



Palestine Economic Policy Research Institute (MAS)

Encouraging the Use of Treated Grey-Water In Palestine

Peter Hansen

2012



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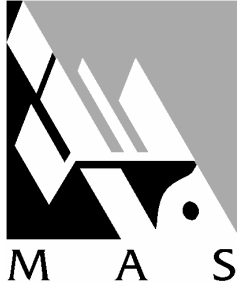
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Foreword

Any research into managing the crisis of water shortage in the Occupied Palestinian Territory, including the present paper, must begin by establishing that the predicament is the result of Israel's arbitrary control of the Palestinian water resources, allowing the Palestinians access to only 15% -20% of the supplies, while burgling the rest for its own purposes as well as for the settlers in the occupied West Bank. As such, it is not an overstatement to say that the radical solution to this dilemma starts with ending the Israeli occupation and its control over water sources and all other economic and natural resources.

This dire fact, however, should not demoralize us from taking any effort that would attenuate the severity of the plight through making available more sources of water for different uses. This study, which examines the development of policies to process and use gray water, is part of these efforts. We believe that such policies can respond to the current water shortage crisis in the Occupied Palestinian Territory, and they will be of great benefit in the future after our inevitable freedom.

We also believe that we need to immediately undertake a rational exploitation of water resources available to us as the search for ways to increase these resources through the treatment of gray water (which can be made available for use in the irrigation of many crops and in some industries) means that we can save fresh water that we desperately need for other purposes. Furthermore, this pragmatic approach will help us in building the necessary expertise and consolidating the culture required for the wise exploitation of our water resources, taking into consideration the needs of generations to come.

This study is an important contribution to these efforts, as we believe it provides conclusions and recommendations worthy of consideration by policy makers and people working in development in general, and in developing water resources in particular.

We would like to thank Peter Hansen for his valuable contribution in this study. Special thanks go to Barbara Sabitzer who edited the study and added some important paragraphs.

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Dr. Samir Abdullah
Director General

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Executive Summary

Palestine is currently in the throes of a water crisis to which government policy has not been sufficiently responsive. Today, data reveals a worsening of water trends across the board. If there are no changes to the current trajectory, Palestine will soon face a full-fledged water catastrophe. For many years policy debates regarding the development of alternative water management strategies have come up short. Those in the policy community who emphasize strategies of water conservation and reuse are rebuffed by opponents who argue that consumption patterns in Palestine are already dangerously low. Moreover, those opposed to rationalization policies see conservation as tacit acceptance of the current inequitable water distribution imposed by the Israeli occupation. Accordingly, this faction of the policy community refuses to accept the status-quo as legitimate and rejects any policy agenda which works from within the Israeli imposed constraints. Instead, their strategic focus is placed on achieving a political solution through the realization and fulfillment of Palestinian water rights and an equitable distribution of water resources. As the quest for a political solution drags on, however, the average Palestinian family, especially those in rural Area C, pays a high price in the form of chronic water insecurity. Policy makers in Palestine are therefore in the unenviable position of having to steer a course between the Scylla of alleviating water insecurity through a demoralizing acquiescence to Israeli control and the Charybdis of a just defiance which is sure to perpetuate the misery of the people.

The aim of this study is not to deepen this disagreement by arguing for one strategy at the expense of the other. Rather, it questions the wisdom of such binary thinking and offers an alternative, balanced approach which recognizes both the strategic and symbolic significance of securing Palestinian water rights while concurrently stressing the need for water conservation and reuse. Such a balanced approach is imperative, as even if negotiators were able to secure the most equitable distribution of water resources today, projections show that demand in Palestine would still exceed supply sometime between 2035 and 2050. Faced with this reality, it becomes evident that resolving the issue of access, no matter how successful, will only temporarily alleviate the problem of water scarcity in Palestine. Clearly the only way out of this blind alley is a holistic, long-term water strategy which blends the pursuit of a political settlement with the techniques of conservation and reuse.

Past experience clearly shows that large-scale, centralized water infrastructure plans are not politically feasible due to the ongoing legal obstructionism of Israeli. It is therefore vital that policy makers consider an alternative, smaller-scale, decentralized approach to water management. This would allow the PA to act unilaterally by circumventing many of the extant legal barriers. To achieve these objectives this study recommends the use of treated grey-water for household agriculture. Not only is the technology small-scale and decentralized, it can also help to alleviate short-term water insecurity in rural communities. Furthermore, it can aid in closing the long-term gap between water supply and demand in Palestine. The widespread adoption of grey-water recycling techniques in Palestine would also produce numerous 'knock on' salutary economic, social, and environmental effects.

In addition to promoting treated grey-water, this study turns a critical eye to the problems which confront its implementation in the context of Palestine. Hence, it aims to categorize, detail, and offer solutions to the specific barriers associated with the West Bank and Gaza Strip. For instance, negative public perception about waste-water recycling represents one major barrier to the wide-spread adoption of grey-water technology in Palestine. In order to address the issue, this study recommends education programs and public awareness campaigns that stress the safety of the system, its effectiveness in crop irrigation, and the financial benefits it confers upon users. In addition, it argues that incorporating treated grey-water into conservation education in public schools and installing the technology in mosques could prove beneficial in changing attitudes. Targeted public awareness campaigns reaching out to the social groups responsible for water management (e.g. women and village councils), is also recommended. In regard to financial barriers, the study recommends that the PA create a cost-sharing program based on a pre-approved gravel up-flow system. In addition, donor funds provide an avenue through which external capital for grey-water systems might be secured. In this respect, the PA could facilitate donor funding for the project by coordinating and pointing out channels that communities or individuals could use in order to secure funds. Promotion and coordination of funding could be carried out through pre-existing social bodies like cooperatives and councils.

The recommendations produced by this study urge all stakeholders to consider grey-water recycling as part of an alternative smaller-scale, decentralized approach to water management. It recommends grey-water reuse not only for its potential to aid in the long-run fight against water

scarcity in Palestine and enhance the water security of rural communities in the short-term, but also for its political expediency in circumventing occupational barriers. Finally, it is important to note that while treated grey-water use is not a silver bullet capable of solving the water crisis facing Palestine, it can begin contributing to a solution today

1. Introduction

The Palestinian water situation, like the economic situation more generally, is ensnared within a classic catch-22 predicament. On one hand, policy makers might pursue a strategy of water conservation and reuse as the rationalization of consumption would provide some much needed relief to those elements of society currently suffering from chronic water shortages. However, a caveat must be introduced: Palestinian water consumption patterns are already low¹, so reducing them further seems counterintuitive. Furthermore, this particular brand of policy implicitly accepts and works from within the current, unjust water distribution framework imposed by Israel. Demand management and recycling policies are therefore rejected by critics as irrational or worse, as a de facto legitimization of the occupation and a potential rallying cry for the Government of Israel to deny Palestine additional water in the future. On the other hand, policy makers could choose a strategy founded on defiance by rejecting any policy agenda that works within the Israeli imposed constraints. Instead, strategic focus would be placed on achieving a political solution through the realization and fulfillment of Palestinian water rights and an equitable distribution of water resources. Yet, strategies of defiance harbor a high human cost. Brimming with rancor and recrimination, past negotiations show that success in the political sphere cannot be assumed as the negotiation process can drag on for decades without yielding tangible results. In the meantime, the average Palestinian family pays the price in the form of chronic water insecurity. Policy makers in Palestine are therefore in the unenviable position of trying to steer a course between alleviating water insecurity through a demoralizing acquiescence to Israeli control and a just defiance which is sure to perpetuate the misery of the people.

The aim of this study is not to deepen this disagreement by arguing for one strategy at the expense of the other. Rather, it questions the wisdom of such binary thinking and offers an alternative, balanced approach which recognizes the strategic and symbolic significance of securing Palestinian water rights while also stressing the need *for* water conservation and reuse. Consider the following counterfactual: if tomorrow, Palestinian negotiators were able to secure the most equitable distribution of water resources

¹ The World Health Organization (WHO) recommends 100-150 liters/person/day. In 2010 the average Palestinian consumes roughly half that amount (PASSIA 2011: 341).

possible², projections still show that demand in Palestine would exceed supply sometime between 2035 and 2050 (Glover & Hunter 2010: 69). Faced with this reality, it is evident that resolving the issue of access, no matter how successful, will only temporarily alleviate the problem of water scarcity in Palestine. Securing greater access to shared water resources is simply not the silver-bullet solution to Palestine's water problems. Unfortunately, over the past few decades, the policy community seems to have worked under this assumption as the leitmotif of access has consistently dominated the water discourse, overshadowing the need for alternative strategies based on conservation and reuse (Jagerskog 2005: 786). Clearly, the only way out of this blind alley is a holistic, long-term water strategy which blends the pursuit of a political settlement with the techniques of water conservation and reuse.

1.2 Problem Statement

Palestine is currently in the throes of a water crisis to which government policy has not been sufficiently responsive. This is illustrated by an across-the-board worsening of water trends. Should the ship of state prove incapable of steering a new course for Palestine, the current trajectory will lead the territories to the brink of a full-fledged water catastrophe. For many years Palestinian policy debates regarding the development of alternative water management strategies have come up short (Glover & Hunter 2010: ix). The reality of working with hostile Israeli bureaucrats coupled with the fear that reducing consumption patterns would further weaken the Palestinian bargaining position has been sufficient to dissuade the policy community from pursuing alternative water strategies. While this is certainly an understandable, if politically expedient reaction in the short-term, the long-run consequences will be nothing short of disastrous. In the Gaza Strip today, the population suffers from a manifold of water related illness due to the coastal aquifer – Gaza's sole fresh-water resource – being over extracted and degraded by high salinity and other pollutants (Amnesty International 2009: 29). If current patterns hold, projections show that the potable water supply in Gaza will be completely depleted within fifteen years. Similarly, in the West Bank some communities in hard hit area C receive less than 10 liters of water per capita per day, a number below the minimum standard adopted by international

² According to Glover & Hunter (2010) the most equitable distribution of water resources that could ever realistically be attained would be the "per capita distribution of the groundwater resources of historic Palestine coupled with a per capita distribution of Israel's current allocation of Jordan river water" (2010: 66).

humanitarian disaster agencies for the avoidance of epidemics. Furthermore, low-end supply predictions show that demand for water could outstrip supply as early as 2020 (Glover & Hunter 2010: 7). The urgency of the water crisis demonstrates the pressing need for the policy community to look beyond the issue of access and focus on alternative strategies to ensure that Palestinian water needs are met in the long-run.

Of course, designing and implementing such a policy given the constraints associated with the Israeli occupation represents a major challenge to the Palestinian Authority (PA). Because the PA's ability to carry out infrastructure projects is circumscribed by Israeli legal barriers (permit requirements, etc.), the development of an extensive, centralized water/sewage system is not feasible without full Israeli support – and such support has never been forthcoming. In spite of this obvious barrier, since the start of the Oslo process, new sweeping master plans for the development of the Palestinian water sector have appeared with some frequency (Glover & Hunter 2010: ix). Predictably, the legal intransigence of Israel has ensured that the vast majority of the recommendations contained within these master plans have not come to fruition (Glover & Hunter 2010: ix). So, while such plans are great in theory and necessary for a future Palestinian state, they are not feasible given the existing political climate. Meanwhile, as the protracted “master plan process” drags on, the basic water needs of the Palestinian people continue to go unfilled. Clearly then, it is imperative that policy makers begin focusing on smaller-scale, decentralized water strategies that will circumvent these legal constraints and allow the PA to act unilaterally.

In light of this, it is important to underline the key premise of this study: that the use of treated grey-water – defined as wastewater derived from kitchens, bathroom sinks, and laundry – for small-scale agriculture can make an important contribution to the alleviation of short-term water insecurity and aid in reducing the long-term gap between supply and demand in Palestine. Furthermore, the study argues that the widespread adoption of grey-water recycling techniques would produce salutary ‘knock on’ economic, social, and environmental effects. Unlike black-water (wastewater from toilets), grey-water does not contain dangerously high levels of pathogens, making its recycling and reuse a safe, efficient, and environmentally friendly option (Redwood 2008: 110). More importantly still, grey-water represents the lion's share of total household effluent – an estimated 55 to 60 percent in some regions and up to 80 percent in some rural Palestinian communities (Burnat & Eshtayah 2010: 17). Urban and environmental planners McIlwaine and Redwood argue

that, “if used wisely and appropriately, [treated] grey-water – 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” (2010: 30). Estimates regarding the total amount of household water saved through grey-water reuse systems can vary greatly and depend on several factors such as climate, household income, and cultural dynamics. Preliminary research, however, suggests that a range exists between 75 liters per household per day in certain areas and up to 275 liters per household per day in others (Redwood 2010: 3). While the most obvious advantage of treated grey-water reuse is the conservation of fresh-water resources, the fact that the technology is small-scale and decentralized means that it can be implemented without Israeli interference.

The key points to be taken away from this section are twofold: first, there is a serious water crisis gripping Palestine and it can only be resolved in the long-run through public policy which blends a political solution with techniques of water conservation and reuse. And second, the current water insecurity experienced by many Palestinian communities, especially those in rural area C, is being exacerbated by strategies which focus on large-scale, centralized water/sewage ‘master plans’. In view of these facts, this study urges consideration of treated grey-water as part of an alternative smaller-scale, decentralized approach to water management. It recommends treated grey-water not only for its potential to aid in the fight against water scarcity, but also because it is politically feasible within the given occupational constraints.

1.3 Methodology

This study includes analysis of the current condition of the water sector in Palestine and an evaluation of various grey-water reuse development strategies which might be adopted in order to help meet the current and future water needs of Palestine. The recommendations offered are the result of an extensive literature review focused on the water sector in Palestine, the political and legislative context which defines it, and of grey-water policies and projects carried out both in the Palestinian territories and in other states experiencing water scarcity. Particular attention is paid to grey-water recycling projects and strategies employed in neighboring states as well as Palestine. When evaluating the success of the policies and projects in other states, special focus is placed on low-

cost, community-level grey-water projects which could be implemented in the most marginalized, poor, and water insecure communities around the Palestinian territories.

The information and insights obtained from the literature review are then put to use in a selection of policy recommendations. These recommendations are geared toward meeting the specific challenges of implementing grey-water reuse systems in the West Bank and Gaza Strip. Of course, the unique sets of constraints faced by policy makers in Palestine are of particular concern and therefore given due consideration. In general, the recommendations focus on enabling factors, or incentives that will increase the adoption of treated grey-water systems. It is important to highlight that the study is meant to raise the awareness of policy makers and the public to the benefits of treated grey-water, and is therefore not technical in nature.

1.4 Research Objectives

The central objective of this study is to highlight the potential contribution that treated grey-water reuse systems might make to the alleviation of water insecurity in Palestine in the short-run as well as its potential to aid in the effort to close the gap between water demand and supply in the long-run. Moreover, it analyzes some of the key barriers that must be addressed for treated grey-water to be accepted and implemented on a large-scale in Palestine. A complex intersection of both natural and manmade constraints (each of which will be explored in some detail) have produced the current untenable water situation in Palestine, which according to numerous metrics, has already reached crisis levels. Due simply to its geographical location and arid climate, it is likely that Palestine will always experience a certain measure of hydrological uncertainty. However, with the implementation of efficient, long-term water management strategies such as treated grey-water, there is no reason that this uncertainty cannot be reduced to a reasonable level. Grey-water recycling systems constitute but one weapon in the arsenal of alternative water management strategies available to policy makers in their fight against the ongoing water crisis in the West Bank and Gaza Strip. As grey-water systems are one of the most cost effective means available for improving the efficiency of water use at the household level, strategic focus can be placed on bringing its conservatory, fiscal, social, and environmental benefits to the most water insecure and economically marginalized communities in Palestine.

There are, of course, complex problems which confront the implementation of any new water management strategy in Palestine. This study, therefore, aims to categorize, detail, and offer solutions to the specific sets of problems associated with grey-water recycling in the West Bank and Gaza Strip. Aside from the traditional, generic problems linked to waste-water management projects (i.e. financial, social, institutional and technical); the political climate of Palestine adds an additional layer of complexity and its own unique set of challenges. Development under the yoke of a hostile occupying power whose stated goal is to stymie economic growth and retain strict control over water resources allows for minimal policy space in which law-makers can maneuver (Arnon 2007: 576). Furthermore, lingering tensions within the newfangled unity government between Hamas and Fatah threatens to add additional delays and obstacles to an already sluggish political process. Some of the critical obstacles which wastewater reuse projects in Palestine are sure to face include: a lack of integrated vision for reuse issues within the political and institutional framework, a general lack of public awareness about water reuse (especially in potential locations for wastewater reuse), unstable political conditions, lack of communication with the Israelis, ineffectual marketing and tariff setting, and public concerns over the safety of treated water.

The nature of water in Palestine is ineliminably political, therefore understanding the contemporary political climate is crucial to producing policy recommendations which are both strategic in their response to existing problems and feasible to implement given existing constraints. Consequently, section two of this study consists of an investigation into the historico-political context which defines the contemporary nature of the water shortage in Palestine and places the current debate over water resources in context. This investigation is essential as we cannot hope to understand the present political climate without bringing the past to bear. Following from this, section three then outlines the regulatory and legislative setting of the water sector in Palestine. In obtaining a clear grasp of the laws already on the books and the institutional capacity of the water sector, policy recommendations can be better calibrated to the government's capabilities to regulate and incentivize treated grey-water reuse. Moreover, this section sets out to answer whether the extant framework will facilitate or hinder the implementation of treated grey-water reuse strategies.

In section four of this study, grey-water recycling is introduced and its potential benefits and costs as well as its drivers and barriers are explored.

The aim is to familiarize the reader with grey-water recycling and to provide a general overview of the major benefits it can offer Palestine as well as the major obstacles its implementation is sure to face. Section five then takes a look at what the appropriate grey-water technology for Palestine might be and highlights Burnat's low-cost, user friendly and culturally acceptable up-flow, gravel filter grey-water system. One additional important tool of analysis and metric for gauging the feasibility of different grey-water policies and systems in Palestine is to explore previous grey-water legislation and projects which have been implemented successfully. Consequently, section six of this study is devoted to three case studies of treated grey-water reuse in Jordan, Lebanon, and Israel (of course the study will be drawing on experiences in the West Bank and Gaza Strip throughout). Drawing upon the wealth of previous grey-water research and investigating the successes and failures of these programs will provide a necessary foundation for finding relevant solutions to perceived local problems. Finally, section seven reflects on the findings of this study and offers policy recommendations to overcome the barriers associated with treated grey-water use and ultimately encourage its widespread adoption in Palestine.

2. Water, Politics and Palestine

2.1 Natural Water Constraints

Home to 336,770,994 people – or roughly 6% of the world’s population – the Middle East and North Africa (MENA) region is endowed with a scant 1% of the earth’s accessible fresh-water resources (World Bank: 2011). No exception to this paucity of water resources, Palestine requires an effective long-term water management strategy if it is to obviate the looming regional water crisis. One geographical issue which complicates the Palestinian case is the fact that it is not a single, contiguous territory. This means that water resource endowments in the occupied territories vary substantially and must be examined and strategized for in relative independence. In terms of total fresh-water endowments and average rainfall, the Gaza Strip fares far worse than the West Bank. Indeed, Gaza currently holds the dubious distinction of being the most densely populated place on the planet and the second most water deprived (behind Kuwait) (Glover & Hunter 2010: 6). Moreover, its solitary source of fresh water – the coastal aquifer – has, in recent decades, been both over extracted (i.e. the amount of water extracted is outrunning the aquifer’s recharge capacity) and seriously degraded by the intrusion of salt water and other pollutants. This combination has had such a deleterious effect on the coastal aquifer that today only 5 to 10 percent of it remains fit for human consumption. If current trends continue unabated, the United Nations predicts that Gaza’s potable water supply will be completely depleted within the next fifteen years (cited in PASSIA 2011: 340).

Circumstances in the West Bank, however, should prompt cautious optimism. Not only does it compare favorably to the Gaza Strip in terms of conventional water resources and annual rainfall, the West Bank is also far less water poor than the MENA region more generally. Out of the eight total groundwater basins in Palestine/Israel, three are located partially or totally within the West Bank (PASSIA 2011: 340). As such, the West Bank currently has the natural capacity, *ceteris paribus*, to meet the water needs of its Palestinian population (Glover & Hunter 2010: 7). Yet, increasing water consumption rates and demographic shifts threaten to negate this advantage in coming decades. By 2020 the total population of Palestine could reach 14 million. At that point, the combined water needs for household, agricultural, and industrial purposes could reach 859 MCM/year. It is then that when low-end supply predictions show that

demand for water could be higher than the available supply (Glover & Hunter 2010: 49, Palestinian Central Bureau of Statistics 2011: 15).

Additionally, when an independent Palestinian state is founded, it is reasonable to assume that a large inflow of Palestinian refugees and the Diaspora will follow. This influx will necessarily place increased pressure on the water supply. It is thus safe to conclude that while the natural water constraints faced by the West Bank are not as dire as those in Gaza, this fact should not be taken as an invitation for complacency or neglect. Instead, policy makers should take advantage of this narrowing window of opportunity to develop a clear, long-term water management plan which incorporates these predictable future obstacles within its strategic purview.

2.2 Artificial Water Constraints

Since the start of the occupation in 1967, the government of Israel has, in clear violation of international law, imposed severe artificial water constraints on the occupied territory of Palestine. In August of 1967, Military Order (MO) 92 arrogated complete control of all water-resources in the West Bank and Gaza Strip to area military commanders (PASSIA 2011: 340). More draconian measures soon followed; November's MO 158 forbade Palestinians from constructing new or repairing old water infrastructure without a permit, while December's MO 291 declared all water resources state property of Israel (PASSIA 2011: 340). In September of 1995, Palestinian and Israeli negotiators signed the Oslo II interim agreement³ which transferred nominal control over the water resources allotted for Palestinian consumption to the Palestinian Water Authority (PWA). At first this appeared to be a significant victory for Palestinian water rights, however, under closer inspection it is clear that this transfer of power was a mere formality – a victory in name alone insofar as the final control over the flow and volume of water allocated to the West Bank remained under the aegis of the Israeli Mekorot (PASSIA 2011: 340).

Additionally, there are two central techniques by which the Government of Israeli prevents Palestinians from gaining access to their share of common water resources: legal and physical. In terms of legality, the classification of water as an Israeli public resource has forced Palestinians to apply for Israeli government issued permits in order to drill new wells or repair old

3 Article I of the Oslo II accord specifies the agreement to a “transitional period not exceeding five years, leading to a permanent settlement based on Security Council Resolutions 242 and 338” (Oslo II, 1995). This five years interim period, has of course, long since come and gone and to date, no final settlement has materialized.

water or sewage networks. All infrastructure related permits are required to pass through an eighteen-stage Kafkaesque governmental approval procedure out of which very few emerge. From 1967 to 2003, for instance, the government of Israel issued a grand total of only 23 permits (CESR: 2003). This trend has continued unabated into the present and today there are more than 140 Palestinian water-related projects awaiting Israeli approval (PASSIA 2011: 340). If history is any guide, the overwhelming majority of these will be perpetually shelved or rejected outright. One of the obvious consequences of this legal obstructionism has been the underdevelopment of the Palestinian water and sewage sector. As of 2009, only a third of all Palestinians in the West Bank are connected to public water networks and only 31% are connected to sewage networks (World Bank, 2009: 18). Only four towns in the West Bank have functioning waste-water treatment plants and the remainder of the population is forced to dispose their sewage untreated into the environment (World Bank 2009: 18).

Another element of Israel's legal technique of access denial is the destruction its military systematically inflicts upon the existing water and sewage infrastructure of Palestine. For example, the UNDP, World Bank, UNESCO and USAID have estimated that in 2002, between the months of March and May alone, the Israeli military caused more than US \$7 million in damages to West Bank water supply and sewage infrastructure (Mair, Kamat, and Liu 2003: 4). More recently, Oxfam has reported that since June of 2009, "Israel has carried out 100 water related demolitions in the West Bank including 44 cisterns, 5 springs, 28 wells and 1 water pipeline" (Oxfam 2011: 2). While the pretense of illegality is often used as a justification for such demolitions, other times no explanations are forthcoming.

In addition to the legal barriers, Israel has also set up a series of physical impediments which consolidate their control over water resources. In the West Bank, for instance, the continued construction of Israeli settlements behind the green line has denied Palestinians access to key natural resources, including water. The strategic placement of settlement enclaves and the network of bypass roads have maximized Israeli control over key water resources such as the Western Aquifer basin, and various other springs and wells (Yusef 2009: 48). The World Bank estimates that Israeli settlers in the West Bank currently control 40 wells which extract an estimated 44 MCM/year from water resources within the West Bank (2009: 12). The over-exploitation of these wells by settlers has resulted in the drying up of many surrounding Palestinian wells and springs as they

are drawn from shared water sources forcing Palestinians to purchase water from the very settlements that created the conditions of scarcity in the first place⁴ (World Bank, 2009: 12).

In 2002, the Israelis began construction on the furthest reaching and most permanent of its physical impediments, the separation wall/barrier. With a carefully planned route that encloses the majority of Israeli settlements, the barrier also serves to destroy the contiguity of the West Bank and annex/consolidate control over its land and water resources (Yusef 2009: 52, UNOCHA & UNRWA 2008: 20). It is no accident then, that upon completion, the wall will encompass the vast majority of the western aquifer. Ultimately this will strengthen Israel's claim to and command over the most important of the shared water resources. Despite that fact that the International Court of Justice issued an advisory opinion decreeing that the separation barrier was a clear violation of international law and that those segments of the structure built in the occupied territory and east Jerusalem were to be "dismantled forthwith" – today the separation barrier remains a stark reality for Palestinians and its construction continues unabated (UNOCHA & UNRWA 2008: 20, ICJ 2004: 69).

The final tactic associated with the physical side of Israel's access restriction regime comes in the form of the so called, 'policy of closure' – a multi-faceted military-bureaucratic system of checkpoints, physical impediments (road blocks, barriers etc.), and permit policies which crisscross and dissect the West Bank. According to the Office for the Coordination of Humanitarian Affairs (OCHA), as of 2008, there were more than 630 closure related obstacles in the West Bank (2008: 1). Coping mechanisms which Palestinian communities have developed to deal with the lack of piped water and the policies of closure (typically the hardest hit communities are the rural poor) include the use of springs, cisterns and tankers – all of which are costly and tend to yield low quality water (World Bank 2009: 18). During the dry summer months, many of these traditional resources are exhausted and communities are then forced to purchase water trucked in by Israeli firms. In the regions where the 'closure' policies are heaviest, such as area C, prices for tanked water have increased between 60 and 300 percent, while in the less militarized areas (A and B) the standard rate for trucked water is four to five times the price of piped water purchased from Mekorot or around 12 NIS per cubic meter

⁴ The 2009 World Bank Report entitled *Assessment of Restrictions on Palestinian Water Sector Development* provides detailed analysis of this phenomena occurring in the towns of Barlada, Fasayil and Auja (2009: 12).

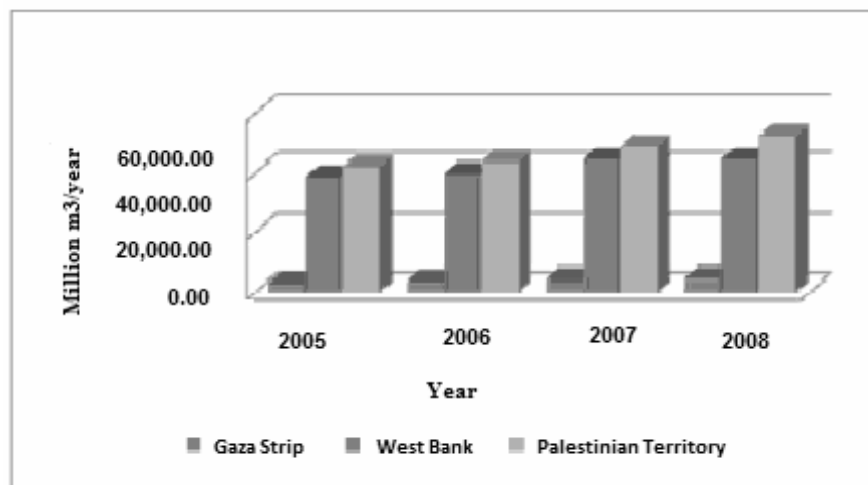
(World Bank 2009: 18). Overall, water costs have become so exorbitant in Palestine that the average urban family spends 8% of household income on the water bill, while the rural poor who rely on trucked water can spend up to a sixth of their total household income (World Bank, 2009: 17). To provide a measure of context, The World Health Organization and UNICEF recommend that expenditure on water should not exceed 3.5% of household income, less than half of the average Palestinian expense (World Bank, 2009: 21). In the end, the combination of inaccessibility and high price of water has placed many Palestinians, especially the poorest and most marginalized groups, in a vicious cycle of water insecurity.

The issue of access restriction is made all the more acute when the total amount of shared water resources between Israel and Palestine are taken into consideration. The first of the two interrelated systems is the underground 'Mountain Aquifer' which subdivides into three smaller aquifers: the Western, Northern, and Eastern. The most important of these, the Western aquifer, produces the highest quality water and is recharged by rainwater which falls almost exclusively within the West Bank. However, the storage area of the Western Aquifer lies mostly within Israel proper, making it all the easier for Israelis to exploit more than their fair share; as such, Israel currently utilizes 95% the Western Aquifer. The recharge and storage for the Northern and Eastern Aquifers, by contrast, effectively lie within the West Bank. Despite the geographical advantage this confers on Palestinians, Israel still manages to extract 70% and 37%, respectively. The total amount of potable groundwater found in the basins of Israel/Palestine is estimated to be around 2,989 MCM per year; of this, 2,570 MCM are exploited by Israel while Palestine is allotted only 271 MCM (PASSIA 2011: 340).

The second of the shared water systems is the above ground Jordan River Basin. According to international law, the Jordan River basin is to be shared amongst its five recognized riparians: Syria, Lebanon, Jordan, Israel and Palestine. With a utilization rate of 58.7%, Israel controls the lion's share of the river's resources; Jordan is next with 23.4%, followed by Syria and Lebanon with 11% and 0.3% respectively. As a legitimate riparian, Palestine has the right to "an equitable and reasonable allocation" of the waters of the Jordan River System (PASSIA 2011: 339). Yet, since 1967 Israel has utterly negated this right, denying Palestinians any access to the Jordan whatsoever (PASSIA 2011: 339). In aggregate, Palestinian access to surface and runoff water resources is equally inequitable as Israel controls and utilizes roughly 90% of both (PASSIA 2011: 340).

As of 2008, the 3.9 million Palestinians living in the West Bank and Gaza Strip had access to a mere 13% of total shared water resources; an amount insufficient to meet the basic hydration, sanitation, and food preparation needs of the population (PASSIA 2011: 340). The PWA estimates that the West Bank alone runs a yearly water deficit of around 40 to 70 MCM (PASSIA 2011: 340). It is a tragic irony that Palestinians are forced to compensate for this paucity by purchasing water, much of which was extracted from wells within the West Bank, from Mekorot or other private Israeli suppliers. According to the World Bank, in 2007, an estimated 45% of the domestic water consumed in Palestine was purchased from Mekorot; of this, 10 MCM were extracted directly from West Bank resources (2009: 16). Put as succinctly as possible, each year Israel usurps tens of millions of cubic meters of water from Palestinian land, then through policies of access denial, forces the Palestinians to buy back their own water at inflated prices. This cycle has fostered reliance upon Mekorot and its importance as a water supplier to the West Bank continues to grow. Figure 2 shows the amount of water the PWA purchased from Mekorot between 2005 and 2008.

Figure 1: Quantity of Water Purchased from Mekorot for Domestic Use (2005-2008)



Source: (Palestinian Central Bureau of Statistics 2009: 42)

2.3 Consumption Patterns

Ultimately, every aspect of the Palestinian water issue, from natural and artificial constraints to crumbling infrastructure and the policies of access restriction coalesce into a single statistic of overriding importance: per capita water availability. Currently, the average daily water supplied to Palestinian communities is estimated to be somewhere between 50 and 122 liters per capita per day (l/c/d) in the West Bank and between 90 and 170l/c/d in the Gaza Strip, depending upon which source is to be believed (PASSIA 2011: 340, World Bank 2009: 5, Yusef 2009: 63, PCBS 2009: 45).⁵ And while the discrepancy in per capita water availability between the two territories is itself large, the discrepancy between communities within the West Bank is even greater. The fragmentation of water access experienced by West Bank communities is primarily due to the fact that as a political issue, water access is mostly beyond the control of the PA. Ramallah's citizens for instance, are estimated to have access to around 150l/c/d, while some households in Hebron receive as little 10l/c/d (World Bank 2009: 10). The discontinuity between these communities becomes clearer yet when they are ranked in order of access. In 2008, 7 percent of West Bank communities (43 out of 708) had a per capita supply of less than or equal to 30 liters per day; an additional 36 percent of communities (225) had access to between 30 and 50 liters per day; some 41 percent of communities (264) were supplied between 50 and 100 liters per day; and a mere 16 percent (100) of West Bank communities had a per capita supply in excess of 100 liters per day (Yusef 2009: 63). These amounts should be compared to the World Health Organization minimum water access standard which stipulates that individuals need access to between 100-150 l/c/d in order to meet basic hydration, sanitation, and food preparation needs (PASSIA 2011: 340). Taken together, only 16 percent of the communities in the West Bank meet this standard; more importantly still, 7 percent of communities (primarily in area C) whose access is below 30 l/c/d (with some as low as 10 l/c/d) border on the minimum standard adopted by international humanitarian disaster agencies in order to avoid epidemics (World Bank 2009: 17). As the World Bank notes, "some communities of the West Bank, notably in Area C, face water access comparable to that of refugee camps in Congo or Sudan" (World Bank 2009: 17).

5 The large discrepancies in these estimates can most likely be attributed to methodological differences among studies. The World Bank for example, argues that other studies fail to take into account the water lost in piped network transit, and thus water availability data is skewed high (2009: 17). Consequently, in accounting for these losses, they produce an estimate at the bottom end of the range; 50lc/day in the West Bank (2009: 17).

Despite severe international opposition and condemnation, Israel continues to pursue a strategy of aggressive Jewish settlement construction and expansion within the West Bank. Clusters of settlements have been strategically placed throughout the territory in sensitive locations such as the tops of mountains and semi-deserted areas which provide the Israelis with the tactical advantage of consolidating control over much of the region's vital natural resources, including water (Freijat 2005: 155). As such, the PA has been left to administer over a series of fragmented territories which are essentially arid and lack any reliable water resources (Freijat 2005: 157). Settlement populations have expanded in recent decades and Oxfam notes that the 9,400 settlers living in the Jordan Valley region alone use some 45 MCM of water to irrigate land confiscated from Palestinian farmers each year (Oxfam 2011: 6). This amounts to almost one-third of the total amount of water allocated to the entire Palestinian population of the West Bank. In 2003, the last year from which data was available, the water consumption of an average Israeli settler was over nine times that of the average Palestinian (Freijat, 2003:160). Other studies, such as the one done by Oxfam in 2011, claim that the number is slightly lower, putting it somewhere in the range of four to five times higher than the average Palestinian (Oxfam 2011: 2). Nevertheless, the point is clear: the artificial water constraints placed on the Palestinians by Israel manifest themselves in dramatically asymmetric patterns of consumption.

3. Institutional and Regulatory Setting

3.1 Institutional Setting

The institutional setting of the water sector in Palestine is deceptive for two reasons: first, it contains all the trappings of a formally sovereign government body, yet it operates in an environment over which it can exert very little control, and second the legal framework of the water sector is not reflected in its current institutional arrangement (Haddad 2003: 137). When, in 1994, the Israeli military handed over nominal control of the water resources allotted to Palestine, the PA was faced with the daunting task of administering over a decaying and underfunded water sector plagued by institutional fragmentation, spread out over several geographical locations, and not designed to meet Palestinian water needs (Glover & Hunter 2010: 20). What's more, under the constraints of the Oslo II framework it remained a political impossibility for the PA to fully integrate its management of water resources in the West Bank as the Israeli military retained direct control over the large swaths of land which comprise Area C. Even though Oslo II did produce a collaborative Palestinian-Israeli governance mechanism – the Joint Water Committee (JWC) – tasked with facilitating water sector investment in Palestine; in practice the JWC has accomplished just the opposite of its intended purposes by serving as mechanism through which Israel restricts water sector development. By utilizing the veto power granted them under Article 40, the Israelis have stymied nearly all PA proposed water management measures and infrastructure projects. For instance, wastewater treatment and reuse projects currently have the lowest rate of approval from the JWC as the Israeli faction will insist that wastewater recycling facilities also need to service Israeli settlements in order to be approved. Naturally, Palestinian negotiators, who recognize this attempt to legitimize the illegal colonization of the West Bank, reject these demands and the projects are never able to get off the drawing board (Glover & Hunter 2010: 21). The World Bank notes that there are currently “106 water projects and 12 large scale wastewater projects awaiting JWC approval, some since 1999” (World Bank 2009: ix). With the Israeli Mekorot retaining control over a large volume of water allotted to Palestine and the JWC wantonly vetoing management and development projects, the PA has been left with very little room for unilateral action in the water sector.

Despite its limited capacity for action, the PA has recognized the strategic impotence of the water sector. In 1995 a Presidential decree established a central regulatory agency for water management in the West Bank and Gaza – the Palestinian Water Authority (PWA). A statutory institution, the PWA has its own budget and legally falls only under the authority of the Cabinet of Ministers and the National Water Council (NWC), which was created in 2002. An interministerial body comprised of representatives from various relevant ministries, NGOs and key universities, the NWC was established according to Palestine Water Law No.3 to be the water sector's supreme decision making body. As the head of the water sector, the NWC's primary responsibilities are to strategize water policy, set national water quotas and evaluate the legality of water ownership. Yet, since its inception nearly a decade ago, the NWC has met only once and has so far failed to fulfill its intended purpose. This failure to launch has left the water sector bereft of leadership and a clear direction. As a result, the PWA acts not only as a regulator and manager but as a designer and implementer of policy as well. According to a World Bank study on the Palestinian water sector, the result of these forces tugging the PWA in all directions have left it "spread too thinly" and "over centralized" (World Bank 2009: 57).

The situation is unfortunately similar in the lower echelons of the water sector's pyramid of hierarchy. While the PWA acts as a middle man responsible for water resource management and bulk water distribution, the institutional architecture proposed the creation of four regional utilities: one in the Gaza Strip and three others in the West Bank (North, Center and South) for the purpose of carrying out the process of retail water distribution to local communities. However, to date, only one regional utility, the Coastal Municipalities Water Utility (CMWU) in Gaza, has been established. Retail water distribution services in the West Bank remain heterogeneous and fragmented. The two largest West Bank providers are the sub-regional Jerusalem Water Undertaking (JWU) which supplies Ramallah and its surrounding area and the Water Supply and Sewage Authority (WSSA) which services the Bethlehem area. In the hundreds of other urban areas and towns in the West Bank, water is supplied by the municipalities while the rural population relies on village council water departments (World Bank 2009: 15).

Taken together, two important facts about the institutional structure of the water sector emerge. First, irrespective of the effectiveness of Palestinian water institutions, the central obstacle to the development of sustainable, integrated resource management in Palestine has been and remains the

sector's subordination to the Government of Israel. Due to the asymmetry of power and the fragmentation of control in the West Bank, the water sector in Palestine remains subject to the final authority of Israel which has been extremely successful in limiting its scope of action. Second, the water law in Palestine has been set up in such a way as to create sectoral governance which entails the strict separation of the decision making, regulatory, and distribution elements of the water sector. However, this vision has never come to fruition and it is not reflected by present institutional arrangements. As a result, the fragmented water sector lacks coordination and its overlapping spheres of authority work to circumscribe institutional capacity. Tables 1 below clearly contrast the divergence between the institutional layout and function as intended by Palestinian water law and the actual existing function.

Table 1: Intended vs. Actual Institutional Framework

| Intended Institutional Framework | | Actual institutional Framework | | |
|----------------------------------|------------------------|--------------------------------|---------------|------------------------|
| National Water Council | Decision Making Level | N/A | | Decision Making Level |
| Cabinet of Ministries | | | | |
| Palestinian Water Authority | Institutional Level | Palestinian Water Authority | | Institutional Level |
| Regional Water Utilities | Service Delivery Level | Municipal and Village Councils | JWU and WASSA | Service Delivery Level |
| | | | CMWU | |

3.2 Regulatory and Legislative Setting

There are currently 3 central regulatory documents which pertain to the collection and treatment of wastewater for reuse in the West Bank and Gaza Strip: 1999's Environmental Law No. 7, 2002's Water Law No. 3, and the agreements signed with Israel (in particular 2003's Memorandum of Understanding (MOU)) (World Bank 2004: 12).

The central premise of 1999's Environmental Law No. 7 is to protect water resources which are to be treated and reused.

- ✧ Article (28): The Ministry in cooperation with the specialized agencies shall specify the standards for the quality and characteristics of fresh water.
- ✧ Article (29): The Ministry, in coordination with the specialized agencies, shall set standards and norms for collecting, treating,

reusing, or disposing waste and storm water in a sound manner, along with the preservation of the environment and public health.

- ✧ Article (30): No person shall be allowed to discharge any solid or liquid or other substance unless such a process conforms to the conditions and standards that the specialized agencies determine.

The function of 2002's Water Law No. 3 is to highlight the need for the development of sustainable water resources in a way that is not only equitable, but also adheres to the following standards in regard to the disposal, treatment and reuse of the water:

- ✧ Article (3): All water resources available in Palestine are considered public property.
- ✧ Article (4): It is prohibited to drill or explore or extract or collect or desalinate or treat water for commercial purposes or to set up or operate a facility for water or wastewater without obtaining a license.
- ✧ Article (29): [Regulates] the use of agricultural and industrial materials, which may cause pollution to the water resources or its supply systems.
- ✧ Article (32): Anyone who causes pollution in any water resource or its supply system must remove the pollution to that source or system at his own expense, and in case he refuses or fails to do so, the Authority must remove the pollution and carry out the cleaning operations on the expense of the party causing the pollution after notifying him of this regardless of the costs, which shall be levied from him in accordance with the Law for Collecting Public Monies.

The final regulation comes by way of 2003's MOU, signed by both Israel and the PA. The agreement encompasses collection systems, wastewater treatment, sludge treatment, effluent reuse, and disposal (World Bank 2004: 12). According to the World Bank, the MOU is the most important of the regulations as it "will drive the treatment technology and reuse strategies that will be used in the West Bank and Gaza Strip." For our purposes, the central implications of the MOU are:

- ✧ Agricultural reuse is to be the primary focus for reuse. This must include sufficient seasonal effluent storage.
- ✧ Other forms of reuse must gain mutual agreement from both parties.
- ✧ All sewerage projects must be complete systems – i.e. collection systems from source, conveyance to treatment plant, treatment plant, a plan for reuse or safe disposal, conveyance to the point of reuse or discharge, and safe reuse or disposal of sludge.

Given the number of legal documents and agreements pertaining to the treatment of sewage and wastewater reuse, it is clear that the PA and PWA recognize the importance of wastewater reuse and establishing proper regulation. However, practically speaking, these regulations only exist on the books and are not enforced in any effective manner. As such, even after these laws and regulations were officially put on the books there has been little improvement in the capacity for wastewater collection and reuse in Palestine. In fact, negative environmental and health impacts of wastewater have generally increased over time. Currently, the majority of raw sewage (some 25 MCM) is discharged, untreated, into wadis throughout Palestine each year (World Bank 2009: iv). Further, because regulated wastewater reuse remains virtually non-existent, the informal use of untreated wastewater for small scale crop irrigation has proliferated despite its negative environmental and health impacts (Glover & Hunter 2010: 20). A survey taken in Qebia village near Ramallah underscores the prevalence of this practice, finding that 89% of households use untreated grey-water to irrigate their gardens, even though the majority (53%) believe that it adversely affects soil, plants and health (Burnat & Eshtayah 2010: 22). The clear correlation to be drawn from the discrepancies between written and practiced regulatory measures is twofold: first, there is widespread institutional dysfunction within the water sector which undermines the possibility of effective enforcement. Second, Israeli intransigence toward the development of the Palestinian water sector drastically decreases its capacity to function as an effective regulatory agency.

4. Grey-Water

4.1 Defining Grey-Water

Treated grey-water falls under the broader category of treated wastewater, which, put in its most basic terms, is the process by which effluent from domestic residences, commercial properties and industrial and agricultural processes is filtrated and/or undergoes chemical or biological processing to remove harmful solids and other contaminants (Glover & Hunter 2010: 88). For the most part, wastewater is treated in large facilities which use combinations of sophisticated chemical, physical and biological processes (Glover & Hunter 2010: 88). However, the level of treatment any wastewater requires is dependent on both the source from which it was generated (as industrial wastewater contains different contaminants than that of domestic wastewater etc) and the intended, final purpose of the use of treated water.

Grey-water is one type of domestic wastewater, which is itself reducible into three distinct categories: grey-water, dark grey-water, and black-water (see table 3). Although slight variations exist throughout the world, the most broadly accepted definition of grey-water is that it is generated from household uses such as bathing and laundry and which has not come into contact with raw sewage. The central characteristic which distinguishes grey-water from the other types of household effluent is that the concentration of contaminants in grey-water is relatively low and therefore it yields a far higher quality effluent. It is true that grey-water might contain some of the same contaminants that are found in raw sewage, but these contaminants are found in far lower concentrations. For instance, it is recognized that grey-water can contain fecal matter as well as nitrogen and phosphorus (Allen, et al., 2010: 8). By contrast, so called “black-water” or the discharge from toilets (kitchen sinks and dishwashers are sometimes included in this category), contains high concentrations of contaminants and thus requires more sophisticated treatment processes which cannot be easily undertaken at the individual household or even small-scale community level. Unlike black-water then, grey-water has the potential to be treated by relatively simple and cost-effective systems which can be installed and operated at the household level. Below, table 3 clearly delineates between the different types of wastewater while table 4 lists possible contaminants by grey-water source.

Table 2: Types of Wastewater

| Type of Wastewater | Definition |
|-----------------------|---|
| Grey-water | Untreated household effluent which has not come into contact with raw sewage. |
| Black Water or Sewage | Wastewater which is derived from toilets, bidets, water used to wash diapers, and sometimes water from kitchen sinks and dishwashers. |
| Dark grey-water | Sometimes considered to fall under the definition of black-water, dark grey-water is untreated household wastewater which has not come into contact with raw sewage; but which comes from lower quality household uses such as kitchen sinks and dishwashers. |

Source: (WHO 2006: 3)

Table 3: Grey-Water Contaminants by Source

| Grey-water Source | Possible Contaminants |
|--------------------|--|
| Washing-machine | Suspended solids (dirt, lint), organic material, oil and grease, sodium, nitrates and phosphates (from detergent), increased salinity and pH, bleach |
| Dishwasher | Organic material and suspended solids (from food), bacteria, increased salinity and pH, fat, oil and grease, detergent |
| Bathtub and shower | Bacteria, hair, organic material and suspended solids (skin, particles, lint), oil and grease, soap and detergent residue |
| Sinks | Bacteria, organic matter and suspended solids (food particles), fat, oil and grease, soap and detergent residue |

Source: (WHO 2006: 3)

In properly matching the quality of water to its final use, treated grey-water has the potential to replace the use of expensive fresh water for applications which do not require it. One example of this is the treated water that has been used in showers, sinks, or for clothes washing being diverted to the house-hold garden for irrigation purposes. This in turn reduces the household demand for expensive fresh-water which would have otherwise been used for outdoor irrigation purposes. Because treated grey-water lends itself to small-scale agriculture and can be implemented at the house-hold level, its primary beneficiaries tend to be marginalized and rural. This is because households in rural areas tend not to have access to alternate water sources, or cannot afford to purchase expensive trucked water from Israel, or they are already using untreated grey-water (McIlwaine & Redwood 2010: 168).

4.1.1 Selecting the Appropriate Technology

Selecting the appropriate grey-water reuse technology is absolutely crucial to the long-term sustainability of any grey-water project. Today there is a plethora of grey-water reuse technology which ranges from complex physical and chemical systems serving large-scale infrastructure to small, decentralized systems designed for use by a single household. The appropriateness of the technology for any project can be divined through examining a few important criteria, such as: the area it is serving, the system's quality of effluent, its cost, its ease of use, and most importantly, its socio-cultural acceptability. Should a grey-water system fail to meet any of these criteria, the sustainability of the entire project could be put in jeopardy. It is clear that in the Palestinian case, the use of small-scale on-site technology is appropriate because, according to the World Bank, "such systems are suitable for low sewerage flow due to low water consumption which is the case in most Palestinian villages and towns" (World Bank 2004: 4). Consequently, this narrows the selection criteria for technology to one end of the technological spectrum which caters to small-scale, rural use.

As the Pacific Institute's study on grey-water reuse notes, "appropriate technology means choosing a grey-water treatment system that follows local grey-water codes and matches the quantity and quality of water to its intended use" (Allen, et al., 2010: 33). In the case of rural and peri-urban Palestine, there are no specific local grey-water codes to be in compliance with; however, it remains absolutely crucial to match the quality of grey-water output to its intended use in order to avoid any potential public health problems. In our case, the grey-water system must provide water which is safe for the purpose of small scale crop irrigation. In this regard it is important to be sure that the technology produces grey-water which is in compliance with the WHO's safety standards for use in crop irrigation.

Additional criteria on which the success of any grey-water technology in Palestine depends are its costs (both construction and operational) and its ease of use. Because this project is meant to target rural, impoverished communities it is extremely important that the grey-water system be low-cost, both in terms of capital investment and operation. As Abu-Madi makes clear in a comparative analysis of cesspit and grey-water systems, "the implementation of grey-water systems is often limited by the availability of external funding, and most Palestinian communities have not reached a stage where they are able to implement grey-water systems with their own funding" (*Abu-Madi, et al., 2010: 89*). Consequently, even

extremely low cost technology will be unaffordable to most rural household, so along with low-cost technology, some sort of cost-sharing mechanism will undoubtedly be required. It is also extremely important that the reuse system generate economic benefits over and above the current cesspit systems or else there will be little incentive for households to adopt the technology. Similarly, operational costs must be kept low or at least prove to be far less than the cesspit system. This means that the system cannot use up excessive amounts of energy nor should it require expensive, non-local replacement parts if something malfunctions or breaks. Finally, it is imperative that the system should be user friendly. The ability to train members of the household to safely and efficiently operate the technology without external guidance will ensure the long-term sustainability of the system. Taken together, the any system must meet the following four criteria: it must be low-cost, use only locally available materials, provide positive economic benefits, and be extremely user friendly.

Finally, the issue on which the entire grey-water enterprise stands or falls is that of socio-cultural acceptability. Again, as Abu-Madi notes of previous grey-water projects in Palestine, “Many grey-water treatment-and-use projects failed, where planning, design, and implementation were based mainly on technical aspects, without adequate examination of the economic or socio-cultural issues. Therefore, a socio-cultural, ecological, and cost-benefit analysis should be considered to ensure that on-site GW treatment-and-use schemes are designed to be sustainable, irrespective of the project size” (Abu-Madi, et al., 2010: 91). For a technology to be embraced by a local group it needs to be embedded within their own cultural and socio-economic reality (Laban 2010: 102). For instance, it is true that prohibitions or taboos about waste-water reuse which are rooted in Islam (these may or may not be scripturally based) have made some communities hesitant about grey-water use. It is thus important to assuage these fears before trying to implement grey-water systems. If the cultural and religious values of the communities are not taken into consideration, it will be very difficult to apply grey-water technology on a large-enough scale to achieve the desired impact (Laban 2010: 103). In sum, the selected technology must meet all of the previous criteria if it is to be successfully implemented in the case of Palestine.

Even though this narrows down the amount of suitable systems, there are still too many to properly analyze. In lieu of this, two possibly suitable systems have been selected to highlight the different options available. The first, Burnat’s on-site treatment system, is designed to serve households

with between 6 and 25 persons and is “gravity loaded, with a maximum flow during the day and zero flow at night” (Burnat & Eshtayah 2010: 19). The technical layout of the system is shown in Figure 4 and a detailed description of its functioning follows:

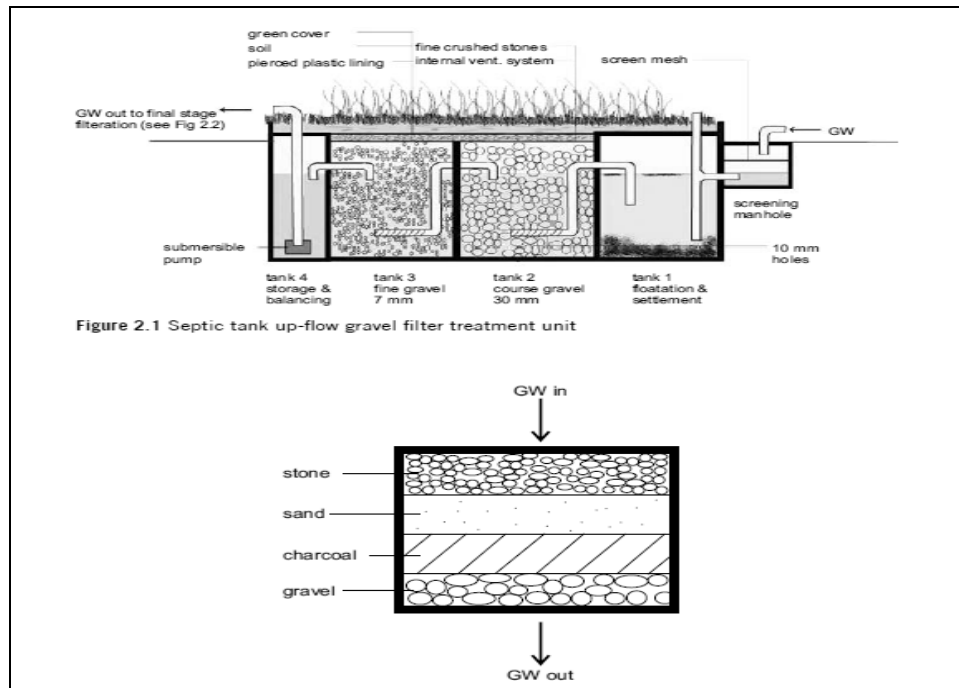
The gravel filter medium is mostly a crushed, hard limestone, 0.7–3.0 cm in size. The tanks are made of concrete and/or bricks, and are divided into four compartments. The first compartment is a septic tank and grease trap and receives the GW – from the shower, kitchen, sinks and washing machine – through a 5 or 7.5 cm diameter PVC pipe, via a screened manhole, by means of a T-shaped outlet. One end of this outlet is directed upward and open to atmospheric pressure and the other is at a level of about 30 cm from the bottom of the tank. The second and third tanks act as up-flow graduated gravel filters. The fourth compartment acts as a balancing tank for the treated GW, with a submersible pump flow from the top tank, the GW passes through the filter layers (sand, coal, and gravel – as shown in Figure 2.2) to a storage tank from where it can then be supplied to the irrigation network (Burnat & Eshtayah 2010: 20).

Essentially, the main treatment stage is an anaerobic process which is followed by the aerobic multilayered filter containing sand, coal, and gravel (Burnat & Eshtayah 2010: 19). The efficiency of this system has proven to be high as in practice it was capable of lowering the levels of Chemical Oxygen Demand (COD) and fecal coliform by several magnitudes, bringing them into line with the WHO’s acceptable limits for fruit trees and vegetables to be cooked and eaten (Burnat & Eshtayah 2010: 19). Figure 5 below shows that across the board, the treatment process adequately reduced the concentration of pollutants to levels that meet WHO standards for grey-water use.

Burnat designed the septic gravel up flow system specifically for the rural Palestinian communities and consciously choose local, low-cost parts and materials. As a result the system is relatively easy to use and the final product is inexpensive. According to Abu-Madi’s comparative analysis, the average capital cost for the system was \$1,212 per household while capital costs for the traditional cesspit system averaged \$1,405 per household (Abu-Madi, et al., 2010: 92). In addition, the median operation cost for those using Burnat’s grey-water system was significantly lower than it was for households using traditional cesspits, with \$65 per household per year and \$151 per household per year respectively (Abu-Madi, et al., 2010: 93). Finally, due to the system’s simple design which consists completely of local materials, households have found it extremely

easy to operate and maintain. An independent survey carried out by Birzeit University found that the system was very robust in terms of instances of instances of failure, and operation/maintenance time (Nidal & Mimi 2008: 3). Indeed, the combined time it took users to monitor the system (which includes routine checks of the treatment basin, irrigation, and pump work) and maintain the system through repairing and cleaning was only 41 hours per year per household (Nidal & Mimi 2008: 4). On the whole, Burnat's system meets the following three criteria of success: it confers economic benefits on its users, it is low cost and the materials are locally available, and it is easy to maintain and operate.

Figure 2: Burnat's septic gravel up-flow system



Source: (Burnat & Eshtayah 2010: 20)

Finally, most important characteristic of Burnat's system is the widespread cultural acceptance it has garnered. After beginning the pilot project with 23 units, researchers soon found that demand had grown and an additional 25 systems were installed (Abu-Madi, et al., 2010: 104). However, surveys found that the interests of surrounding villages had been piqued and that the 48 systems covered only 30 percent of the local demand (Abu-Madi, et

al., 2010: 105). Similarly, a Birzeit University study discovered that 74.5% of the beneficiaries were very satisfied, 21.3% were satisfied, and only 4.3% were not satisfied with their systems (Nidal & Mimi 2008: 3). Moreover, the vast majority of the beneficiaries, some 95.7%, recommend the system to be applied for other non served houses (Nidal & Mimi 2008: 3). This clearly displays that Burnat's system has found wide cultural acceptance and augers well for its ability to make a wide impact on the lives of the most water insecure communities. On every relevant metric, then, Burnat's gravel up-flow system performs exceptionally well and is clearly an excellent option for rural and peri-urban Palestinian communities.

Figure 3: Samples of grey-water before and after treatment in the units

| <i>Parameter</i> | <i>Unit</i> | <i>GW influent</i> | <i>GW effluent</i> | <i>WHO/FAO guidelines</i> |
|---------------------------------|-------------|---------------------------------------|---------------------------------------|-----------------------------|
| DO | mg/l | 0 | 0.5–2.0 | |
| pH | | 6.60–6.86 | 6.70–7.79 | 6.5–8.4 ^b |
| BOD | mg/l | 941–997 | 21–121 | 20 ^c |
| COD | mg/l | 1,391–2,405 | 58–266 | |
| NH ₄ ⁺ -N | mg/l | 25–45 | 12–48 | |
| Surfactant | | 11–17 | 5–13 | |
| NO ₃ ⁻ | mg/l | 0–1.3 | 13–36 | 9.5–518.5 ^b |
| Total Suspended Solids (TSS) | mg/l | 36–396 | 4–24 | 20 ^c |
| EC | | 891–899 | 844–1,493 | 0.7–3.0 (dS/m) ^b |
| Total Dissolved Solids (TDS) | mg/l | 483–515 | 465–849 | 450–2,000 ^b |
| Faecal coliforms | cfu/100 ml | 1×10 ⁴ –37×10 ⁴ | 0–1×10 ² | 200 ^a |
| Total coliforms | cfu/100 ml | 1×10 ⁹ –5×10 ⁹ | 2×10 ² –10×10 ² | 1,000 ^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

Source: (Burnat & Eshtayah 2010: 23)

Another, less sophisticated but cheaper grey-water treatment system was implemented by the International Center for Agricultural Research in the Dry Areas (ICARDA) and the International Water Management Institute (IWMI) in neighboring Jordan. The system consist of a septic tank followed by an intermittent sand filter was installed in some communities. This cost effective system yielded positive results for treated grey-water and can be used for agricultural purposes (Qadir, 2008: 38).

Figure 4: Performance of septic tank followed by sand filter in Abu Al-Farth- Jordan

| Parameter | Unit | Raw graywater | Effluent from dosing tank | Effluent from sand filter | Septic tank efficiency (%) | Sand filter efficiency (%) |
|--------------------|--------------------|---------------|---------------------------|---------------------------|----------------------------|----------------------------|
| BOD ₅ | mg L ⁻¹ | 1181.67 | 480.25 | 67.50 | 59 | 86 |
| COD | mg L ⁻¹ | 2248.00 | 862.43 | 143.43 | 62 | 83 |
| TSS | mg L ⁻¹ | 608.75 | 199.86 | 37.00 | 67 | 81 |
| FOG | mg L ⁻¹ | 182.90 | 8.00 | 8.00 | 96 | 0 |
| MBAS | mg L ⁻¹ | 26.73 | 51.51 | 22.45 | ** | 56 |
| NO ₃ -N | mg L ⁻¹ | 46.50 | 3.29 | 0.75 | 93 | 77 |
| NH ₃ -N | mg L ⁻¹ | 52.71 | 111.00 | 39.25 | ** | 65 |
| Total N | mg L ⁻¹ | 121.28 | 111.50 | 34.00 | 8 | 70 |
| Total P | mg L ⁻¹ | 26.9 | 16.4 | 5.3 | 39 | 68 |
| SAR | - | 6.7 | 5.9 | 3.8 | 12 | ** |
| K | mg L ⁻¹ | 27 | 32 | 21 | ** | 34 |
| B | mg L ⁻¹ | 0.302 | 0.569 | 0.391 | ** | 31 |
| <i>E. coli</i> | MPN/100 mL | 6841 | 4420 | 64 | 35 | 99 |

** No removal occurred

Source: Qadir, 2008

4.2 Treated Grey-water: Potential Benefits & Challenges

4.2.1 Treated grey-water and Public Health

Although grey-water contains a number of the same pollutants as other types of wastewater, it is, from a health standpoint, much less dangerous because the concentration of these pollutants in grey-water is much lower. Nevertheless, according to the WHO's wastewater reuse standards, untreated grey-water is still far too contaminated for activities such as drinking, bathing or even irrigation (Allen, et al., 2010: 22). And although treated grey-water reuse has never been directly linked to any documented cases of public health impacts, this is not definitive proof that there is no causal link, especially since illness is notoriously difficult to trace back to its source (Allen, et al., 2010: 22). Hence, when research about the impact of treated grey-water is conducted, several points have to be taken into account before attributing any negative or positive effects to the quality of grey-water (WHO IV 2006: 73):

- ✧ The specificities of the soil; to establish if the soil has already high levels of salinity and bacteria before the use of treated grey-water.

- ✧ The overall health of the people who are consuming products grown with the use of treated grey-water as well as the age of these people.
- ✧ The overall hygienic habits of the households using products produced with treated grey-water.

The most salient consideration is not whether treated grey-water reuse is intrinsically risky, but rather if these risks are acceptable in relation to the benefits the system confers upon users and if grey-water systems represent a net reduction in public health risks when compared to the cesspit system currently being used in rural Palestine. The question this section seeks to answer is: how can potential health risks be effectively managed and would the widespread adoption of treated grey-water recycling in Palestine represent an increase or decrease in health risk when compared against the current cesspit system?

Most of the current literature suggests that treated grey-water reuse, when properly conducted, represents a minimal risk to public health. Nevertheless, it should be noted that there is also wide agreement that additional studies on the long-term health impact of treated grey-water reuse need to be conducted. With this caveat in place, it is clear that the key to avoiding the negative health impacts associated with treated grey-water reuse primarily lies in user awareness of these risks and their proper use of the system to mitigate those risk factors.

To decrease any possible negative health implications and maximize the crop yield it is important that the crop is matched to the treated grey-water quality and the irrigation system. There is an overall consensus that spraying treated grey-water onto the crop has to be avoided at all times, whereas underground irrigation is deemed the safest use for all plants and crops. Over ground drip irrigation is consensually deemed safe for plants whose crops do not come into contact with the soil (Redwood 2010: 5). There is still ongoing research on the impact above ground drip irrigation has on produce which comes into contact with the soil such as tomatoes, carrots or cucumbers. Furthermore, with some crops, it is important to stop irrigation with treated grey-water well before the harvest to give potentially dangerous organisms time to retreat (WHO IV 2006: 73). A survey conducted by Birzeit University found that the majority of grey-water system users in Qebia village believe that introducing a wastewater management system reduced disease and that the system did not cause them any physical harm (Nidal & Mimi 2008: 4). What this makes clear, that so long as proper training and basic precautionary steps are in place, grey-water recycling poses little to no health risks for rural Palestinian communities.

In general, the current cesspit system which is used by most rural communities in Palestine is fraught with public health risks which can be mitigated or eliminated through the implementation of grey-water recycling systems. Cesspit systems fail to protect Palestine's vital fresh-water resources and jeopardize public health by saturating soil with dangerous pollutants which then percolate into groundwater supplies. This poses a major public health risk as it further reduces the already scant amount of potable water available in Palestine and degrades it to such a condition that the risk of water-borne illness drastically increases. Grey-water treatment systems help to mitigate this problem as the reuse of a large percentage of household wastewater for garden irrigation significantly reduces the load put on the cesspit system and thus puts groundwater resources under far less stress. Taken together, the public health benefit of reusing treated grey-water for application in small scale agriculture is clearly positive, especially when the alternative, in the Palestinian context, is to either use untreated grey-water or alternatively, to dump the untreated waste into the environment where it then contaminates the surrounding soil and ultimately seeps into groundwater.

4.2.2 Environmental Aspects

Grey-water recycling, like any waste-water reuse scheme, has the potential to produce both positive and negative environmental externalities. Accordingly, the net effect which any grey-water treatment system has upon the environment, be it salutary or harmful, is simply a factor of how well the system has been implemented and administered. A comprehensive environmental impact study conducted by the WHO, found that "[treated] grey-water can be beneficial to the environment" so long as "careful planning and management" are in place (WHO IV 2006: 59). Where this foresight and administration is lacking, such as in the previously discussed case of Qebia village, where the use of untreated grey-water for crop irrigation arose spontaneously and without planning, negative environmental outcomes proliferated; citizens of Qebia suffered from offensive odors, explosions in the population of pests such as flies and mosquitoes, clogged soil, and the growth of algae and fungi among other ecological problems (Burnat & Eshtayah 2010: 22). By contrast, when properly managed, the WHO found that negative environmental impacts such as these can be largely obviated and moreover, that the "direct use of excreta and grey-water on arable land tends to minimize the environmental impact in both the local and global context. Reuse of excreta on arable land secures valuable fertilizers for crop production and limits the negative impact on water bodies" (WHO I 2006: 59). This is clearly borne out by

the evidence in Qebia village, whereby after grey-water treatment processes were brought in line with the acceptable WHO limits through the instillation of recycling systems, organic soil pollutants declined sharply, foul odors disappeared and the researchers found that overall there was a “significant reduction in environmental impact from treated grey-water” (Burnat & Eshtayah 2010: 24). The central point to be taken away from this is that the treatment and management of grey-water reuse must be adequately implemented if negative environmental outcomes are to be avoided and beneficial outcomes ensured.

For our purposes, it is important not only to analyze the environmental benefits of treated grey-water use in the abstract, but also to note the impact its use will have given the particular local conditions and the current wastewater practices in Palestine. Such an analysis not only provides a general overview of grey-water and its relationship to the environment but will also offer a clearer understanding of the real, on the ground benefits it can offer to Palestine. According to the WHO, the environmental impacts of different sanitation systems can best be measured in three ways: first, in their conservation and use of natural resources, second on the basis of their discharges to bodies of water, and finally on the impact they have on soil (WHO I 2006: 59). In general terms, the WHO has found that using these assessment standards “source separation and household-centered use systems [i.e. grey-water systems] frequently score more favorably than conventional systems” (WHO I 2006: 59). Looking at the first metric, conservation of resources, grey-water treatment systems represent an improvement over their conventional counterparts because a) using treated grey-water instead of higher-quality fresh water to irrigate crops allows for the preservation of drinking water supplies and b) because treated grey-water contains a variety of nutrients which are recycled into the soil, it reduces reliance on fertilizers which in turn decreases the amount of energy going into fertilizer production and the mining for its constituent parts (i.e. phosphorus etc.) (WHO I 2006: 8. WHO II 2006: 132).

The second of the metrics, the effect of waste-water systems on bodies of water, also produced favorable results for grey-water treatment systems over conventional waste-water systems. The WHO notes that “Where wastewater treatment services are not provided, the use of wastewater in agriculture actually acts as a low-cost treatment method, taking advantage of the soil’s capacity to naturally remove contamination. Therefore, the use of wastewater in irrigation helps to reduce downstream health and environmental impacts that would otherwise result if the wastewater were

discharged directly into surface water bodies” (WHO I 2006: 42). As far as the final metric, the impact on soil, is concerned, the results of treated grey-water reuse are a bit more mixed. On the positive side, grey-water contains many nutrients such as phosphorus, potassium and other organic matter which improves soil structure and fertility (WHO II 2006: 112). On the other hand, the long-term use of grey-water can, if improperly managed, cause damage to soil. The most significant soil related problem associated with treated grey-water irrigation is the gradual increase in salinity that it engenders. In the long-run, increased soil salinity can lead to changes in osmotic pressure at the root zones of plants, increase soil toxicity, interfere with plant uptake of essential nutrients and destroy soil structure (WHO II 2006: 109). However, it is important to note that increased soil salinity can be controlled and kept at manageable levels with relatively simple, cost effective methods, such as: soil washing, proper drainage, controlling household salt inputs from detergents, water softeners etc., or installing a saline water filtration (WHO II 2006: 109). The same holds true for the other, less severe soil related problems; with some amount of planning and foresight these negative environmental impacts can be all but negated.

Turning away from the abstract cost-benefit analysis of treated grey-water vs. conventional systems and applying the same criteria of assessment to the Palestinian case yields similarly favorable results for grey-water recycling. When the first of the WHO’s metrics, conservation of resources, is applied to Palestine, grey-water systems prove to be more environmentally beneficial than traditional Palestinian cesspit systems. As detailed above, grey-water treatment projects implemented in Palestine found that households using the system were able to preserve hundreds of thousands of liters of fresh-water per year when compared to those using conventional cesspit systems (Burnat & Eshtayah 2010: 17). Moreover, the use of treated grey-water for irrigation purposes means that Palestinian families are able to reduce or end their reliance on expensive fertilizers, as the nutrients inherent to treated grey-water work as a suitable fertilizer substitute. On a whole then, when compared to current wastewater practices in Palestine, the adoption of grey-water treatment systems would produce a net conservation of resources by reducing pressure on fresh-water resources and lessening the demand for fertilizer.

As far as discharges into bodies of water, the second of the WHO metrics, is concerned, grey-water treatment systems again fare far better than their cesspit counterparts. Recall that today, wastewater is one of the chief sources of environmental degradation in Palestine as the majority of

sewage goes untreated and is simply discharged into various wadis (Haddad 2009: 117). Only 25 % of Palestinian households are connected to a sewerage network and those few treatment facilities that do exist are, in general, poorly managed and produce low-quality effluent (World Bank 2009: vi, Glover & Hunter 2010: 90). The other 75% of households tend to rely on cesspits for the collection of sewage. As a disposal system, cesspits are fraught with environmental hazards as they jeopardize groundwater and the environment (Abu-Madi, et al., 2010: 90). Often, untreated or insufficiently treated wastewater from cesspits will slowly percolate into nearby groundwater, contaminating reserves, and ultimately rendering them non-potable (Zecharya, Keinan & Bromberg 2007: 417). As such, the large-scale pollution of fresh ground-water resources is one of the greatest environmental challenges facing Palestine today. Clearly then, the net benefit of reusing nutrient-rich treated grey-water for irrigating crops is positive, as the alternative cesspit systems are the leading source of ground-water pollution today (Redwood 2010: 4). Ultimately, recovering and reusing the 80% of household wastewater which grey-water comprises, reduces pressure on the overloaded and over-polluted environment in Palestine and helps to maintain the integrity of its precious fresh-water resources.

Finally, the effects of grey-water treatment systems on soil in Palestine is a bit more ambiguous. The first important point to note is that in cases where untreated grey-water is already being used to irrigate crops, the installation of grey-water treatment systems is unquestionably beneficial to the soil. The use of untreated grey-water leads to serious degradation as the soil becomes polluted with organic matter and pathogens. As PHG studies have demonstrated, the treatment process of grey-water treatment systems adequately reduces the concentrations of pollutants to within the WHO's acceptable guidelines and is thereby able to restore soil integrity (as in the case of Qebia village) (Burnat & Eshtayah 2010: 26). By contrast, the soil salinity engendered by grey-water irrigation remains a concern. And while there is nothing in the literature which provides concrete figures for the Palestinian case, grey-water projects undertaken in neighboring Jordan have found that there were slight increases in soil salinity in the years after grey-water systems were introduced (Murad, Al-Beiruti & Ayes 2010: 44). According to the WHO guidelines, salinity problems can occur when soil conductivity is greater than 3 m/Sm (deciSiemens per meter); in the Jordanian case, salinity levels rose from 0.34-0.96 m/Sm before grey-water use to 1.1-1.82 m/Sm afterward (WHO II 2006: 121, Murad, Al-Beiruti & Ayes. 2010: 41). While this increase is worrisome, it remains well below the levels at which salinity problems can occur. As such,

salinity increases must be properly monitored and managed, but are ultimately not serious enough to negate the large number of benefits that grey-water systems offer. Table 7 below provides a brief summary of some of the most salient environmental factors associated with grey-water reuse.

Table 4: Environmental Benefits and Hazards Associated with Grey-water Technology

| Potential Benefits | Potential Hazards |
|--|--|
| The safe use of wastewater, excreta and grey-water contributes to less pressure on freshwater resources and reduces health risks for downstream communities. | Industrial discharges containing toxic chemicals are mixed with domestic wastewater in many countries, creating serious environmental problems. |
| Improved sanitation in support of safe excreta use reduces flows of human waste into waterways, helping to protect human and environmental health. | Soil salinity increases after long-term exposure to grey-water. Without proper management to mitigate this effect, soil productivity can decline. |
| Nutrients found in grey-water help to fertilize soil and produce greater crop yields. | Organic chemicals from excreta can minimally impact surface water bodies due to their absorption of soil particles after application. However, because the soil acts as a filter before the respective pollutants reach ground and surface water, risks are largely mitigated. |

4.2.3 Circumvention of Occupational Constraints

One important point that has been stressed throughout this study is that past ‘water master plans,’ which look great on paper, have failed in practice because they are not politically feasible given existing Israeli legal obstructionism. Grey-water reuse systems provide one possible solution to this problem because the small-scale and decentralized technology involved can be applied at the community and household levels without the need for Israeli permits or permission from the JWC. In essence, this allows the PA to act unilaterally in area C and therefore bypasses the legal arm of the Israeli water access restriction regime. Moreover, the fact that these area C communities will be able to do more with less provides the ancillary benefit of reducing their reliance on water purchased from Israeli companies. Rural communities in area C have been those hardest hit by the long procession of failed water infrastructure projects; thus increasing the water security of these communities is both important as an end-in-itself and will also serve to improve the legitimacy of the PA with its rural constituency.

4.2.4 Treated Grey-water as a Demand Management Strategy

Demand management is a strategy to both conserve and increase the efficiency of water use through realizing the greatest possible benefit of any single unit of water (Allen, et al., 2010: 6). In the context of grey-water, this involves matching water quality with its end use so that consumption which would have otherwise drawn upon fresh, potable water is instead replaced with treated grey-water. As we have seen, treated grey-water is perfectly suited for small-scale agriculture; yet, because households do not separate, treat, and redirected it for this purpose, high-quality, expensive fresh water is often used for irrigation instead. By failing to match the quality of water to its use, this practice wastes water, energy, and money. Conversely, if treated grey-water replaces potable water in small scale agriculture, then not only are valuable fresh-water resources preserved, but households are able to meet their water needs at a lower cost. In essence, treated grey-water has the capacity to meet the segment of water demand in Palestine which goes toward non-potable purposes. This, in turn, translates into aggregate potable water savings. Moreover, using treated grey-water for non-potable applications such as crop irrigation also addresses the growing competition between agricultural and domestic water needs in Palestine. By maximizing the efficiency of use, new supplies need not be drawn on as heavily and the competition between these sectors can, in part, turn from conflict to cooperation. In sum, when demand management techniques are applied to treated grey-water reuse, the total amount of fresh-water demanded decreases, thus conserving high-quality, potable reserves.

The water-saving benefits that grey-water reuse systems can offer Palestine are directly related to the aggregate volume of household effluent which it represents. While the percentage of household grey-water does tend to be region specific, the best research done on the Palestinian case suggests that it comprises some 80% of total effluent (Burnat & Eshtayah 2010: 17). Grey-water reuse projects implemented by the PHG throughout the West Bank and Gaza Strip have consistently demonstrated that of the 80%, it is possible to reclaim and reuse around 60% - translating into some 150,000 liters of treated grey-water per household per year (Burnat & Eshtayah 2010: 17). By using these numbers as a jumping off point, it is possible to estimate the total water savings that the widespread adoption of grey-water reuse technology in Palestine might offer. Today, the total wastewater quantity produced in Palestine each year is estimated to be about 106 MCM, with the West Bank producing 50 MCM/yr and the Gaza Strip 56 MCM/yr (PASSIA 2011: 341). Less than 10% of this is treated

and an even smaller fraction of that is actually reused, meaning that nearly all of Palestine's grey-water resources go unutilized (PASSIA 2011: 341). There is little in the literature to suggest what the total potential for treated grey-water penetration in Palestine would be, however, research done in Israel suggests that given the current social, economic and cultural circumstances, on-site grey-water penetration in that country could range from between 19 and 31 percent of households (McIlwaine & Redwood 2010: 3). If the same penetration rates were achieved in Palestine, it would yield fresh-water savings of between 14.59 MCM and 23.81 MCM annually. Of course, telegraphing the economic, social and cultural assumptions built into the Israeli model is not practical for the Palestinian case, where, due to the restrictions of the Israeli occupation, penetration rates are certain to be far lower; however, this analogy does allow for a general impression of the considerable savings that the widespread adoption of grey-water reuse systems could offer a Palestine free of movement/access and permit restrictions.

In the meantime, the strategic focus of initial grey-water reuse projects is best restricted to the rural and peri-urban communities of Palestine which represent some sixty percent of the total population and generally lack appropriate management for their wastewater (these communities are often in area C) (Abu-Madi, et al., 2010: 89). These impoverished communities are the hardest hit by the Israeli occupation and suffer the worst water-shortages, waste-water derived environmental degradation and water borne illnesses. Consequently, not only is the demand for grey-water treatment systems strongest in these communities, each household would, on average, receive disproportionately greater marginal benefits from grey-water recycling. Furthermore, the most inexpensive and efficient grey-water treatment technology available in Palestine caters specifically to this demographic. It is difficult to say with any degree of certainty what the kind of aggregate water savings such a program might achieve; however, with the potential for each household using a grey-water system to save 150,000 liters per year, the net savings would still be substantial.

Before going any further it is important to stop and note the particular difficulty associated with the prediction of potential contributions that unconventional water resources, such as treated grey-water, might have on future water supplies. Even amongst experts in the hydrological community there are significant disagreements over the amount of savings such technologies might offer. One study, carried out by the Palestine Economic Council for Development and Reconstruction (PECDAR) at the behest of the Palestinian Water Authority (PWA), attempted to estimate

the quantity of future wastewater effluents which would be available for irrigated agriculture through 2020 after treatment. Table 5 below shows the predicted quantities by year:

Table 5: Estimated Wastewater Effluents Available for Irrigated Agriculture

| | 2000 | 2005 | 2010 | 2020 |
|-----------|------|-------|------|-------|
| West Bank | 0.0 | 2.72 | 8.4 | 56.3 |
| Gaza | 10.6 | 31.0 | 46.7 | 88.6 |
| Total | 10.6 | 33.72 | 54.5 | 144.9 |

Source: (PEDCAR 2000: 40)

Contrast the findings of the study above with the estimates produced by the German Agency for Technical Cooperation's (GTZ) *Middle East Regional Study on Water Supply and Demand Development*, which predicts that Palestine will have a total of 149 MCM/yr of wastewater effluent, after treatment, available for irrigated agriculture not in 2020 but in 2040 (GTZ, 1996: 7). The point of highlighting these numerical discrepancies is not to cast doubt on one projection or the other; it is simply to note that because there are so many unknown factors associated with these projections, it is all but impossible to provide anything more accurate than a very broad series of guesses about the potential impacts of grey-water recycling on future fresh-water supplies in Palestine. As such, the suggested amount of fresh-water savings offered up in this section are meant to be taken as just that, suggestions. While it is, of course, the aim of this study to be as precise as possible, the margin of error is substantial and recognizing the limits of the validity of these projections is important part of designing goals which can actually be achieved. It is also important to remember that while the aggregate amount of water savings which grey-water treatment systems can offer will always be somewhat modest its true value should not be measured in aggregate water savings alone; instead, it must be evaluated in the broader context of the other benefits which it confers on users such as easing some of the more extreme exposure to problems of poverty resulting from water scarcity.

4.2.5 Treated Grey-water as a Poverty Reduction Strategy

While a 'top-down' view of treated grey-water reuse benefits highlights the potential for aggregate water savings, a 'bottom up' approach emphasizes treated grey-water's potential as a poverty alleviation tool. There are four distinct ways in which grey-water reuse systems can aid in

the fight against poverty. First, there are economic benefits associated with treated grey-water irrigation in the value of the crops that are produced for household consumption and, in some cases, the sale of those surpluses. Families who use treated grey-water for small-scale agriculture are able to decrease their expenditure on food by consuming the produce grown in their home gardens and in some cases can add additional income by selling surplus products if they are generated (Naser & Al-Jayyousi 200: 25). Grey-water projects implemented in neighboring Jordan found that all participating households saw a net reduction in food expenses ranging from 3 to 44 percent of family income, with an average of 10 percent (Naser & Al-Jayyousi 200: 25). This type of small-scale agriculture is not meant to replace large-scale agriculture, rather it is meant to act as a complement by allowing the poorest households to replace expensive crops, such as tomatoes, olives, and mushrooms with the produce from their own gardens. The World Health Organization considers the agricultural produce cultivated through treated grey-water an important tool in generating food security amongst the rural poor (WHO 2006: 4). This claim is clearly borne out by the evidence as the annual value of household agriculture in Jordan in 2002 was estimated to be \$4 million, almost 2.5% of the total value of all agriculture (Naser & Al-Jayyousi 200: 3). Clearly, savings which seem relatively small on an individual scale can add up to a sizeable haul when taken together.

The second way that grey-water reuse systems help to reduce poverty comes via the reduction of aggregate household fresh-water consumption. As we have seen, on average, the installation of a grey-water system reduces household fresh-water consumption by some 150,000 liters per year. In Qebia village near Ramallah, the average household purchased 300,000 liters of water per year for domestic and agricultural purposes⁶ (Burnat & Eshtayah 2010: 17). At a cost of \$1 USD per 1,000 liters, each household using a grey-water system was able to save \$150 USD per year, or half of the total household expenditure on fresh-water. This might not seem like a very significant amount on the surface, but with half of the village population making \$3,600 USD or less per year, the savings to these families was substantial as “water bills were reduced dramatically” (Burnat & Eshtayah 2010: 18, 24). An additional study on the comparative socioeconomic effects of grey-water and cesspit systems carried out in five peri-urban communities near Ramallah, found that on average, the share of the water supply expenditure as a percentage of the households’ income

⁶ Note that purchases water does represent total water consumption as most households use alternate water sources such cisterns and rain-water harvesting techniques.

was about USD \$28.60/month for households with grey-water reuse systems and USD \$38.90/month for those using the traditional cesspit system (Abu-Madi, et al., 2010: 94). Similar to the results of the study conducted in Qebia then, households with grey-water systems were able to significantly pare back their yearly expenditure on water bills. Table 6 shows in clear numerical terms, the average monthly saving on water expenditure that those households using grey-water systems achieved.

Third, grey-water recycling helps fight poverty through a net reduction in the amount of wastewater that households are forced to pay to dispose of. Studies by the PHG have shown that the average rural Palestinian household produces 14.7 m³ of wastewater per month which is then stored in a cesspit, the average size of which, is around 30 m³ (Burnat & Eshtayah 2010: 18). If grey-water is not separated from black-water, cesspits are filled to capacity in less than 3 months and thus must be emptied 5 or more times annually. Emptying cesspits is not cheap; many communities rely on mobile tankers which, on average, cost the family \$22 USD per month or \$264 USD per annum (Burnat & Eshtayah 2010: 18). Grey-water reuse systems reduce the amount of effluent flowing into the cesspit by 80%, meaning that the total amount of waste-water a household generates per month falls from 14.7 m³ to 2.94 m³. At this reduced rate, a 30 m³ cesspit only needs to be emptied once every 10 months. In fact, because the waste stays in the cesspit for a much longer duration, natural biological processes are given more time for decomposition, thus the frequency of disposal declines further yet. In the case of smaller families, decomposition can replace disposal altogether. Ultimately, the net effect of using a grey-water system yielded household waste-water disposal savings of somewhere in the range of \$240 and \$270 USD per year, or just less than 5% of the average household income. Table 6 compares the average percentage of total household income spent on water and wastewater between homes with grey-water systems and those using traditional cesspits – on average, those with grey-water systems spent nearly 4% less (Abu-Madi, et al., 2010: 94).

The fourth and final economic benefit grey-water systems can confer on users comes by way of the savings it allows on fertilizer expenditure. Because treated grey-water naturally contains nutrients, it is inherently more valuable for agricultural purposes than fresh-water, which needs to be supplemented by fertilization. According to the World Health Organization, the majority of treated grey-water contains “important sources of plant nutrients, such as phosphorus, nitrogen and potassium” (WHO 2006: 8). When used for agricultural purposes then, the nutrients

found in treated grey-water enhance crop productivity and thus yield an increase in the availability of products. This aspect would be especially important for citizens of the Gaza Strip as the Israeli siege has caused fertilizer prices to skyrocket or become completely unavailable. As such, treated grey-water acts as a low-cost replacement to the expensive fertilizer households would otherwise need to purchase. Although there is nothing in the literature to provide concrete numbers for household fertilizer savings, it should, nevertheless, be recognized as an important economic benefit associated with grey-water systems.

Table 6: Impact of Grey-water System and Cesspits on Household Expenditure on Water/Wastewater

| Household System | Average Monthly Water Expenditure (USD) | Water/Wastewater Expenditure as % of Income |
|--------------------------|---|---|
| <i>Grey-water System</i> | \$28.64 | 7% |
| <i>Cesspit</i> | \$38.86 | 10.8% |

Source: Numbers are derived from survey data taken from 30 households using grey-water systems and 100 households using traditional cesspits (Abu-Madi, et al., 2010: 94)

4.2.6 Treated Grey-water and Gender

The installation of grey-water treatment systems affects the lives of its beneficiaries in many ways, including the make-up of the household's internal bargaining power – that is, the relative capacity of the man and woman to negotiate or secure agreements on their own terms. Of course, gender relations, or the relation of power between men and women, are highly complex and fluid – changing both across cultures and over time (Agarwal 1997: 1). Consequently, the effects that household grey-water systems have upon gender relations will always be highly local.

In the context of Palestine, studies have demonstrated that men and women benefit from the use of grey-water systems in very different ways. For instance, in rural Palestinian households gender roles are such that women are, for the most part, responsible for the overseeing, managing and, maintaining both the household's water and cesspit operations, while men are responsible for the household's income (Burnat & Eshtayah 2010: 25). It follows then, that the benefit which grey-water systems confer on the men tends to be economic in nature, while women realize benefits in terms of time saved, as well as a reduction in the effort and workload that must be expended on water and cesspit activities (Keough, Smirat & Benjamin 2010: 122). The extra time which this generates then allows women to

direct more attention to the family, toward work in the household garden, or toward engaging in a myriad of other productive activities. Moreover, because the productivity of household agriculture is boosted by the use of grey-water it further enhances the woman's economic position in the household, as surplus crops can be sold for profit (WHO I 2006: 4). Because women are not typically employed outside the home, this second stream of income increases the woman's decision making power within the household. Taken together, these aspects of grey-water recycling strengthen a woman's bargaining power with the household and thus facilitate gender equality.

Many grey-water projects were initially implemented as tools for water savings and poverty reduction but researchers soon discovered that the empowerment of women was an unexpected benefit. One grey-water project in Tannoura, Lebanon, for instance, found that women were far more active in project implementation than men, which resulted in an increase in both their level of household and community decision making (Haddad 2010: 135). Similarly, grey-water projects in Karak, Jordan saw women play a key role in the maintenance and sustainability and operation of the grey-water recycling systems. As the researchers noted, "It was apparent that women in the project area were hard working and willing to learn more about grey-water and ways to support the family income" (Murad, Al-Beirut & Ayesh. 2010: 54). When the project concluded, a group of women who owned grey-water units decided to combine their financial resources and founded the first local women's cooperative, the central aim of which was to promote the use of grey-water and other development projects (Murad, Al-Beirut & Ayesh. 2010: 55). These examples clearly demonstrate how water management projects can lead to greater gender equality and act as a catalyst for women's empowerment.

5. Potential Barriers

5.1 Public Perception

A recent poll of rural West Bank communities revealed that 75% of Palestinians are opposed to using treated wastewater for irrigation (McNeil, Almasri & Mizyed, 2008: 317). What this statistic makes absolutely clear is that public perception of wastewater recycling is one of the central challenges that must be overcome in order to achieve the widespread use of waste-water recycling technologies in Palestine. And while it is certainly true that concerns about the quality of recycled water and the negative public health impacts that could arise if water is not treated correctly are legitimate, most of these fears are based on habits and taboos rather than legitimate hygienic concerns (Glover & Hunter 2010: 95). As this study has noted time and again, the long-term impact of treated grey-water on public health is not yet completely clear and further research is required; however, all available data indicates that treated grey-water, when used in accordance with the WHO's safety standards, presents little to no public health risk. In terms of concrete experiences with treated grey-water reuse in Palestine, the vast majority of its beneficiaries found that it had a positive impact on public health (Nidal & Mimi 2008: 4). The majority of participants in the Qebia pilot project now believe "that the introduced wastewater management system reduces diseases" and only one person surveyed continues to worry that the grey-water system might cause disease (Nidal & Mimi 2008: 4). Again, when asked if the system causes any sort of harm, the vast majority of respondents said they were certain it does not, while only about 15% stated that it was very unlikely (Nidal & Mimi 2008: 4). The key point to be taken away from all of this is that experience with grey-water technology assuages or eliminates user's fears about its safety. Recall that, when surveyed, 75% of West Bank communities stated that they were opposed to using treated wastewater, yet nearly 96% of the participants in the Qebia pilot project recommend the system to be applied for other non served communities. The lesson here is clear: experience with the technology undermines the negative perception of treated waste-water reuse by breaking down cultural and hygienic taboos.

By far the most cost effective and important method of popularizing and spreading the use of grey-water systems is to engage in awareness campaigns which alter public opinion about the safety of waste-water reuse. As we have already seen, one important way to disabuse the public

of its negative perceptions is to allow them to see and experience the technology first-hand. Consequently, field visits to Qebia and other grey-water project sites coupled with participatory awareness campaigns in which locals would be taken to existing grey-water sites could play an important role in breaking down taboos and improving community-based understanding of the technology. In addition to this, more general public awareness campaigns, such as workshops directed at community organizations and leaders, as well as programs within the public education system, will be essential to achieving widespread acceptance. In 1999 a water conservation education program piloted in Jenin schools demonstrated that through raising awareness, both student's attitudes about and habits towards water conservation were improved (Glover & Hunter 2010: 127). Furthermore, it is imperative that public awareness campaigns specifically target women, who are the key stakeholders in household water management in Palestine. Educating women in the benefits that grey-water systems will confer on them will certainly lead to greater demand for the systems. Finally, previous experiences have shown that religion can be an effective tool in public awareness campaigns. There is evidence to suggest that public awareness campaigns based on religious principles are successful, especially in low-income communities and to those with lower levels of education (Glover & Hunter 2010: 127). It is possible to provide Imams with special training to incorporate water conservation messages into their sermons or to install grey-water systems at mosques to familiarize the communities with the technology.

5.2 Financial

There can be little doubt that financial barriers present a major obstacle to the widespread adoption of grey-water technology in Palestine. Even the PHG's low-cost system represents a significant financial burden to the average rural households. As was noted in section 4, most Palestinian communities have not reached a stage where they are either able or willing to implement grey-water systems with their own funds despite the fact that grey-water systems are "superior to cesspits in terms of construction costs, operational costs, water consumption and saving in water consumption and water bills" (Laban 2010: 104). Paradoxically though, cesspits are typically built by rural households using their own funds whereas grey-water systems are, except for a very few cases, always externally funded (Abu-Madi, et al., 2010: 95). Indeed, researchers found a strong resistance to the idea of self-funding the systems. For instance, Abu Madi discovered that 72% of those he questioned were only willing to construct the systems

with external funding while a mere 17% said they would be willing to fund the system themselves (Abu-Madi, et al., 2010: 96). When asked why they rejected the idea of implementing grey-water systems with their own funds, three main reasons were given:

- ✧ A refusal to restructure the internal piping of the home in order to separate grey and black water.
- ✧ A refusal to use treated grey-water for garden irrigation.
- ✧ The unaffordable nature of construction costs.

This suggests that there is an awareness gap about the relative economic and health benefits of grey-water systems and drawbacks of cesspit systems. Additionally, it makes clear that the wide scale implementation of the system will be limited by the availability of external funding.

Due to the nature of the concerns about the grey-water system it is clear that specific efforts are needed to close the awareness gap and change perceptions about the economic and health virtues of grey-water systems and the drawbacks of cesspits. Stressing the financial revenues users receive from implementing the system, such as reduced water consumption, decreased operating costs, and nutrients recirculation in irrigation, will be important in garnering public acceptance. Again, participatory awareness programs which utilize the existing grey-water project in Qebia as a demonstration site would be highly beneficial. Nevertheless, even if public perception about the economic advantages related to grey-water change, the fact that most households simply cannot bear the burden of construction costs on their own remains. Efforts to finance grey-water systems will benefit from a variety of approaches across various sectors. For instance, a targeted subsidy program could prove very effective as cost sharing would not only act as a powerful incentive to install the system, but would also provide the user a real, financial stake in the project and thus better ensure long-term sustainability. Another option would be to take advantage of the vast amounts of donor funding which flow into Palestine each year. The PWA or some other government ministry could potentially act as a coordinating medium which would point out channels which communities or individuals could use in order to secure external funding. Moreover, promotion and coordination of funding could be done through already established social bodies like cooperatives and councils. All in all, the awareness gap must be closed and efficient financing strategies must be developed in order to overcome the considerable financial barriers.

6. Three Grey-water Case Studies

6.1 Karak, Jordan

Project Outline:

- ✧ The project was conducted in the Karak Governorate in southern Jordan and was intended to aid the peri-urban poor who would benefit from the use of treated grey-water in their home gardens.
- ✧ Two simple and low-cost four barrel confined trench grey-water systems were installed in 110 low-income households not served by a sewerage network. The resulting grey-water was used to irrigate crops that are not eaten raw (Murad, Al-Beiruti & Ayes. 2010: 29).

Sociopolitical Outcomes:

- ✧ The implementation of the system in the communities had a favorable effect in the context of future developments on water sustainability at institutional and community levels.
- ✧ Following the case study, local institutions were more aware of the benefits of grey-water and more likely to pursue it as a policy option.
- ✧ In the Karak case, women emerged as key players in the successful day-to-day operation and maintenance of the systems. This increased the importance of their role in the generation of household income as it enhanced household garden production. The success of the grey-water project in Karak was closely linked to greater gender equality.

Economic Outcomes:

- ✧ The average quantity of treated grey-water, following the installment of the grey-water instruments, was 237 liters/household/day; enough to irrigate 20 olive trees.
- ✧ Increases in property value due to the improvements in waste treatment.
- ✧ Decreases in costs related to cesspits.
- ✧ Decreases in waste treatment costs.
- ✧ Increases in the amount of fresh water available (especially in the summer months):

An employee working at the local governorate offices and in charge of following up on water shortage complaints during summer months informed INWRDAM that the offices did not receive many complaints from villages using grey-water technology. Since no change occurred in the water supply situation, he attributed the reason for the decrease in the

number of complaints about water shortages to the grey-water project helping the community offset the demand with the use of grey-water for irrigation.

Other:

- ✧ Treated grey-water seemed to have little to no effect on the quality of the agricultural products produced, relative to those produced with fresh water.

Lessons for Palestine:

- ✧ If properly implemented, grey-water projects are self-sustaining, can strengthen local institutions, and act as a beacon for other interested communities.
- ✧ Community participation in planning and operation is important for long-term sustainability.
- ✧ The economic and environmental impact of grey-water systems is positive.

6.2 Tannoura, Lebanon

Project Outline:

- ✧ This project was conducted in Tannoura, a rural town located in the Bekaa Valley of Lebanon. It was conceived of as primarily being a poverty reduction scheme in one of the poorest regions of Lebanon.
- ✧ The project established 70 grey-water systems in the households of Rashaya Caza, of which 30 were located in the town of Tannoura. The grey-water treatment system used in Tannoura collects wastewater in treatment kits and irrigation is later carried out automatically when an electric pump is activated (Haddad 2010: 130, 134).

Sociopolitical Outcomes:

- ✧ Although the project was initially implemented to combat poverty and enhance the economic situation of the beneficiaries, in the end its main contribution was women's empowerment.
- ✧ Because women are in charge of household water they were much more involved in the project than men and actually pushed the men to follow through on the cost sharing burden so that the system could be implemented.
- ✧ The project empowered women through participation in community level decision making groups.

Economic Outcomes:

- ✧ Decreased women's daily workload by shortening water related chores. This freed women up to perform other productive household activities.
- ✧ The project did not provide additional freshwater for households or reduce the loads of water which had to be carried from the spring to the home.
- ✧ Decreases in costs related to emptying cesspits.

Lessons for Palestine:

- ✧ Gender empowerment is not simply an ancillary benefit, but a powerful tool in the fight for public acceptance of grey-water recycling.
- ✧ Women are key stakeholders and any programs implemented in Palestine should keep this target demographic front and center in public awareness campaigns.

6.3 Israel (Pilot Project)**Project Outline:**

- ✧ Shomera, an Israeli NGO, spearheaded a joint governmental, private sector, and academic initiative to test grey water recycling systems in Israel.
- ✧ After two years of planning and preparation, the grey-water recycling Initiative is in the final stages of permit approval. The project will install two grey-water units which would recycle shower water at a Jewish mikva, or ritual bath.

Objectives:

- ✧ Shomera's stated goal for the pilot project is to create the first authorized urban grey-water recycling facility in Israel as a way to inspire additional grey-water recycling projects.
- ✧ According to Shomera's executive director Miriam Garmaise, "assuming the pilot project yields favorable results, the next phase would be an open demonstration and a broad-based educational campaign." Garmaise also noted that "grey water recycling would be an effective conservation measure for the long term, rather than an immediate solution to the country's current water scarcity" (Waldocks, 2011).
- ✧ Shomera chose to implement the pilot application at a mikve for two reasons; first, so the same model could be replicated in a broad range

of facilities which use large amounts of water such as hotels, country clubs, sports clubs and schools (Allen, et al., 2010: 20). And second, so a connection between Judaism and the environment would be made. Accordingly, the mikve offers “the opportunity for dialogues between Jewish precepts and concepts of environmental sustainability” (Waldocks, 2009).

Lessons for Palestine:

- ✧ Though the Israeli case is different from that of Palestine in many ways, one important takeaway is that the use of religion may be an important tool in achieving widespread public awareness and acceptance of grey-water reuse.
- ✧ A second lesson is that targeting large, public or private facilities such as religious centers or schools could be an excellent way to familiarize people with the technology, raise awareness, and to recycle relatively large volumes of grey-water.

7. Policy Recommendations

7.1 The Wrong Kind of Policy

In terms of implementing proper grey-water policy for Palestine, what the PA does do will be just as important as what it does not do. In effect, Palestine needs a supportive grey-water policy that protects public health, but that is not so unduly burdensome that it could restrict the expansion of grey-water reuse. There is no doubt that treated grey-water reuse carries some inherent risk; but the most pertinent question is whether that risk is greater than the risk associated with the traditional cesspit system which is currently in use. As this study has been at pains to point out, the answer to this question is clearly no; grey-water reuse systems represent a net benefit and a reduction of risk in every pertinent metric (economic, conservation, environmental etc). Hence, grey-water policy in Palestine must reflect this reality. So, where treated grey-water reuse might carry an unacceptable risk in countries with abundant water resources and efficient centralized water and sewage systems, in the context of Palestine treated grey-water reuse will actually reduce overall health and environmental risks, or at a very minimum carry a risk which is acceptable when balanced against the benefits of the practice. The key point of this is to note that grey-water policy in Palestine should be wholly focused on promotion and not prevention – this means that anything which would increase the transaction costs or barriers to either grey-water users or facilitating agencies should be discarded. For instance, the PA should not require permits, demand soil tests or impose water quality standards or strict regulations about disposal. In fact, due to the realities of Israeli occupation and the overburdened nature of the PWA, a comprehensive grey-water regulatory regime (especially in area C) is simply not feasible. Placing as small a burden as possible on local authorities and the system's users will help to ensure that the technology is able to spread with minimal barriers.

7.2 Policy to Overcome Public Perception Barriers

Achieving widespread public acceptance of grey-water recycling will require education programs and public awareness campaigns that stress in equal measure the safety of the system, the efficacy of treated grey-water in crop irrigation, and the financial benefits of grey-water system use. As we noted in section 5, experience with grey-water technology is effective in breaking the cultural habits and taboos which surround it. Recall that

75% of rural Palestinians are opposed to using treated wastewater for irrigation but 95% of the participants in the Qebia project approved of the system and recommended that it be applied for other non-served households. Consequently, it is important to build upon the success in Qebia which could serve as an excellent pilot program. As such, field visits to this and other sites along with participatory awareness campaigns in which local community members would be taken to existing grey-water projects could prove highly beneficial. In addition to site visits, training courses, workshops, regular meetings, and group discussions are other possibilities. Incorporating grey-water into conservation education in public schools could also prove beneficial in changing attitudes toward the technology. It is also important that public awareness campaigns specifically target those social groups responsible for the management of water resources – women. Educating women in the importance of grey-water and providing them with the knowledge about the system's benefits could help considerably. Women's cooperatives are an excellent source to solicit. Previous experiences in the MENA region and in Palestine suggest that the effectiveness of public awareness campaigns can be improved by emphasizing the religious dimensions of water conservation. Thus, it may be beneficial to provide Imams with special training to incorporate water conservation messages into their sermons. Finally, promoting the PHG's gravel up-flow system as a pre-approved treatment system would assuage safety fears and remove the burden of seeking out professional advice.

7.3 Policy to Overcome Financing Barriers

As we saw in section 5, the implementation of grey-water systems is often limited by the availability of external funding and most Palestinian communities have not reached a stage where they are able or willing to purchase and install grey-water systems on their own. In this regard, a targeted subsidy program could be very effective in lowering the financial burden to households. The PA could create a cost-sharing program based around the pre-approved gravel up-flow system. Donor funding provides an additional avenue through which external funding for grey-water systems might be secured. The PA could help facilitate donor funding for the project by coordinating and pointing out channels that communities or individuals could go through in order to secure external funding. Promotion and coordination of funding could be done through already established social bodies like cooperatives and councils. Additionally, the PA could offer financial incentives for household using grey-water recycling systems and thereby reduce the use of fresh water. This could be

done, for example, by subsidizing per unit water prices when grey water recycling systems are being used. Through the reduced water bill, households could off-set some of the initial capital costs for the system.

7.4 Results from Exploratory Meeting

The results of this study were presented to members of the PWA and the PHG in early December, 2011. The PWA expressed concerns about the long-term sustainability of the PHG's grey-water system, noting that users have been known to neglect the system if they have no personal interest in gardening or if they had no direct financial investment at stake because the system was simply gifted to them. It was suggested that the system should never be given away and that cost-sharing would be important to ensure sustainability. Following in that vein, it was stressed that choosing the right beneficiaries would also be very important for long-term success. Concerns were also raised over the system's robustness and doubts over its long-term viability lingered. It was suggested that installing grey-water systems in local mosques and schools would be an important way to introduce and familiarize communities with the technology and would act as examples that households may want to emulate. Because the system requires that the user possess and use a home garden, it was suggested that promotion of home gardening should be included in public awareness campaigns. Finally, there were certain concerns over the objectivity of some the sources used in this study with a general consensus more surveys should be carried out.

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