in relation with satisfaction of GWTP**:** high percent (73.1%) of beneficiaries were not educated (high school or less), 73% of them were satisfied. Less percent of educated people (university degree or above) were satisfied; as (58.8%) of them were satisfied, this explains that educated people had more concerns on the treatment efficiency, effluent quality and health aspects.

- Education level of responsible people of GWTPs in relation with confidence of effluent quality: 60.6% of not educated beneficiaries are confident of water quality, while 55.9% of educated people are confident as well, this emphasize that educated people have more concerns regarding the treated water quality.
- Education level of responsible people of GWTPs in relation with shame of reuse treated grey water in irrigation: the majority of beneficiaries (84.4%) were not shamed of reuse treated grey water in irrigation. 86.0% of not educated beneficiaries of high school or less were not shamed of reuse treated grey water in irrigation. While more percent (94.1%) of educated people who got university degree or above were not shamed. This explains that educated people are more open mind than not educated people.

4.2.8 Aesthetic Impact

The aesthetic impact of the system was very positive which encourage its application in rural communities, 66% of the treatment plants were constructed below the ground level, 74.9% of beneficiaries stated that the treatment systems have no effects on the general view. Moreover 10.2% stated that these systems have a good impact, and only 9.0% have a bad aesthetic impact.

With respect to odour emission from GWTPs and treated effluent, the majority of beneficiaries stated that the systems have odour emission, as 38.3% of the interviewed people stated that there is frequently odour emitted from the system, 35.9% stated that the system sometimes emit odour, as well as 21.1% stated that there is no existence of odour emission.

The produced noise from the system is rather negligible, as stated by 83.9% of the people, and only 6.6% stated that the system sometimes produce noise from the source of pump.

28.7% of people stated that the system cause significant spread of insects infestation, and the same percent (28.7%) stated that the system have no effects on insects infestation, while 35.3% stated that the system cause low spread of insects. 77.2% of interviewers people stated that they never have problems with neighbors because of the applied system.

4.2.9 Public Health

In terms of people exposure to touching grey water, the system was rather safe and had no significant effect on health. As 35.9% of the beneficiaries stated that the family members never exposed to touching grey water, and 34.7% stated that the incidence of touching grey water was very little. In terms of hygienic status, 49.7% of the interviewers stated that the grey water systems contribute for reduction of diseases, by decreasing pollution and solving the seepage of wastewater from cesspit. 19.8% of the interviewers stated that the applied system do not contribute to reduce diseases.

Regarding exposure to physical harm, the system didn’t cause any physical harm; 60.5% of the interviewers stated that there was no potential for exposure to physical harm, and 30.5% of them stated that they were rarely exposed to physical harm of the system. Majority of the beneficiaries stated that the treatment systems don’t cause spreading of any epidemic disease

4.2.10 Monitoring and Operation of the GWTP

Women play a major role in GWTPs management; 68.9% of the treatment systems are running by men side by side with women (fathers and mothers), and 24% is running completely by women, therefore more focusing should be targeted to women in terms of training and managing onsite sanitation systems, since they are more involved in household water management. The majority of interviewers (73.1%) of them got the high school or less, 20.4% have a university degree and higher education. Least efforts required for operation and maintenance of the grey water treatment plants, which the average yearly working hour is up to 19.7 hours, that means 0.4 hour per week.

Operation and maintenance works

Operation and maintenance works included; clean and check of inlet manhole, remove scums from the first compartment (septic tank), pipes cleaning, cleaning of the whole treatment plant and washing of gravel filter in the second and third compartments, as well as cleaning of aerobic filter and storage tank.

Replacement of Apparatus and Tools

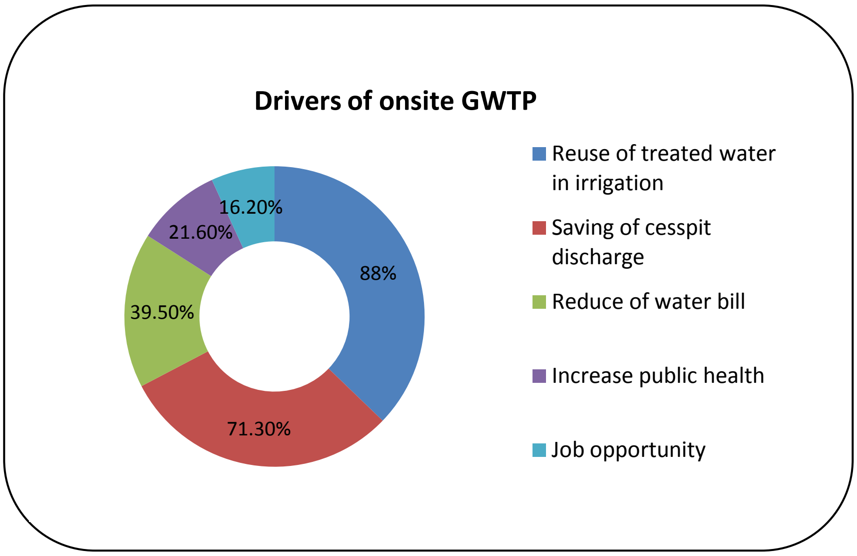
There is a minor change for the apparatus of GWTPs components which include; replacement of pump in which most of the beneficiaries change submersible pump after one to two years from installation and change of internal pipes inside the treatment plant.

4.2.11 Drivers and Barriers of Applying Onsite GWTPs

The Drivers for Application of Onsite GWTPs

The most important drivers of onsite GWTPs which raised by the beneficiaries are presented in Chart (4-4), 88.0% of the beneficiaries stated that the main driver for applied sanitation GWTPs is for the purposes of reuse of treated water in irrigation and agricultural purposes, the second driver is to maintain saving of cesspit discharge, and the third driver is to get reduction of water bill. With less percent (21.6%) of beneficiaries stated that these system raise the public health, finally the least percent of the main drivers is to find new job opportunity through working in agriculture. In terms of fertilizers utilization in agriculture, it's found that there is no significant change on the quantity and cost of utilized fertilizers before and after utilization of treated grey water.

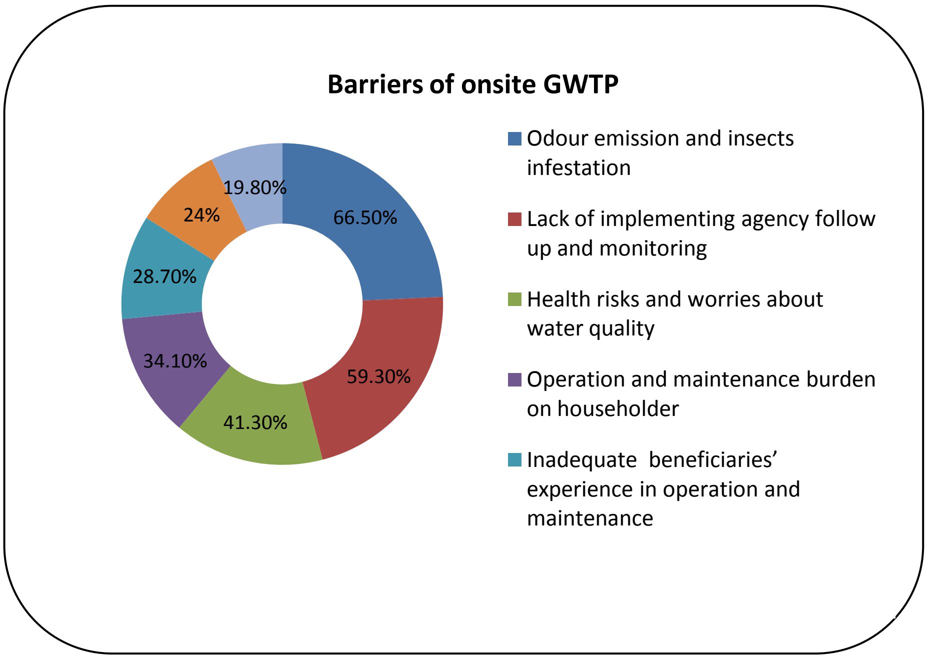
Chart 4-4 Drivers of onsite GWTPs



The Barriers for Application of Onsite GWTPs

Many barriers were raised by interviewers for the application of GWTPs, the following barriers are arranged from high priority as illustrated in Chart (4-5) the first barrier is the odour emission and insects infestation, this realize the importance of further developing the systems to improve its performance. The second barrier is the lack of implementing agency (NGOs) follows up especially after the end of implementation, these NGOs don't consider the evaluation and monitoring after the end of projects, accordingly the beneficiaries don't have the required experience in operation and maintenance. Health risks and worries about water quality is another barrier since people were unconfident about the quality of treated grey water. Lower percent of beneficiaries stated other barriers such as operation and maintenance burden on householder, lack of beneficiaries experience in operation and maintenance, financial burden for operation & maintenance. It's also indicated by (Ahmad et al., 2009) that no monitoring systems were available for the treatment plants although those systems were used for the irrigation. This emphasizes the importance of considering the follow up process and practical training of operation and maintenance as a part of project implementation.

Chart 4-5 Barriers of Onsite GWTPs



Separation of internal pipe lines

60% of interviewers had a separated internal wastewater pipe system (separate grey from black pipes), where they don't need to make internal work for separation. Furthermore separation of internal pipes was not considered as a barrier for providing onsite GWTPs.

4.2.12 Replacement of GWTPs in Case of Providing Sewerage Networks

52.1% of GWTPs owners would not replace the treatment plant in case of providing sewerage networks, while 37.7% of them stated that they would replace the treatment plant in case of providing sewerage networks. The mentioned results refer to many aspects that interfere with replacement of GWTP in case of providing sewerage networks as discussed below:

1- Water shortage: 56.6% of GWTP beneficiaries who accepted providing GWTPs because of water shortage were not willing to replace the onsite GWTP in case of providing sewerage network, while 43% of GWTP beneficiaries who don't faces water shortage accept replacing the onsite GWTP in case of providing sewerage network. This result indicates that water shortage is a significant reason to maintain the onsite GWTP.

2- Availability of fund by external donor: 66.6% of GWTP beneficiaries who accept providing GWTPs because its supported by external fund were not willing to replace the onsite GWTPs in case of providing sewerage network, while 52.1% of GWTP beneficiaries who accept providing GWTPs as it's not supported by external fund were not willing to replace the onsite GWTPs in case of providing sewerage network, which means that fund availability was not a significant reason for replacing the onsite GWTPs.

3- Reduction of cesspit discharge frequency: 53.9% of GWTPs beneficiaries who accept providing GWTP for reduction of cesspit discharge frequency were not willing to replace the onsite GWTP in case of providing sewerage network, while 37.4% of GWTP beneficiaries which accept providing GWTP for not saving of cesspit discharge were willing to replace the onsite GWTP in case of providing sewerage network. From the mentioned results it's concluded that reduction of cesspit discharge frequency is a major reason for preference of GWTPs.

4- Reuse in irrigation: 54.4% of GWTP beneficiaries who accept providing GWTP for purpose of reuse in irrigation were not willing to replace the onsite GWTP in case of providing sewerage network, while 47.4% of GWTP's beneficiaries who accept providing GWTP for not reuse in irrigation were willing to replace the onsite GWTP in case of providing sewerage network. From the mentioned results it's concluded that reuse in irrigation is an important reason for preference of GWTPs.

5- Saving in water bill: 61.5% of GWTP beneficiaries which accept providing GWTP for saving in water bill were not willing to replace the onsite GWTP in case of providing sewerage network, while 40.0% of GWTP beneficiaries which accept providing GWTP for not saving in water bill were willing to replace the onsite GWTP. which means that saving in water bill is very important reason for preference of GWTPs.

6- Satisfaction of applied system: 68.1% of GWTP beneficiaries who were satisfied from the unit's performance were not willing to replace the onsite GWTP in case of providing sewerage network, while 71.3% of GWTP beneficiaries who were not satisfied from the unit's performance were willing to replace the onsite GWTP. Which indicate that satisfaction of the existing sanitation system is a significant issue to replace it with another one.
7- Contribution of GWTPs to solve the water shortage: 60.3% GWTP beneficiaries who benefit from the treatment units by contribution to solve the water shortage were not willing to replace the onsite GWTP in case of providing sewerage network, while 72.0% of GWTP beneficiaries who didn't got benefit from the treatment units by contribution to solve the water shortage were willing to replace the onsite GWTP.

4.2.13 Miscellaneous

Findings showed that almost all of onsite GWTPs were funded by external donors, and most were constructed by local or international NGOs. Availability of fund was an important driver for construction of GWTPs, as 70.7% of the interviewers stated that if external funding was not available, they would not have constructed the system on their own contribution, this shows that wide scale implementation of the system in the rural communities is apparently limited to the availability of external funds.

Suggestions for improving the performance of the treatment plants: many suggestions were raised by beneficiaries in order of priority that included; regular investigation and maintenance by the implementing agency after finalizing implementation, construction works should be executed according to the prepared design and technical specifications, advance system to eliminate odour and insects infestation, checking of treated effluent and its suitability for agriculture. There are some minor suggestions such as appropriate site selection, enlarge the treatment plant to connect a group of neighboring households to one treatment unit, remove of the aerobic filter since it has no effect on the treatment efficiency.

4.3 Applied Black Wastewater Systems “Cesspits”

4.3.1 Description of Black Wastewater System

91.6% of the interviewers used cesspits as the main applied system for black wastewater disposal, the vast majority of interviewers as 80% of GWTPs owners depend on cesspits for black wastewater disposal and only 5% use septic tank, 90.4% of beneficiaries used concrete only for the top of the cesspit, 15.0% of the beneficiaries use concrete for the side walls of cesspits, and only 3.6% use concrete for the ground. 47.9% of the cesspits owners didn’t ever discharge the wastewater from cesspits since construction, and 43.1% discharge the cesspits, this explains the pollution of the ground water in which wastewater percolate directly into the ground layers cause a direct pollution to ground water, soil contamination, and the negative effects on agriculture (PWA, 2010).

4.3.2 Satisfaction of the Black Wastewater System

80.8% were satisfied of cesspits. This reveals that people were satisfied because the reduction of significant amount of wastewater discharges to the cesspit, consequently less amount of emptying the cesspit and saving the opportunity cost of emptying. 20% of cesspit’s owners were not satisfied due to many reasons such as financial burden on householders of continuous cesspits emptying, environment pollution and leakage of wastewater to the neighboring cistern, health concerns and odour emission, insect’s infestation, flood risk, high capital cost for cesspit construction and system’s blockage. 33.5% of the interviewers stated that they were very annoyed during cesspit emptying, as well as 30.5% of the neighbors were very annoyed during cesspit emptying.

4.3.3 Reasons of Un-satisfaction of Cesspits

- Continuous emptying of cesspits,
- Financial cost for cesspit emptying,
- Insects infestation,
- Odour emission,
- Pollution of environment and surrounded area,
- Seepage of wastewater to the nearby cistern, risk of floods.

The results showed that the average number for emptying the cesspit per year before construction of onsite GWTP was 6.3, while this number decreased to 4.1, this means that the emptying of the cesspit reduce by 35% from the previous.

4.4 Cesspits Owner's Questionnaire

4.4.1 General Information on Families and Houses

The survey results revealed that the average family size varies in the governorates from 2 up to 15 persons per household, and the average size was between 7-8 persons, the families in rural communities considered as poor families with average monthly income between 285 US$ to 570 US$. The unemployment rate is 11.7%, 48% of interviewers classified as daily workers, 22.5 % were employee, 5.1% were farmers. The average water bill per month varies between 14-30 US$ with a maximum value of 120 US$ per month.

The water price per cubic meter is between 1.2 to 6 US$ (this is in case of purchasing water tankers especially in the summer), where 61.7 % of households pay (1.2-1.5) US$/$m^3$ of piped water, sometimes the price is up to 6 US$ (4 times the network price), where people enforce to buy water from tankers especially in the summer, since the water is continuously cut off and there is no affordable choice of water providing.

4.4.2 Cesspit Characteristics

The average volume of cesspits is 60 m^3,the vast majority (87.3%) of household owners depend on cesspits for wastewater disposal, only 12.1% use septic tank, these cesspits where constructed with range from 1960 up to 2010. 92% of cesspit's owners used concrete only for the top of the cesspit, 6.7% used concrete for the ground, walls and top of the sanitation system, these results indicated that the wastewater percolated into the ground and surrounded area without any kind of treatment. 50.8% of the cesspits owners didn't ever discharge the cesspits since its construction, and 49.2% discharged the cesspits after 1 up to 40 years after cesspits construction, the emptying started after 10 years from construction, this explains the pollution of the ground water, where wastewater percolated directly into the ground layers causing a direct pollution to ground water, soil contamination, and the negative effects on agriculture.

4.4.3 User's Satisfaction

The satisfaction of cesspit's owners of wastewater disposal was described in terms of many aspects including; system's acceptance, disturbance, social problems, affordability, and noise. People's satisfaction of applied wastewater system was not promising where 49.2% of the cesspits owners were not satisfied of the applied sanitation system. The un-satisfaction was due to; additional financial burdens on the people from high cost cesspit's emptying, the cesspits are adjacent to cistern and potential for water pollution, health concerns, pollution of environment and ground water, leakage of the cesspits, problems with neighbors, odour emission, insects infestation like mosquito, and separation of house internal grey and black wastewater piping system.

Findings showed that the average discharge of the cesspits was 7 times per year, 6.7% of cesspit's owners discharged the cesspits 24 times per year, the interviewers pay (15–86) US$ each time of emptying with an average of 35 US$, this make additional financial and social burden on the people to sustain these poor systems. The people pay 6% out of their monthly income on cesspit's emptying.

75.7% of interviewed people complained from high disturbance during discharge of the cesspits, 68.5% of the interviewer's neighbors were also disturbed during cesspits discharge. 74.3% complained from noisy sound during cesspits discharge, 10.4% of them had problems with neighbors during discharge of cesspits, these indicates that the people who depend on the sanitation system using cesspits are not pleased with these systems.

4.4.4 Availability of Water for Irrigation

54.9% of the interviewers had a home garden. The average area of the garden is 600 m^2, 76.7% of the household had rainwater harvesting systems, where 63.7% of total harvesting systems were concrete made, and 18.7% drilled in rocks formation. The rain water harvesting systems were located at a distance with an average of 31.4 meter from existing cesspits. This indicates that the wastewater management systems wouldn't cause pollution to the harvested water systems, according to the Palestinian Standards Institution which impose a minimum distance of 15 m with the cistern located upstream.

Most of surveyed household who have a garden try to have some agricultural practices, where 51.7%, 44%, 1.7% and 2.6% are planted respectively with fruit trees, vegetables, flowers and fodders. The Water source for irrigation varies between water network, cistern, and untreated grey water, rain water at respectively percentage of 25.8%, 32.8%, 16.4% and 25.0%. 32.2% of interviewer stated that there is availability of water for irrigation, and 66.1%

stated that the available water was not sufficient for plants irrigation. This clarify that water was not enough for irrigation and showed that there was an actual shortage of water especially for the purpose of irrigation, as well as there was a significant percent of people depend on untreated grey water, this reality showed that to a certain extend people had no objection on using treated grey water in irrigation.

4.4.5 Acceptance of Grey Water Systems

The survey included the possibility of applying wastewater management in the rural communities; the findings showed that 46.3% of household interviewers have knowledge about grey water treatment systems, while 52.6% have no idea about grey water treatment systems. The majority of people (74.8%) preferred sewerage networks for wastewater management, 15.5% of people preferred onsite GWTPs, and 9.5% preferred cesspits. This according to the behavior of people where they don’t prefer to take responsibility of managing wastewater systems. In addition (Al-Sa’ed and Mubarak, 2006) mentioned that the respondents agreed on having centralized wastewater management facility, as their financial share will be minimal due to donor countries financial and technical support. For the interviewers who prefer cesspits, this is according to the reason that people are used to conventional methods, and they do not have knowledge about the GWTPs.

Preferred system was varied between Palestinian rural communities in surveyed governorates as demonstrated in Table (4-5). The percent of acceptance of onsite GWTPs in the West Bank is approximately close to each other between all governorates.

Table 4-5 Preferred systems of sanitation per governorate

Governorate	Central wastewater network (%)	Grey water treatment plant (%)	Cesspit (%)
Ramallah	82.2	14.3	5.0
Jerusalem	83.3	16.7	0.0
Betlehem	81.3	18.8	0.0
Hebron	66.1	15.2	18.2
Nablus	85.7	14.3	0.0
Tulkarem	80.0	20.0	0.0
Jenin	72.6	19.8	7.5
Tubas	96.0	4.0	0.0
Total	74.8	15.5	9.5

Financial aspects and affordability are significant issues for construction of onsite GWTPs in rural communities. 55.4% of the interviewers accepted construction of onsite GWTPs supported by external funding, 94.3% of the interviewers rejected the construction of onsite GWTPs on fully owner's contribution; this result indicated that financial issue was a main factor interferes with providing any new wastewater management. These results were in harmony with the findings of other research. A study by (Abu Madi et al., 2010) conducted in Western Ramallah towns and villages, the results showed that about 72 % of the surveyed households were willing to implement GWTPs with external funding while 17% would be willing to fund a GWS themselves. The major reason behind these findings was that most (80%) of the respondents did not show a willingness to pay or contribute to the construction costs.

43.9% rejected construction of onsite GWTPs supported by external funding, this according to the mentioned result which stated that, the majority of people (74.8%) preferred sewerage networks for wastewater management other than any methods, as well as 52.6% had no idea about grey water treatment systems.

4.4.6 Acceptance of construction GWTPs by external funding

Equation Developing for Acceptance of construction GWTPs by external funding:

1- For purpose of equation developing for acceptance of providing onsite GWTPs, the variables of Cesspit's owner's questionnaire were inserted using SPSS program in "Logistic Regression" using "Backward Stepwise (Conditional)", which reduce the variables of each step in regression to finally have the significant variables to build the equation, for more analysis refere to Annex 5 (Logistic Regression Analysis).

2- The following variables were found significant by using "Logistic Regression"

Table 4-6 Acceptance of construction GWTPs in rural areas

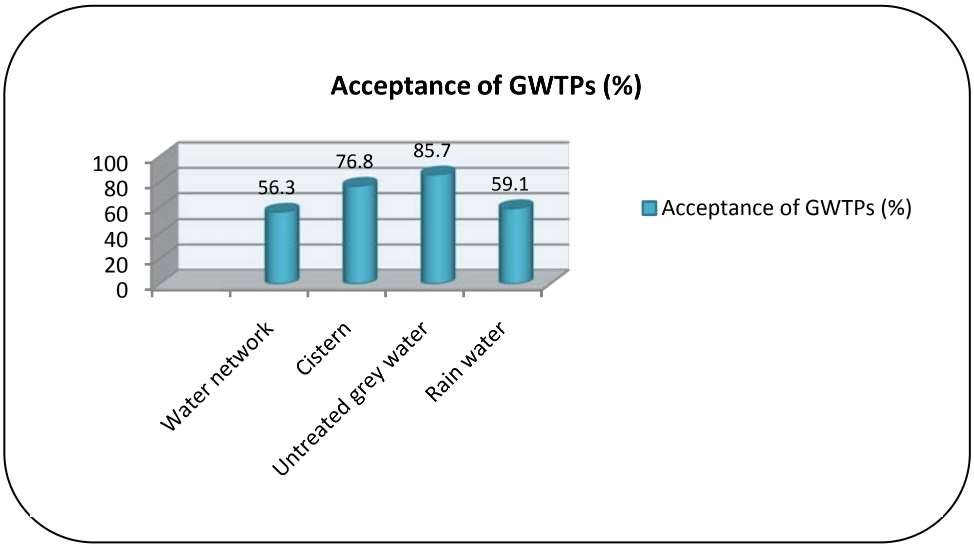
Independent value	**Acceptance of GWTPs Asymp. Sig. (2-sided) Value***
Water source for irrigation : untreated grey water	.025
Knowledge of grey water treatment systems	.009
Acceptance of separation inside housing system	.012
Preferred system of sanitation: Central wastewater network	.006
Garden availability	.025

**: Significant value, if Asymp. Sig. (2-sided) Value is less than or equal 0.05*

From Table (4-6) it's concluded the followings:

1- Source of water for irrigation: acceptance to have GWTPs was varied between people who depend on different source of irrigation, where high percent (85.7) goes for the farmers who utilized untreated grey water in irrigation, and water network is the least one as illustrated in Chart (4-6), this indicated that availability of water is major reason for acceptance of GWTPs.

Chart 4-6 Acceptances of GWTPs relative to water source of irrigation



2- Knowledge of grey water treatment systems: this variable is very important for acceptance of providing onsite GWTP in rural communities, it's indicated to the importance of people awareness of wastewater technologies and their involvement in waste water management.

3- Acceptance of separation of house piping system: 78.2% of people who accepted separation of inside house piping system accepted GWTPs, and only 13.2% of people who didn't accept inside home separation had no objection on providing GWTPs.

4- Preferred system for sanitation (Central waste water network): 51.8% of people who preferred centralized wastewater system accept GWTPs, while high percent of 85.7% of people who preferred onsite GWTPs accept GWTPs, and least percent 38.1% of people who preferred cesspits accepted providing onsite GWTPs.

5- Garden availability: 72.6% of people who had a home garden would be willing to replace cesspits with onsite GWTPs, however 34.6% of those who didn't have a home garden were not willing to replace their cesspits.

Table (4-7) demonstrates the significant variables that the acceptance of construction GWTPs depends on.

Table 4-7 Variables in the Equation

Variables in the Equation							
		B	S.E.	Wald	Df	Sig.	Exp(B)
	X1: Water source for irrigation is untreated grey water	1.423	.635	5.030	1	.025	4.151
	X2: Knowledge of grey water treatment systems	1.729	.659	6.889	1	.009	5.636
	X3: Acceptance of separation inside housing system	2.446	.972	6.326	1	.012	.087
	X4: Preferred system of sanitation is Central wastewater network	-1.735	.634	7.477	1	.006	.176
	X5: Garden availability	2.255	1.005	5.035	1	.025	.105
	Constant	5.012	2.455	4.167	1	.041	150.154

Where:

B: The coefficient for the constant (also called the "intercept") in the null model.

S.E.: The standard error around the coefficient for the constant.

Wald and Sig. - This is the Wald chi-square test that tests the null hypothesis that the constant equals 0. p-value (listed in the column called "Sig.")

df - This is the degrees of freedom for the Wald chi-square test. There is only one degree of freedom because there is only one predictor in the model, namely the constant.

Exp(B) - This is the exponentiation of the B coefficient, which is an odds ratio. This value is given by default because odds ratios can be easier to interpret than the coefficient, which is in log-odds units.

From Table (4-7) the equation is:

$Logit\ y = 5.012 + 1.423\, x_1 + 1.729 x_2 + 2.446 x_3 - 1.735 x_4 + 2.255\, x_5$

Logit Y: Logistic regression of acceptance of construction GWTPs by external funding

Discussion of the equation:

- The acceptance would be increase if there is available garden of 2.255
- The acceptance would be increase if there is an acceptance of separation of house piping system by 2.446
- The acceptance would be decrease if the preferred system for Wastewater management was central networks by -1.735
- The acceptance would be increase if the water source for irrigation is untreated grey water of 1.423

- The acceptance would be increase if the people have a knowledge of grey water treatment systems of 1.729

Separation black from grey water in existing houses could be a problem because of the possible need to destruct the tiles which causes extra cost and annoyance, as 35.5% consider it as a barrier for construction GWTPs. In the same context another research by (Abu Madi et al., 2010) found that unwilling to restructure their internal piping system was a reason for unwilling to implement onsite GWTPs. However, the results showed that 64.5% of the interviewers accepted separation of house internal piping system for the sake of construction onsite GWTPs. Since the majority accepts the separation inside house, it's concluded that separation of plumping systems was not a barrier for accepting the house onsite sanitation system.

Social aspects of the sanitation systems were important for the acceptance of onsite GWTPs as an unconventional wastewater management, especially in the planning phase and realizing the potential options of wastewater management in rural communities. Results showed that 71.1% of cesspit's owners accept utilizing treated grey water in irrigation without conditions; more over 80.4% have no problems of using treated grey water in irrigation.

As illustrated in Table (4-8), the acceptance of using treated grey water in irrigation is varied between rural communities in surveyed governorates, findings showed that Nablus, Tulkarem and Jenin with the highest percent (100, 93.3 and 87.0%) respectively, accept reuse treated grey water in agriculture. The least percept of acceptance (49%) is for Ramallah governorates, this is according to the nature of the area which is not an agricultural area.

Table 4-8 Acceptance of using treated grey water in irrigation per governorate

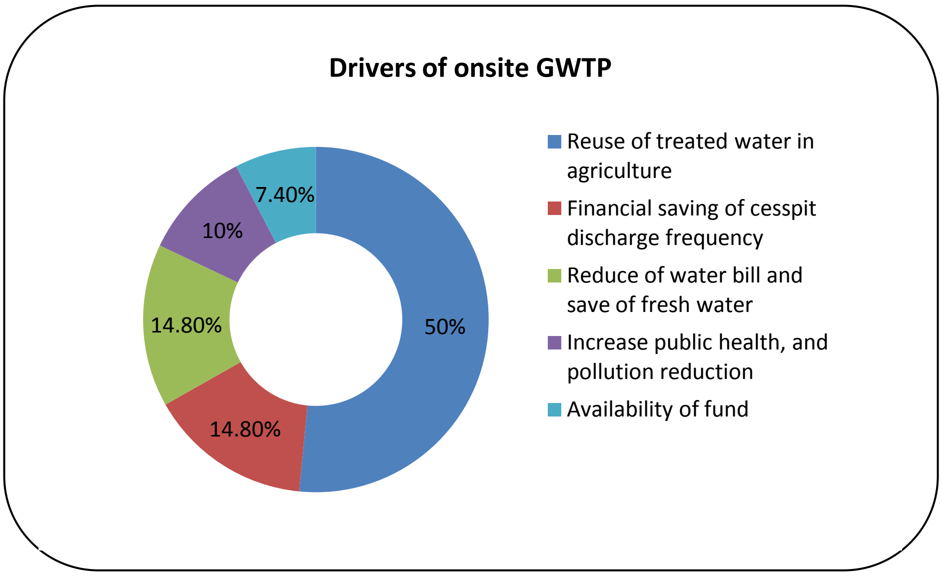
Governorate	**Acceptance of using treated grey water in irrigation**
Nablus	100.0%
Tulakarem	93.3%
Jenin	87.0%
Tubas	84.0%
Betlehem	81.3%
Jerusalem	68.4%
Hebron	67.9%
Ramallah	49.5%
Total	**71.1%**

4.4.7 Drivers and Barriers of onsite GWTPs

Drivers of GWTPs

As mentioned by 50% of the interviewers in Chart (4-7), the main drivers for acceptance of construction treatment plant is for purpose of reuse treated water in agriculture, followed by financial saving of cesspit discharge frequency, as well as for the purpose of reduction water bill and save fresh water for domestic use. With less percent some of them accept construction GWTPs to increase public health and reduce pollution, and finally only 7.4% mentioned availability of fund as a driver for providing GWTPs.

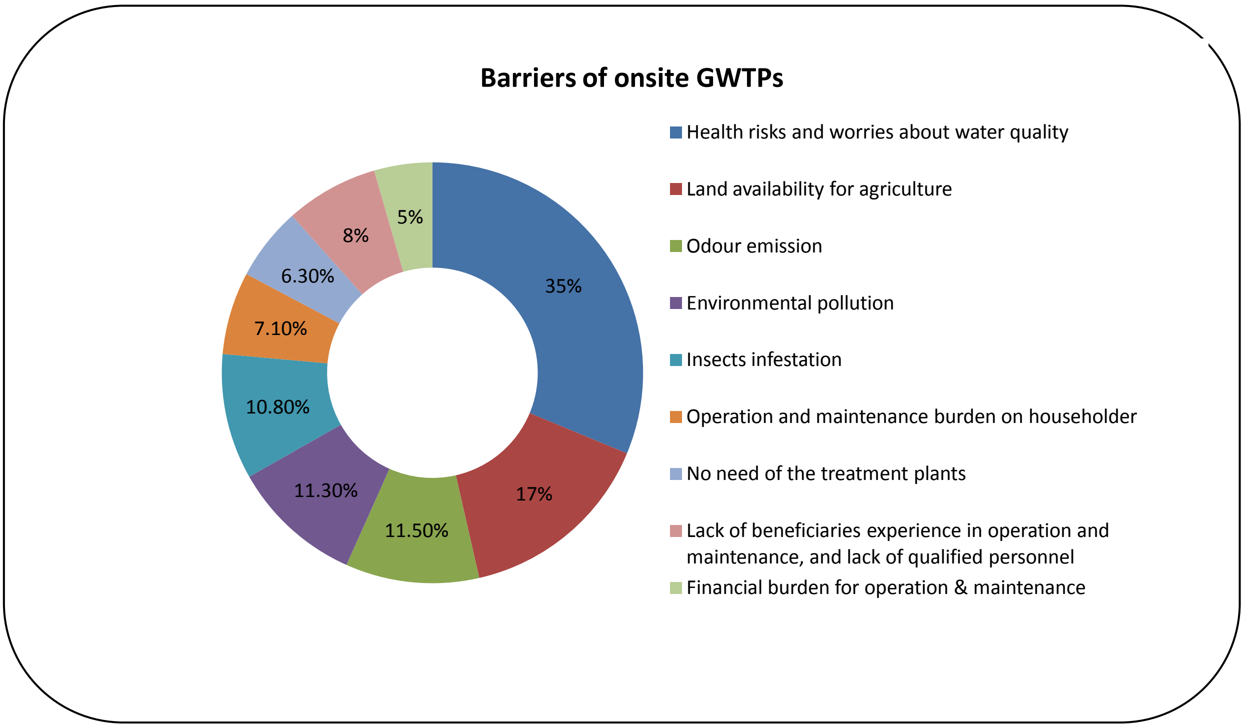
Chart 4-7 Drivers of onsite GWTPs for cesspit's owners



Barriers of Onsite GWTPs

The main barriers of construction treatment plant with the highest percent (35%) is the exposure for health risks and worries about water quality, this a significant percent where the people were not confident about treated water quality and its suitability for irrigation. Some of people mentioned other constrains such as, land availability for agriculture which is a vital component of GWTPs. With less percent the interviewers raised some constrains regarding GWTP's performance including odour emission, environmental pollution, insect's infestation. In addition to other barrier with less percent which mentioned in Chart (4-8).

Chart 4-8 Barriers of onsite GWTPs for cesspit's owners



4.4.8 Separation of House Internal Pipes

Separation of house internal pipe is the first step for acceptance construction of GWTPs; however some people didn't accept separation of in house piping system as mentioned in Table (4-9). 27% of the interviewers didn't accept separation because there is no available land for purpose of agriculture, with same percent people stated that there is no need for the treatment plant. Some of them stated the technical difficulty of internal plumping works especially inside house.

Table 4-9 Reasons for not acceptance of separation

Reasons for not accepting	Percent
Land availability for agriculture	27.3
Not convenience, no need for the treatment plant	27.2
Technical difficulty of separation	22.7
Health risks and worries about water quality	13.6
Cost of separation	4.5
Operation and maintenance burden on householder	4.5

4.4.9 Miscellaneous

In terms of acceptance construction of treatment units funding agency; 54.5% of cesspits owners who frequently empty the cesspits were willing to apply GWTPs by external funding, while 45.5% of cesspits owners who never empty the cesspit were not willing to have GWTPs. 71.2% of cesspits owners accepted using of treated grey water in irrigation; 92.7% of householders who use untreated grey water in irrigation accepted using of treated grey water without restrictions, followed by 74.4% of cesspit's owners who depend on cistern accept using of treated grey water in irrigation, while 57.1% of them who depend on water network for irrigation accepted using of treated grey water. The mentioned findings showed that water shortage is a main driver for construction, since the vast majority of those who used untreated grey water were willing to use treated grey water in irrigation. On other side, people who had a continuous source of water (water network) for irrigation, less percent were willing to reuse treated grey water in irrigation.

4.5 Comparison of Cesspits for Total Wastewater and Cesspits for Black Wastewater

People in rural communities were not satisfied of utilizing cesspits as a main tool for sanitation management systems, where only 50% of the cesspits owners were satisfied of the applied sanitation system before construction of onsite GWTPs. However, this percent increase to 80.8% after providing onsite GWTPs, this reveals that people are now satisfied because reduction of significant amount of wastewater discharge to the cesspit, consequently less frequency of emptying the cesspit and saving the opportunity cost of emptying. 60.2% of interviewers pay 14–30 US$ each time of cesspit emptying, this make additional financial and social burden on the people to sustain these disposal management. The results showed that the average number for emptying of cesspit per year before construction of onsite GWTPs was 6.9, more over 6.7% of cesspits owners discharge the cesspits 24 times per year, while this number decreased to 4.1 after providing onsite GWTPs, means that the emptying of the cesspit reduce by 40.5%.

Most people in rural communities were willing to have onsite GWTPs, but the majority were not affordable to have such systems, as 94.3% of the interviewers were not capable to have GWTPs on fully owner's contribution, as well as 55.4% of the interviewers accepted construction of onsite GWTPs supported by external funding.

4.6 Success and Failure Lessons

During preparation of this research and throughout field survey and site visits for onsite GWTPs, the success and treatment efficiency of these units were varied from one household to another. The success and failure of onsite GWTPs refer to many aspects and household practices as discussed below.

Success Lessons

- Water shortage is a main driver for success of onsite GWTPs, where the beneficiaries finally found a solution for water scarcity and utilizing of untreated grey water in irrigation,
- Farmers with a long experience in agriculture were more capable of managing the grey water systems than others, and the treatment units were well functioning,

- Success of onsite GWTPs was obvious for families who were frequently used to discharge their cesspits before providing GWTPs.

Failure Lessons

- Failure of treatment units happened as a result of inappropriate operation and maintenance, in addition for lacking of system understanding from beneficiaries' side,
- Some times failure occurred as a result of lacking technical support from the side of the implementing agency,
- The failure happened as a result of improper construction of GWTPs and seepage of grey water throughout unit faults into surrounded area,
- Failure also occurred because of lack of reuse schemes and agricultural plans, as well as some beneficiaries had a limited experience in agricultural practices.

Chapter Five

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Drivers of applying GWTPs: Reuse of treated grey water in irrigation was the main incentive for applying GWTPs as stated by 88.0%, reduction of cesspit discharge frequency and its financial consequences as stated by 71.3%, 35.3% of them mentioned water shortage, reduction of potential risk on ground water pollution, then comes reduction of water bill and enhances hygienic status. Availability of fund was an important driver for construction of GWTPs as stated by 70.7%. Islamic religion considered as driver; the majority of people (70%) accept reuse of treated grey water in irrigation. Women play a major role in GWTPs management since they are more involved on household water and sanitation management; 68.9% of the treatment systems are running by men side by side with women (fathers and mothers), and 24% is running completely by women. The aesthetic impact of the system is very positive; as mentioned by 74.9% of beneficiaries. The majority of GWTP's beneficiaries (70.4%) are satisfied. Little efforts are required for operation and maintenance, with only an average 0.4 working hour per week.

Barriers of applying onsite GWTPs: The first barrier as mentioned by 66.5% is odour emission and insect's infestation. 59.3% stated that the systems lack follow up and monitoring from implementing agency side. The system failures were also caused by inadequate beneficiaries' experience in operation and maintenance, lack of system understanding as stated by 34.1% of beneficiaries. Health concerns and doubt of the crop quality irrigated by treated grey water was another barrier raised by beneficiaries.

From "Logistic Regression Analysis" the following variables were considered significant for acceptance of onsite GWTPs, garden availability, when water source for irrigation is untreated grey water, preference system of sanitation is central wastewater network, acceptance of separation of house piping system and knowledge of sanitation systems.

Satisfaction of applying cesspits: For the People who still depend on cesspits, most of them were not satisfied of applying cesspits. 75.7 % of interviewed people complained from high disturbance during discharge of the cesspits. The results show that the average number for emptying the cesspit per year before construction of onsite GWTP is 6.9, where the people pay 6% out of their monthly income on cesspit's emptying, more over 6.7% of cesspits owners discharge the cesspits 24 times per year, while the frequency of cesspits' emptying decreased to 4.1 after providing onsite GWTPs. In terms of financial aspects, 55.4% of the interviewers accept construction of onsite GWTPs supported by external funding. It's worth mentioning that the majority of people (74.8%) prefer sewerage networks for wastewater management, 15.5% of people prefer onsite GWTPs, and 9.5% prefer cesspits.

Acceptance of utilizing treated grey water in irrigation: For the people who still depend on cesspits, 71.2% of cesspits owners accept utilizing of treated grey water in irrigation. 92.7% of householders who use untreated grey water in irrigation accept utilizing treated grey water without restrictions, followed by 74.4% of cesspit's owners who depends on cistern, and 57.1% of people who depends on water network in irrigation. It's concluded that water shortage is a main driver for construction GWTPs.

Success and failure lessons: water shortage is a main driver for providing onsite grey water system, as well as farmers with long experience in agriculture is more capable of manage the grey water system and reuse schemes than others. Failure of GWTPS happened as a result of inappropriate operation and maintenance and lack of system understanding, as well as lack of technical support from the implementing agency. Sometimes failure happened as a result of improper utilizing of treated water and seepage of water into surrounded area, lack of reuse schemes and agricultural plans, and finally beneficiaries limited experience in agricultural practices.

House onsite grey water management systems is acceptable in rural communities, therefore, a more proper system is required to handle the wastewater and replace cesspits and its harmful implications on environment, ground water and public health.

5.2 Recommendations

There is a significant concern on the treated effluent quality, therefore, the effluent quality compliance with local effluent disposal requirements should be assessed, and further technical improvements are still needed to enhance the system performance and to solve the problems such as odour emission. For the people who still depend on cesspits, they are un-satisfied, a more proper system is required to handle the wastewater and replace cesspits and its implications on environment, ground water, financial aspects and public health.

In addition to the following specific recommendations

- There is an essential need to improve the performance of the treatment plants and to raise up the treatment efficiency, and to introduce well-operated wastewater treatment facilities.
- Ensure treated water quality to comply with applied local and international standards and its suitability for reuse purposes,
- At the policy level, the government should encourage and be more aware for potential applying of onsite GWTPs in rural communities, so the government should be more involved in wastewater management in rural areas to replace cesspits.
- The government should encourage the use of non-conventional water resources in agriculture especially treated grey water.
- Implementing agency should make regular monitoring and maintenance of the onsite GWTPs, especially after the end of implementation and consider this phase as a part of the project implementation,
- Implementation of GWTPs should be applied according to social and technical feasibility studies, and involvement of people in the planning and implementation process to ensure understanding of the whole system,
- GWTPs beneficiaries require needed training of operation and maintenance on the system management to maintain sustainability and to handle system successfully,
- Development of public awareness programs, to better understanding and improve public knowledge of wastewater systems and perception toward reuse schemes, in parallel with field visits of local people to other wastewater treatment and reuse for sharing knowledge and ideas.
- A more proper system is required to handle the wastewater and replace cesspits and its implications on environment, ground water and health in rural communities.

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APPENDIX 1

Cesspits Questionnaire

استبيان خاص بأصحاب الحفر الامتصاصية

1 - معلومات الاستمارة		
1.1	اسم الباحث	
1.2	رقم الاستمارة	☐☐☐
1.3	تاريخ تعبئة الاستمارة	/ /

2 - معلومات عامة عن الأسرة			
الرقم	**السؤال**	**الإجابة**	**هذا العمود خاص بأعمال التحليل وليس للتعبئة**
2.1	اسم المحافظة		☐☐
2.2	اسم القرية		
2.3	كم عدد افراد الأسرة؟		☐☐
2.4	مهنة رب الأسرة		☐☐
2.5	معدل دخل الأسرة (شيكل/شهر)		☐☐☐☐
2.6	ما مقدار فاتورة المياه الحالية؟ (شيكل/شهر)		☐☐☐☐
2.7	كم يبلغ سعر المتر المكعب من المياه؟		☐☐

3 - معلومات حول الحفرة الامتصاصية المستخدمة في المنزل:			
3.1	في أي سنة تم إنشاء الحفرة الامتصاصية؟	....	☐☐☐☐
3.2	ما هو نوع الحفرة الامتصاصية؟	1 - حفرة منفذة. 2 - حفرة مصمتة (غير منفذة). 3 - غير ذلك/ حدد..................	☐
3.3	ما هي أبعاد الحفرة الامتصاصية بالأمتار؟	1 - الطول: .... 2 - العرض: .... 3 - العمق:	☐☐☐
3.4	كيف كانت الطبيعة الجيولوجية للحفرة عند حفرها؟	1 - 100% صخر+ 0% تربة 2 - 75 % صخر + 25% تربة 3 - 50 % صخر + 50% تربة 4 - 25 % صخر + 75% تربة 5 - 0 % صخر + 100% تربة	☐
3.5	أين تم استخدام الخرسانة (الباطون) خلال إنشاء الحفرة الامتصاصية؟	1 - في إنشاء غطاء الحفرة الامتصاصية. 2 - في صب جوانب الحفرة. 3 - في صب قاع الحفرة.	☐ ☐ ☐
3.6	ما هي تكلفة إنشاء الحفرة الامتصاصية؟ (بالشيكل)	....	☐☐☐☐☐

3.7	هل يتم نضح الحفرة الامتصاصية؟	1 - نعم 2 - لا	☐
إذا كان جواب 3.7 نعم أجب 3.8-3.14			
3.8	في أي سنة بدأت عمليات النضح	....	☐☐☐☐
3.9	كم مرة يتم نضح الحفرة الامتصاصية خلال السنة في الفترة الحالية؟	....	☐☐
3.10	ما هي تكلفة نضح الحفرة الامتصاصية في كل مرة يتم نضحها؟ (بالشيكل)	....	☐☐☐
3.11	ما مدى انزعاج الأسرة من عملية نضح الحفرة الإمتصاصية؟	1 - كبير 2- متوسط 3- قليل 4 - لا تنزعج	☐☐
3.12	ما هو مستوى الصوت الذي ينتج ضمن محيط المنزل من عملية نضح الحفرة الإمتصاصية؟	1 - صوت لا يذكر 2- صوت مقبول 3- صوت عالي –غير مقبول	☐☐
3.13	ما مدى انزعاج الجيران من عملية نضح الحفرة الامتصاصية؟	1 - كبير 2- متوسط 3- قليل 2 - لا تنزعج	☐☐
3.14	هل لديك مشاكل مع الجيران بسبب عملية نضح الحفرة الامتصاصية؟	1 - نعم 2- لا	☐
3.15	هل يتم التخلص من محتوى الحفرة الامتصاصية بطريقة أخرى غير النضح؟	1 - نعم 2 - لا	☐
3.16	إذا كان جواب 13.15نعم، فما هي هذه الطريقة؟	....	
3.17	ما هو المبلغ الذي تستعد لدفعه من أجل التخلص من الحفرة الامتصاصية وايجاد بديل لها؟ (بالشيكل/شهر)		☐☐☐☐☐

4 - معلومات عن الحديقة المنزلية والرضى عن نظام الصرف الصحي:			
4.1	هل تتوفر حديقة منزلية (أرض زراعية)؟	1 - نعم 2- لا	☐
4.2	ما هي مساحة الحديقة المنزلية؟ ($م^2$)		☐☐☐☐
4.3	هل يوجد بئر لجمع مياه الأمطار محاذي للمنزل؟	1 - نعم 2- لا	☐
4.4	ما هي مادة إنشاء البئر؟	1 - باطون 2 - صخر 3 - مختلط	☐
4.5	كم تبعد الحفرة الامتصاصية عن البئر؟ (م)		
4.6	ما هي المزروعات المتوفرة في الحديقة؟ *سجل داخل المربع أي الاجابات التالية:*	1. أشجار مثمره 2. خضروات 3. أشجار حرجيه 4. ورود وازهار 5.اخرى..	☐ ☐ ☐ ☐ ☐

4.7	ما هو مصدر ري المزروعات في الحديقة؟	1 - شبكة المياه. 2 - البئر. 3 - المياه الرمادية غير المعالجة. (مياه الغسيل والجلي) 4 - لا تحتاج مياه	☐
4.8	هل كمية المياه المتوفرة لري المزروعات كافية؟	1 - نعم 2- لا	☐
4.9	ما هي وسيلة الري المستخدمة؟	1 - أنابيب تنقيط 2 - طرق أخرى/ حدد.............	☐
4.10	ما مدى رضاك عن نظام الصرف الصحي الحالي؟	1 - راضي جداً 2 - راضي 3 - غير راضي	☐
4.11	في حال عدم الرضى. ما هو سبب عدم الرضى؟		
4.12	هل تعرف عن أنظمة معالجة المياه العادمة الرمادية؟	1 - نعم 2- لا	☐
4.13	هل تقبل بانشاء محطة معالجة للمياه العادمة الرمادية على نفقتك الخاصة ؟	1 - نعم 2- لا	☐
4.14	هل تقبل بانشاء محطة معالجة بتمويل من جهات مانحة؟	1 - نعم 2- لا	☐
4.15	أي الأنظمة تفضل في التخلص من المياه العادمة؟	1 - شبكة صرف صحي. 2 - محطة معالجة للمياه العادمة الرمادية. 3 - حفرة امتصاصية.	☐
4.16	هل تقبل بفصل خطوط المياه الداخلية في المنزل كشرط لفصل المياه الرمادية لانشاء محطة المعالجة ؟	1 - نعم 2- لا	☐
4.17	إذا كانت الإجابة لا. ما هي الأسباب وراء ذلك؟		
4.18	ما هي المحفزات لانشاء محطة لمعالجة المياه العادمة الرمادية؟		
4.19	ما هي التخوفات المستقبلية لانشاء محطات لمعالجة المياه العادمة الرمادية؟		
4.20	هل تقبل باعادة استخدام المياه المعالجة الرمادية في ري المزروعات في الحديقة المنزلية؟	1 - نعم 2- لا	☐
4.21	اذا كانت الاجابة لا، ما هي أسباب عدم قبولك لإنشاء محطات معالجة المياه الرمادية؟		
4.22	هل تخجل من الناس بسبب إعادة استخدام المياه المعالجة الرمادية في المنزل؟	1 - نعم 2- لا	☐

5 معلومات المبحوث		
5.1	اسم المبحوث	
5.2	رقم الهاتف	

APPENDIX 2

Onsite GWTPs Questionnaire

استمارة لجمع بيانات المستفيدين من محطات المعالجة

1 - معلومات الاستمارة		
1.1	اسم الباحث	
1.2	رقم الاستمارة	☐☐☐
1.3	تاريخ تعبئة الاستمارة	/ /

2 - معلومات عامة عن الأسرة المستفيدة من وحدة المعالجة			
2.1	عمر المبحوث بالسنوات		
2.2	الجنس	1 - ذكر 2- أنثى	☐
2.3	المحافظة		☐☐
2.4	اسم البلدة		
2.5	عدد الأسر التي تخدمها المحطة		☐
2.6	عدد أفراد الأسرة المقيمين في المنزل والمخدومين بوحدة المعالجة		☐☐
2.7	عدد الأطفال المستفيدين من المحطة		☐☐
2.8	مهنة رب الأسرة		☐☐
2.9	معدل دخل الأسرة (شيكل/شهر)		☐☐☐☐

3 - معلومات عامة عن وحدة المعالجة			
3.1	نوع النظام المستخدم	1 - معالجة المياه الرمادية 2 - معالجة المياه العادمة (رمادية+سوداء)	☐
3.2	تاريخ إنشاء وحدة المعالجة		☐☐☐☐
3.3	الجهة المنفذة		☐☐
3.4	الممول		☐☐

4 - مراقبة نظام المعالجة:			
4.1	هل تقوم الجهة المنفذة بزيارتكم للتأكد من عدم وجود مشاكل في المحطة؟	1 - نعم بشكل مستمر. 2 - فقط في الفترة الأولى من تركيب المحطة. 3 - لا.	☐
4.2	هل تقوم الجهة المنفذة بأخذ عينات للتأكد من فاعلية المحطة؟	1 - نعم بشكل مستمر. 2 - فقط في الفترة الأولى من تركيب المحطة. 3 - لا.	☐
4.3	هل أنت راض عن أداء الجهة المنفذة؟	1 - نعم. 2- لا	☐

5 - الرضى عن نظام الصرف الصحي			
5.1	ما هو السبب الرئيسي لقبول إنشاء محطة المعالجة؟	1 - نقص المياه. 2 - لأنها ممولة من جهات مانحة. 3 - توفير تكلفة نضح حفرة الامتصاص. 4 - إعادة استخدام المياه المعالجة في الزراعة. 5 - التوفير في فاتورة مياه الشرب. 6 - غير ذلك/ حدد................	☐
5.2	ما هو الخطأ الذي قامت به الجهة المنفذة عند تنفيذها محطة المعالجة؟		
5.3	ما مدى رضاك عن محطة المعالجة؟	1 - راض جداً. 2 - راض. 3 - غير راض.	☐
5.4	في حال عدم الرضى، ما هو سبب عدم الرضى؟		
5.5	هل يوجد بئر لجمع مياه الأمطار؟	2 - نعم 2- لا	☐
5.6	هل كنت تعاني من نقص في كمية المياه قبل انشاء المحطة؟	3 - نعم 2- لا	☐
5.7	هل ساهمت المحطة في حل مشكلة نقص المياه؟	1 - نعم 2- جزئيا 3- لا	☐
5.8	هل تتوفر حديقة منزلية (أرض زراعية)؟	2 - نعم 2- لا	☐
5.9	ما هي مساحة الحديقة المنزلية؟ ($م^2$)		☐☐☐☐
5.10	مساحة الأرض المزروعة قبل وجود وحدة المعالجة ($م^2$)		☐☐☐☐
5.11	هل كنت تستخدم المياه المزودة من الشبكة في ري المزروعات والاشجار قبل وجود وحدة المعالجة؟	1 - نعم 2 - لا 3- احيانا	☐
5.12	مساحة الأرض المزروعة بعد انشاء المحطة ($م^2$)		☐☐☐☐
5.13	نوع الزراعة المستخدم بعد انشاء المحطة والتي يتم ريها من المياه المعالجة؟	1 - بيت بلاستيكي 2- زراعة مفتوحة 2 - اشجار مثمرة	☐
5.14	نوع الري المستخدم في الزراعة	1 - انابيب تنقيط 2- انابيب مغلقة	☐
5.15	هل تستخدم المياه المزودة من الشبكة في ري المزروعات والاشجار بعد انشاء المحطة؟	1 - نعم 2 - أحياناً 3 - لا	☐
5.16	اذا كانت اجابة 5.15 نعم/ احيانا الرجاء اجابة السؤال التالي:متى تستخدم مياه الشبكة عند ري الاشجار والمزروعات بالاضافة الى المياه المعالجة؟	1 - عند بداية الموسم 2 - عند انتاج الثمر 3 - كل فترة معينة حددها	☐
5.17	ما هي المزروعات التي يتم ريها بالمياه المعالجة؟ 1 - نعم 2 - لا	1 - أشجار مثمرة.	
		2 - خضراوات.	
		3 - نبات زينة.	
		4 - أعلاف.	
		5 - غير ذلك/ حدد.	
5.18	كيف تتصرف بمنتوج الحديقة؟ حدد النسبة (%)	1 - استهلاك ذاتي..............%	
		2 - هدايا........................%	
		3 - تسويق......................%	

5.19	ما مدى ثقتك بنوعية المياه المعالجة وصحة المنتج؟	1 - واثق. 2 - متشكك. 3 - غير واثق.	☐
5.20	اذا كنت تبيع المنتج الزراعي هل تخوفت من حافز البيع او التسويق؟	1 - نعم 2- لا	☐
5.21	اذا كانت الاجابة نعم، ما هي النواحي التي تخوفت منها؟		
5.22	هل تتقبل اعادة استخدام المياه المعالجة من ناحية دينية؟	1 - نعم. 2- لا	☐
5.23	هل تخجل من الناس بسبب استخدام المياه المعالجة في المنزل؟	1 - نعم. 2- لا	☐
5.24	لأصحاب نظام معالجة المياه الرمادية، ما هو النظام المستخدم للتخلص من المياه السوداء؟	1 - حفرة امتصاصية. 2 - نظام خاص. (modified cesspit) 3 - غير ذلك/ حدد.	☐
5.25	ما مدى رضاك عن نظام المياه السوداء؟	1 - راض جداً. 2 - راض. 3 - غير راض	☐
5.26	في حال عدم الرضى، ما هو سبب عدم الرضى؟		

6 - تكلفة إنشاء وحدة المعالجة:			
6.1	تكلفة إنشاء المحطة (شيكل)		☐☐☐☐☐
6.2	مقدار المساهمة المالية من قبل المستفيد		☐☐☐☐☐
6.3	تفاصيل المساهمة المالية		☐☐
إذا كان النظام المستخدم هو لمعالجة المياه الرمادية. أجب 6.4، 6.5			
6.4	هل كان نظام جمع المياه الرمادية مفصول عن المياه السوداء في التمديدات الداخلية للمنزل قبل وجود وحدة المعالجة؟	1 - نعم 2 - لا	
6.5	ما هي تكلفة فصل نظام الجمع (شيكل)؟		
6.6	هل كنت قد استخدمت نظام الري بالتنقيط قبل وجود وحدة المعالجة؟	1 - نعم 2- لا	☐
6.7	ما هي تكلفة نظام الري؟		☐☐☐
6.8	ما هو طول برابيج التنقيط (م)؟		☐☐☐
6.9	كل كم سنة تحتاج برابيج التنقيط إلى تبديل؟		☐☐
6.10	ما هي مساحة الأرض التي تشغلها المحطة؟ (م2)		
6.11	ما هو سعر الأرض في المنطقة لكل م2؟		
6.12	هل المحطة موجودة فوق الأرض أم تحتها؟	1 - فوق الأرض 2 - تحت الأرض	

7 - التكلفة التشغيلية لمحطة المعالجة:			
7.1	من المسؤول عن إدارة وتشغيل المحطة؟	1 - الأب. 2 - الأم. 3 - الابن. 4 - غير ذلك/ حدد	☐
7.2	عمر المسؤول عن إدارة المحطة؟		☐☐

7.3	الدرجة العلمية للمسؤول عن المحطة؟	1 - توجيهي أو أقل. 2 - درجة جامعية. 3 - ماجستير أو أعلى.				□
7.4	الأعمال التي يتم القيام بها من قبل أصحاب البيت لتشغيل وصيانة وتنظيف المحطة؟	حدد التفاصيل	ساعات العمل اللازمة	الفترة الزمنية التي يتكرر خلالها العمل؟		ساعات العمل السنوية
					المجموع:	□□□
7.5	الأعطال التي تم اصلاحها والمواد والقطع التي تم تبديلها في وحدة المعالجة؟	حدد التفاصيل	كم مرة تم التبديل؟	الفترة الزمنية التي تم خلالها التبديل؟	التكلفة في كل مرة (شيكل)	التكلفة السنوية
					المجموع:	□□□
7.6	مقدار الطاقة التي تستهلكها وحدة المعالجة من خلال ازدياد فاتورة الكهرباء؟	فاتورة الكهرباء الحالية (شيكل/شهر)				
		فاتورة الكهرباء قبل وجود وحدة المعالجة (شيكل/شهر)				
		مقدار الازدياد في فاتورة الكهرباء (شيكل/شهر)				□□□
7.7	مقدار الطاقة التي تستهلكها وحدة المعالجة من خلال حساب ساعات عمل الماطور؟ (شيكل/شهر)	ما هي ساعات عمل الماطور اليومية؟				
		تكلفة الكهرباء لكل ساعة؟				
		التكلفة الشهرية للكهرباء؟				□□□

8 - المياه العادمة كمصدر للمياه والسماد:			
8.1	فاتورة المياه الحالية (شيكل/شهر)		□□□
8.2	فاتورة المياه قبل وجود وحدة المعالجة (شيكل/شهر)		□□□
8.3	سعر المتر المكعب من المياه (شيكل)		□□□
8.4	كمية المياه المعالجة (م3/يوم)		
8.5	حجم تخزين المياه المعالج:		
8.6	ما هي الفترة التي يمتلئ خلالها الخزان:		
8.7	تكلفة استخدام الأسمدة قبل وجود وحدة المعالجة (شيكل/سنة)		□□□□
8.7	تكلفة استخدام الأسمدة بعد وجود وحدة المعالجة (شيكل/سنة)		□□□□

9 - تأثير وحدة المعالجة على الأمن الغذائي			
إذا كانت المياه المعالجة تستخدم لري الأشجار المثمرة أجب من 9.1 – 9.8			
9.1	عدد الأشجار قبل وجود وحدة المعالجة		□□□
9.2	عدد الأشجار بعد وجود وحدة المعالجة		□□□
9.3	ما هي نسبة الأشجار التي يتم ريها بالمياه المعالجة (%)؟		□□
9.4	ما هي نسبة الإعتماد على المياه المعالجة في الري (%)؟		□□
9.5	معدل عمر الأشجار؟ (سنة)		□□
9.6	ما مدى تحسن حالة الأشجار بعد ريها بالمياه المعالجة من حيث ازدياد خضرتها ونموها؟	1 - تحسن بشكل كبير 2 - تحسن متوسط 3 - تحسن بسيط 4 - لم تتأثر	□□
9.7	ما مدى تحسن حال الأشجار بعد ريها بالمياه المعالجة من حيث انتاج الثمار؟	1 - زاد انتاج الثمر بشكل كبير 2 - ازدياد قليل 3 - لم يتأثر 4 - قل انتاج الثمر	□□
9.8	ما مقدار الازدياد في انتاج الثمار بعد استخدام وحدة المعالجة؟ (كغم/سنة)		□□□□

إذا كانت المياه المعالجة تستخدم لري الخضراوات أجب من 9.9 – 9.13			
9.9	مساحة الأرض المزروعة بالخضراوات قبل وجود وحدة المعالجة (م2)		□□□
9.10	مساحة الأرض المزروعة بالخضراوات بعد وجود وحدة المعالجة (م2)		□□□□
9.11	ما هي نسبة الإعتماد على المياه المعالجة في الري (%)؟		□□□
9.12	ما هي جودة وحالة الأشتال وهي تروى بالمياه المعالجة؟؟	1 - جيدة 2 - مقبولة (عادية) 3 - سيئة	□□
9.13	ما مقدار انتاج الخضراوات؟ (كغم/سنة)		□□□□
إذا كانت المياه المعالجة تستخدم لري نبات الزينة أجب من 9.14 – 9.17			
9.14	مساحة الأرض المزروعة بنبات الزينة قبل وجود وحدة المعالجة ($م^2$)		□□□
9.15	مساحة الأرض المزروعة بنبات الزينة بعد وجود وحدة المعالجة ($م^2$)		□□□
9.16	ما هي نسبة الإعتماد على المياه المعالجة في الري (%)؟		□□□
9.17	ما هي جودة وحالة النباتات وهي تروى بالمياه المعالجة؟	1 - جيدة 2 - مقبولة (عادية) 3 - سيئة	□□

10 -لقيمة الجمالية لوحدة المعالجة:			
10.1	هل يصدر روائح كريهة من نظام الصرف الصحي؟	1 - غالباً 2 - أحياناً 3 - نادراً 4 - لا	□
10.2	ما هي شدة هذه الروائح؟	1 - قوية 2 - متوسطة	□

		3 - خفيفة	
10.3	ما هو المبلغ الذي يمكن أن تدفعه للتخلص من هذه الروائح؟ (شيكل/شهر)		
10.4	هل تصدر المحطة أصوات حول المنزل؟	1 - غالباً 2 - أحياناً 3 - نادراً 4 - لا	
10.5	ما مدى الانزعاج من هذه الأصوات عند صدورها؟	1 - صوت عالي مزعج. 2 - صوت متوسط مقبول. 3 - صوت منخفض لا يذكر.	
10.6	ما هو المبلغ الذي يمكن أن تدفعه للتخلص من هذا الصوت؟ (شيكل/شهر)		
10.7	كيف أثر نظام الصرف الصحي على انتشار الحشرات حول المنزل؟	1 - انتشار كبير وبشكل ملحوظ. 2 - انتشار قليل ومقبول. 3 - لا يوجد تأثير.	
10.8	ما هو المبلغ الذي يمكن أن تدفعه للتخلص من هذه الحشرات؟(شيكل/شهر)		
10.9	كيف أثرتركيب وحدة المعالجة على المنظر العام للبيت والحديقة المنزلية؟	1 - تأثيرجيد. 2 - لم يؤثر (مقبول). 3 - تأثير سيء.	
10.10	ما هو المبلغ الذي يمكن أن تدفعه للحصول أو للتخلص من مثل هذا المنظر؟ (شيكل)		
10.11	هل لديك مشاكل مع الجيران بسبب المحطة؟	1 - نعم. 2 - لا	
10.12	هل تنصح بتطبيق نظام الصرف الصحي لبيوت أخرى في الحي؟	1 - نعم أنصح. 2 - أنصح ولكن بإجراء تعديلات. 3 - لا أنصح بالمطلق. 4 - لا أعرف.	

11 -تأثير المحطة على الوضع الصحي في المنزل:			
11.1	هل تتعرض الأسرة لملامسة مباشرة للمياه العادمة؟	1 - كثيراً. 2 - أحياناً. 3 - نادراً. 4 - لا تتعرض مطلقاً.	
11.2	برأيك، هل يخفف نظام الصرف الصحي من الإصابة بالأمراض نتيجة التقليل من التلوث؟	1 - نعم. 2 - لا. 3 - لا أعرف.	
11.3	ما هي احتماليه أن يتعرض سكان المنزل إلى أذى فيزيائي (جروح ,كسور) نتيجة إمكانية وصولهم إلى معدات نظام الصرف الصحي؟	1 - محتمل جداً. 2 - محتمل/ نادر. 3 - غير محتمل مطلقاً. 4 - لا أعرف.	
11.4	هل لاحظت انتشار أي مرض وبائي بعد تركيب وحدة المعالجة في منزلك؟	1 - نعم 2 - لا	
إذا كان جواب 11.4 نعم، أجب 11.5- 11.8			
11.5	ما هو نوع المرض؟		
11.6	عدد مرات الإصابة (سنة)		
11.7	تكلفة علاج المرض في كل مرة (شيكل)		
11.8	فترة المثول للعلاج (يوم)		

12 -متفرقات			
12.1	ما هي الفوائد التي جنيتها من محطة المعالجة المستخدمة؟ 1 - أوافق. 2 - لا أوافق.	3 - توفير تكلفة نضح حفرة الامتصاص	
		4 - إعادة استخدام المياه المعالجة في الزراعة	
		5 - توفير في فاتورة مياه الشرب	
		6 - رفع المستوى الصحي	
		7 - فرصة عمل جديدة	
		8 - غير ذلك/حدد.........	
12.2	ما هي سلبيات نظام الصرف الصحي الذي تستخدمه؟ 1 - أوافق. 2 - لا أوافق.	1 - عدم الثقة بجودة المياه وصحة المنتج	
		2 - عبئ مادي عند الصيانة والعطل	
		3 - الحشرات والرائحة	
		4 - سيلان المحطة	
		5 - صيانة المحطة وتشغيلها	
		6 - عدم المتابعة من المنفذ	
		7 - نقص خبرة المستفيد في التشغيل والصيانة	
		8 - غير ذلك/ حدد...........................	☐
12.3	لو طلب منك إنشاء المحطة على نفقتك الخاصة فهل ستقوم بذلك؟	1 - نعم. 2 - لا.	☐
12.4	ما هي المقترحات لتحسين المحطة؟		
12.5	إذا كان بالإمكان تزويد الحي بشبكة صرف صحي مركزية، فهل ستستغني عن محطة المعالجة؟	1 - نعم. 2 - لا.	☐
12.6	هل هناك أي ملاحظات أخرى ذات علاقة بنظام الصرف الصحي تود ذكرها؟		
12.7	التوصيات		

13 -معلومات حول الحفرة الامتصاصية المستخدمة في المنزل:			
13.1	في أي سنة تم إنشاء الحفرة الامتصاصية؟	....	☐☐☐☐
13.2	ما هو نوع الحفرة الامتصاصية؟	4 - حفرة منفذة. 5 - حفرة مصمتة (غير منفذة). 6 - غير ذلك/ حدد..................	☐
13.3	ما هي أبعاد الحفرة الامتصاصية بالأمتار؟	4 - الطول: .... 5 - العرض: .... 6 - العمق:	☐☐☐
13.4	كيف كانت الطبيعة الجيولوجية للحفرة عند حفرها؟	6 - 100% صخر + 0% تربة 7 - 75 % صخر + 25% تربة 8 - 50 % صخر + 50% تربة 9 - 25 % صخر + 75% تربة 10 -0 % صخر + 100% تربة	☐
13.5	أين تم استخدام الخرسانة (الباطون) خلال إنشاء الحفرة الامتصاصية؟	5 - في إنشاء غطاء الحفرة الامتصاصية. 6 - في صب جوانب الحفرة. 7 - في صب قاع الحفرة.	☐ ☐ ☐
13.6	ما هي تكلفة إنشاء الحفرة الامتصاصية؟ (بالشيكل)	....	☐☐☐☐☐
13.7	هل يتم نضح الحفرة الامتصاصية؟	3 - نعم. 4 - لا.	☐

إذا كان جواب 13.7 نعم أجب 13.8- 13.10			
13.8	في أي سنة بدأت عمليات النضح	....	☐☐☐☐
13.9	كم مرة كان يتم نضح الحفرة الامتصاصية خلال السنة قبل وجود وحدة المعالجة؟	....	☐☐
13.10	كم مرة يتم نضح الحفرة الامتصاصية خلال السنة في الفترة الحالية؟	....	☐☐
13.11	ما هي تكلفة نضح الحفرة الامتصاصية في كل مرة يتم نضحها؟ (بالشيكل)	....	☐☐☐
13.12	ما مدى انزعاج الأسرة من عملية نضح الحفرة الإمتصاصية؟	2 - كبير 2- متوسط 3- قليل 8 - لا تنزعج	☐☐
13.13	ما مدى انزعاج الجيران من عملية نضح الحفرة الامتصاصية؟	3 - كبير 2- متوسط 3- قليل 9 - لا تنزعج	☐☐
13.14	هل يتم التخلص من محتوى الحفرة الامتصاصية بطريقة أخرى غير النضح؟	3 - نعم 4 - لا	☐
13.15	إذا كان جواب 13.14 نعم، فما هي هذه الطريقة؟	....	

14 -معلومات المبحوث		
	اسم المبحوث	
	رقم الهاتف	

APPENDIX 3

List of Attendees

Professional Workshop

No.	Name	Organization
1.	Dr. Nidal Mahmoud	Birzeit University
2.	Dr. Maher Abu Madi	Birzeit University
3.	Adel Yaseen	Palestinian Water Authority
4.	Hazem Kittani	Palestinian Water Authority
5.	Hanadi Bader	Palestinian Water Authority
6.	Husam Daher	Al Quds University
7.	Ola Adilah	MSc. Student
8.	Abdelhamid Al-Shami	House of Water and Environment
9.	Ghadeer Arafeh	Palestinian Water Authority
10.	Abdel Razzaq Abu Rahma	Palestinian Hydrology Group
11.	Hala Barhoumi	Palestinian Water Authority
12.	Sobhi Salah	Al-Quds University
13.	Bra' Jarrar	Al Najah University
14.	Baker Jawabreh	Al Najah University

APPENDIX 4

Photos of Onsite GWTPs

Onsite Grey water Treatment Plant, Palestine, 2010

Reuse Scheme by Treated Grey Water in Green House, Palestine, 2010

Plants Irrigated by Treated Grey Water, Palestine, 2011

APPENDIX 5

Logistic Regression Analysis

Logistic Regression

Dependent Variable Encoding	
Original Value	Internal Value
No	0
Yes	1

Block 0: Beginning Block

Classification Table(a,b)					
	Observed		Predicted		
			NewAccept		Percentage Correct
			No	Yes	
Step 0	NewAccept	No	80	0	100.0
		Yes	28	0	.0
	Overall Percentage				74.1
a Constant is included in the model.					
b The cut value is .500					

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-1.050	.220	22.859	1	.000	.350

Block 1: Method = Backward Stepwise (Conditional)

Omnibus Tests of Model Coefficients				
		Chi-square	df	Sig.
Step 1	Step	43.186	21	.003
	Block	43.186	21	.003
	Model	43.186	21	.003
Step 2(a)	Step	-.016	1	.898
	Block	43.169	20	.002
	Model	43.169	20	.002
Step 3(a)	Step	-.051	1	.821
	Block	43.118	19	.001

	Model	43.118	19	.001
Step 4(a)	**Step**	-.068	1	.794
	Block	43.050	18	.001
	Model	43.050	18	.001
Step 5(a)	**Step**	-.112	1	.738
	Block	42.938	17	.000
	Model	42.938	17	.000
Step 6(a)	**Step**	-.108	1	.743
	Block	42.831	16	.000
	Model	42.831	16	.000
Step 7(a)	**Step**	-.088	1	.767
	Block	42.743	15	.000
	Model	42.743	15	.000
Step 8(a)	**Step**	-.129	1	.720
	Block	42.614	14	.000
	Model	42.614	14	.000
Step 9(a)	**Step**	-.165	1	.685
	Block	42.449	13	.000
	Model	42.449	13	.000
Step 10(a)	**Step**	-.340	1	.560
	Block	42.110	12	.000
	Model	42.110	12	.000
Step 11(a)	**Step**	-.523	1	.469
	Block	41.586	11	.000
	Model	41.586	11	.000
Step 12(a)	**Step**	-.583	1	.445
	Block	41.003	10	.000
	Model	41.003	10	.000
Step 13(a)	**Step**	-1.423	1	.233
	Block	39.580	9	.000
	Model	39.580	9	.000
Step 14(a)	**Step**	-1.879	1	.170
	Block	37.701	8	.000
	Model	37.701	8	.000
Step 15(a)	**Step**	-2.643	1	.104
	Block	35.059	7	.000
	Model	35.059	7	.000
a A negative Chi-squares value indicates that the Chi-squares value has decreased from the previous step.				

Classification Table(a)					
	Observed		Predicted		
			NewAccept		Percentage Correct
			No	Yes	
Step 1	NewAccept	No	77	3	96.3
		Yes	14	14	50.0
	Overall Percentage				84.3
Step 2	NewAccept	No	77	3	96.3
		Yes	15	13	46.4
	Overall Percentage				83.3
Step 3	NewAccept	No	77	3	96.3
		Yes	15	13	46.4
	Overall Percentage				83.3
Step 4	NewAccept	No	77	3	96.3
		Yes	14	14	50.0
	Overall Percentage				84.3
Step 5	NewAccept	No	77	3	96.3
		Yes	14	14	50.0
	Overall Percentage				84.3
Step 6	NewAccept	No	77	3	96.3
		Yes	14	14	50.0
	Overall Percentage				84.3
Step 7	NewAccept	No	77	3	96.3
		Yes	13	15	53.6
	Overall Percentage				85.2
Step 8	NewAccept	No	77	3	96.3
		Yes	13	15	53.6
	Overall Percentage				85.2
Step 9	NewAccept	No	77	3	96.3
		Yes	13	15	53.6
	Overall Percentage				85.2
Step 10	NewAccept	No	78	2	97.5
		Yes	12	16	57.1
	Overall Percentage				87.0
Step 11	NewAccept	No	77	3	96.3
		Yes	14	14	50.0
	Overall Percentage				84.3
Step 12	NewAccept	No	77	3	96.3
		Yes	14	14	50.0
	Overall Percentage				84.3

Step 13	**NewAccept**	**No**	76	4	95.0
		Yes	13	15	53.6
	Overall Percentage				84.3
Step 14	**NewAccept**	**No**	76	4	95.0
		Yes	13	15	53.6
	Overall Percentage				84.3
Step 15	**NewAccept**	**No**	76	4	95.0
		Yes	15	13	46.4
	Overall Percentage				82.4
a The cut value is .500					

Variables in the equation							
		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Step 1	Governorate	-.579	.211	7.549	1	.6	.560
	Family	-.044	.066	.433	1	.510	.957
	Income	.000	.000	2.034	1	.154	1.000
	Cost of cesspit’s construction	.000	.000	.130	1	.718	1.000
	Frequency of emptying	-.014	.050	.079	1	.779	.986
	Cost of cesspit’s emptying	.002	.003	.425	1	.514	1.002
	Family annoying of cesspits	-.294	.459	.410	1	.522	.746
	Emptying method	-22.445	40192.631	.000	1	1.000	.000
	Availability of cistern	.121	.940	.016	1	.898	1.128
	Water source for irrigation: water network	1.120	1.376	.662	1	.416	3.065
	Water availability	-.223	.609	.134	1	.714	.800
	Knowledge of sanitation systems	1.896	.825	5.288	1	.021	6.661
	Acceptance of separation	2.893	1.257	5.295	1	.021	.055
	Preferred system of sanitation: Central wastewater network	-7.379	7313.272	.000	1	.999	.001
	Shame of using treated water	-.199	.730	.074	1	.785	.819
	Garden availability	2.008	1.215	2.732	1	.098	.134
	Water source for irrigation : water.network	1.422	3.907	.132	1	.716	4.146
	Water source for irrigation : untreated grey water	2.573	2.429	1.122	1	.289	13.104
	Constant	47.329	80385.261	.000	1	1.000	358800586609186100000.000
	Governorate	-.587	.203	8.333	1	.4	.556
	Family	-.043	.066	.422	1	.516	.958
	Income	.000	.000	2.045	1	.153	1.000
	Cost of cesspit’s construction	.000	.000	.123	1	.725	1.000
	Frequency of emptying	-.014	.050	.080	1	.778	.986
	Cost of cesspit’s emptying	.002	.003	.413	1	.521	1.002

Step 2	Family annoying of cesspits	-.305	.448	.464	1	.496	.737
	Emptying method	-22.523	40192.844	.000	1	1.000	.000
	Water availability	-.234	.603	.150	1	.699	.792
	Knowledge of sanitation systems	1.909	.818	5.448	1	.020	6.745
	Acceptance of separation	2.880	1.252	5.288	1	.021	.056
	Preferred system of sanitation: Central wastewater network	-7.383	7277.674	.000	1	.999	.001
	Shame of using treated water	-.186	.722	.066	1	.797	.831
	Garden availability	1.973	1.182	2.783	1	.095	.139
	Water source for irrigation : water.network	1.473	3.893	.143	1	.705	4.362
	Water source for irrigation : untreated grey water	2.582	2.432	1.128	1	.288	13.227
	Constant	47.544	80385.688	.000	1	1.000	444775470326012000000.000
Step 3	Governorate	-.589	.203	8.378	1	.4	.555
	Family	-.044	.066	.430	1	.512	.957
	Income	.000	.000	2.079	1	.149	1.000
	Cost of cesspit’s construction	.309	.331	.874	1	.350	1.363
	Frequency of emptying	.000	.000	.124	1	.724	1.000
	Cost of cesspit’s emptying	-.014	.050	.081	1	.776	.986
	Family annoying of cesspits	.002	.003	.406	1	.524	1.002
	Emptying method	-.301	.448	.452	1	.501	.740
	Water availability	-22.530	40193.157	.000	1	1.000	.000
	Knowledge of sanitation systems	.227	.603	.142	1	.706	.797
	Acceptance of separation	1.911	.819	5.446	1	.020	6.759
	Preferred system of sanitation: Central wastewater network	-2.891	1.252	5.333	1	.021	.056
	Shame of using treated water	-.188	.724	.068	1	.794	.828
	Garden availability	1.986	1.180	2.830	1	.093	.137
	Water source for irrigation : water.network	1.455	3.896	.140	1	.709	4.287
	Water source for irrigation : untreated grey water	2.580	2.436	1.122	1	.289	13.195
	Constant	47.621	80386.315	.000	1	1.000	480115307651072000000.000
Step 4	Governorate	-.578	.198	8.504	1	.4	.561
	Family	-.041	.065	.391	1	.532	.960
	Income	.000	.000	2.122	1	.145	1.000
	Cost of cesspit’s construction	.000	.000	.108	1	.742	1.000
	Frequency of emptying	-.016	.049	.111	1	.739	.984
	Cost of cesspit’s emptying	.002	.003	.390	1	.532	1.002
	Family annoying of cesspits	-.290	.447	.421	1	.516	.748
	Emptying method	-22.658	40193.402	.000	1	1.000	.000

	Water availability	-.199	.591	.114	1	.736	.819
	Knowledge of sanitation systems	1.885	.812	5.390	1	.020	6.587
	Acceptance of separation	2.917	1.248	5.462	1	.019	.054
	Preferred system of sanitation: Central wastewater network	-1.968	.787	6.254	1	.012	.140
	Garden availability	1.987	1.178	2.844	1	.092	.137
	Water source for irrigation : water.network	1.580	3.853	.168	1	.682	4.853
	Water source for irrigation : untreated grey water	2.632	2.414	1.189	1	.276	13.905
	Constant	47.631	80386.805	.000	1	1.000	485332165634040000000.000
Step 5	Family	-.043	.065	.430	1	.512	.958
	Income	.000	.000	2.076	1	.150	1.000
	Cost of cesspit's construction	.000	.000	.118	1	.731	1.000
	Cost of cesspit's emptying	.002	.003	.417	1	.518	1.002
	Family annoying of cesspits	-.280	.445	.394	1	.530	.756
	Emptying method	-22.522	40192.650	.000	1	1.000	.000
	Water availability	1.170	1.338	.764	1	.382	3.221
	Knowledge of sanitation systems	1.846	.801	5.315	1	.021	6.331
	Acceptance of separation	2.899	1.237	5.495	1	.019	.055
	Preferred system of sanitation: Central wastewater network	-1.939	.780	6.176	1	.013	.144
	Garden availability	1.902	1.151	2.730	1	.098	.149
	Water source for irrigation : water.network	1.483	3.836	.149	1	.699	4.404
	Water source for irrigation : untreated grey water	2.576	2.402	1.151	1	.283	13.148
	Constant	47.350	80385.300	.000	1	1.000	366231411122214200000.000
Step 6	Governorate	-.576	.197	8.565	1	.3	.562
	Family	-.039	.064	.369	1	.543	.962
	Income	.000	.000	2.023	1	.155	1.000
	Cost of cesspit's construction	.000	.000	.077	1	.781	1.000
	Cost of cesspit's emptying	.002	.003	.436	1	.509	1.002
	Family annoying of cesspits	-.323	.427	.574	1	.449	.724
	Emptying method	-22.465	40192.710	.000	1	1.000	.000
	Water availability	-.224	.588	.145	1	.703	.799
	Knowledge of sanitation systems	1.894	.784	5.829	1	.016	6.644
	Acceptance of separation	2.754	1.127	5.969	1	.015	.064
	Preferred system of sanitation: Central wastewater network	-1.992	.761	6.843	1	.009	.136
	Garden availability	1.854	1.140	2.644	1	.104	.157
	Water source for irrigation : water.network	1.538	3.842	.160	1	.689	4.656
	Water source for irrigation : untreated grey water	2.602	2.410	1.166	1	.280	13.487

	Constant	46.931	80385.421	.000	1	1.000	240999362105963300000.000
Step 7	Governorate	-.568	.193	8.651	1	.3	.567
	Family	-.036	.063	.325	1	.569	.965
	Income	.000	.000	1.967	1	.161	1.000
	Cost of cesspit's emptying	.002	.003	.430	1	.512	1.002
	Family annoying of cesspits	-.343	.418	.671	1	.413	.710
	Emptying method	-22.473	40193.006	.000	1	1.000	.000
	Water availability	-.210	.585	.128	1	.720	.811
	Knowledge of sanitation systems	1.897	.784	5.851	1	.016	6.665
	Acceptance of separation	2.718	1.117	5.928	1	.015	.066
	Preferred system of sanitation: Central wastewater network	-1.980	.757	6.842	1	.009	.138
	Garden availability	1.866	1.136	2.698	1	.101	.155
	Water source for irrigation : water.network	1.516	3.842	.156	1	.693	4.555
	Water source for irrigation : untreated grey water	2.628	2.408	1.191	1	.275	13.847
	Constant	46.749	80386.012	.000	1	1.000	200849913973543400000.000
Step 8	Family	-.038	.063	.361	1	.548	.963
	Income	.000	.000	1.876	1	.171	1.000
	Cost of cesspit's emptying	.002	.003	.351	1	.554	1.002
	Family annoying of cesspits	-.338	.419	.650	1	.420	.713
	Emptying method	-22.568	40192.826	.000	1	1.000	.000
	Water availability	1.201	1.329	.816	1	.366	3.324
	Knowledge of sanitation systems	1.804	.729	6.124	1	.013	6.072
	Acceptance of separation	2.599	1.046	6.180	1	.013	.074
	Preferred system of sanitation: Central wastewater network	-2.021	.757	7.131	1	.008	.132
	Garden availability	1.896	1.132	2.804	1	.094	.150
	Water source for irrigation : water.network	1.515	3.832	.156	1	.692	4.551
	Water source for irrigation : untreated grey water	2.603	2.398	1.178	1	.278	13.500
	Constant	46.896	80385.653	.000	1	1.000	232691745599930400000.000
Step 9	Family	-.039	.063	.391	1	.532	.961
	Income	.000	.000	2.020	1	.155	1.000
	Cost of cesspit's emptying	.002	.003	.347	1	.556	1.002
	Family annoying of cesspits	-.344	.420	.671	1	.413	.709
	Emptying method	-22.601	40192.950	.000	1	1.000	.000
	Knowledge of sanitation systems	1.813	.731	6.145	1	.013	6.130
	Acceptance of separation	2.618	1.049	6.231	1	.013	.073
	Preferred system of sanitation: Central wastewater network	-2.060	.752	7.503	1	.006	.127

	Garden availability	2.077	1.043	3.970	1	.046	.125
	Water source for irrigation : untreated grey water	1.713	.732	5.478	1	.019	5.544
	Constant	49.195	80385.900	.000	1	1.000	2318995511836828000000.000
Step 10	Family	-.047	.062	.577	1	.448	.954
	Income	.000	.000	2.308	1	.129	1.000
	Family annoying of cesspits	-.286	.403	.504	1	.478	.751
	Emptying method	-22.314	40193.087	.000	1	1.000	.000
	Knowledge of sanitation systems	1.771	.722	6.016	1	.014	5.877
	Acceptance of separation	2.613	1.053	6.158	1	.013	.073
	Preferred system of sanitation: Central wastewater network	-2.074	.756	7.531	1	.006	.126
	Garden availability	2.085	1.045	3.984	1	.046	.124
	Water source for irrigation : untreated grey water	1.768	.731	5.840	1	.016	5.857
	Constant	48.933	80386.175	.000	1	1.000	1784615884760445000000.000
Step 11	Family	-.047	.062	.566	1	.452	.955
	Income	.000	.000	2.863	1	.091	1.000
	Emptying method	-22.000	40192.625	.000	1	1.000	.000
	Knowledge of sanitation systems	1.724	.713	5.853	1	.016	5.607
	Acceptance of separation	2.640	1.043	6.399	1	.011	.071
	Preferred system of sanitation: Central wastewater network	-2.155	.751	8.241	1	.004	.116
	Garden availability	2.199	1.037	4.496	1	.034	.111
	Water source for irrigation : untreated grey water	1.741	.723	5.798	1	.016	5.705
	Constant	47.955	80385.250	.000	1	1.000	670520088524489000000.000
Step 12	Income	.000	.000	2.496	1	.114	1.000
	Emptying method	.360	.301	1.429	1	.232	1.434
	Knowledge of sanitation systems	22.306	40193.029	.000	1	1.000	.000
	Acceptance of separation	1.638	.695	5.553	1	.018	5.147
	Preferred system of sanitation: Central wastewater network	-2.504	1.009	6.157	1	.013	.082
	Garden availability	2.106	.737	8.169	1	.004	.122
	Water source for irrigation : untreated grey water	2.209	1.031	4.594	1	.032	.110
	Income	1.646	.700	5.526	1	.019	5.188
	Constant	48.110	80386.057	.000	1	1.000	783358366026166000000.000
Step 13	Income	.000	.000	2.430	1	.119	1.000
	Emptying method	-21.792	40193.645	.000	1	1.000	.000
	Knowledge of sanitation systems	1.786	.687	6.762	1	.009	5.964
	Acceptance of separation	2.391	.979	5.964	1	.015	.091

	Preferred system of sanitation: Central wastewater network	-1.952	.691	7.984	1	.005	.142
	Garden availability	2.207	1.023	4.652	1	.031	.110
	Water source for irrigation : untreated grey water	1.505	.670	5.051	1	.025	4.503
	Constant	47.436	80387.291	.000	1	1.000	399114303809752000000.000
Step 14	Income	.000	.000	2.696	1	.101	1.000
	Knowledge of sanitation systems	1.908	.682	7.838	1	.005	6.739
	Acceptance of separation	2.452	.983	6.229	1	.013	.086
	Preferred system of sanitation: Central wastewater network	-1.886	.679	7.712	1	.005	.152
	Garden availability	2.216	1.023	4.691	1	.030	.109
	Water source for irrigation : untreated grey water	1.390	.658	4.462	1	.035	4.016
	Constant	3.984	2.525	2.490	1	.115	53.740
Step 15	Knowledge of sanitation systems	1.729	.659	6.889	1	.009	5.636
	Acceptance of separation	2.446	.972	6.326	1	.012	.087
	Preferred system of sanitation: Central wastewater network	-1.735	.634	7.477	1	.006	.176
	Garden availability	2.255	1.005	5.035	1	.025	.105
	Water source for irrigation : untreated grey water	1.423	.635	5.030	1	.025	4.151
	Constant	5.012	2.455	4.167	1	.041	150.154