POST PROJECT EVALUATION OF GREYWATER TREATMENT AND REUSE PROJECT IN TAFILA, JORDAN

FINAL REPORT

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LIST OF ACRONYMS

B/C	Benefit/Cost
EC	Electrical Conductivity
FAO	Food and Agriculture Organization of the United Nations
IDRC	International Development Research Centre
INWRDAM	Inter-Islamic Network on Water Resources Development and Management
JSRW	Jordanian standards recommended for restricted irrigation using reclaimed wastewater
JD	Jordanian Dinar
LSC	Local Stakeholder Committee
MECTAT	Middle East Centre for the Transfer of Appropriate Technology
MOA	Ministry of Agriculture
MOP	Ministry of Planning
MSD	Ministry of Social Development
MW&I	Ministry of Water and Irrigation
NCARTT	National Centre for Agricultural Research and Transfer of Technology
NGO	Non governmental Organization
O & M	Operation and Maintenance
P:N	Plan:Net Limited
PARC	Palestinian Agricultural Relief Committee
PPE	Post Project Evaluation
PPP	Permaculture Pilot Project

SAR	Sodium Absorption Ratio
SDRW	Society for the Development and Rehabilitation of Women
WAJ	Water Authority of Jordan

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EXECUTIVE SUMMARY

The Inter-Islamic Network on Water Resources Development and Management's (INWRDAM) Greywater Treatment and Reuse Project in Tafila, Jordan was successfully implemented over a two-year period, from May 2001 to April 2003 with funding from the International Development Research Centre (IDRC). This report documents the results of an evaluation of the project, conducted from April to August 2004.

The goal of the project was "*to help the peri-urban poor in Jordan preserve precious freshwater, achieve food security, and generate income, while helping to protect the environment*". This was done primarily through the design, construction and installation of greywater treatment and reuse systems in a small number of households in Ein Al-Baida, Tafila, Jordan. The objectives of Phase I were as follows:

1. Increase greywater recovery and make it more convenient and safe to handle
2. Minimize environmental impacts associated with greywater reuse and ascertain whether greywater treatment is necessary and cost-effective
3. Improve gardening/permaculture practices
4. Strengthen local capacity to safely and efficiently reuse greywater
5. Promote changes in policies to encourage greater greywater reuse in Jordan
6. Self-monitor the impacts of the projects
7. Evaluate the impact of the project since it was implemented

Summary of Main Findings, Conclusions and Recommendations

Organization and Management

- The project was well-structured and managed in order to meet its objectives. The success the project has achieved can be attributed in large part to the team's strong technical expertise, and collaboration among team members.

- A few gaps in the original project design have been identified, notably, limited government involvement, lack of community participation, and attention to gender issues. Building both government and community support is integral to the long term success and sustainability of greywater reuse in Jordan.

- The evaluation team endorses the changes to the project structure proposed for Phase II, and recommends that clear agreements be set out with all partners, outlining roles and responsibilities.

Achievement of Objectives

All objectives set out by INWRDAM were achieved. In particular, those activities related to the design, modification and installation of the greywater units and drip irrigation system were well carried out.

- Accomplishment of the objectives related to strengthened local capacity, and improvement of permaculture/gardening practices, were not achieved to the same degree, though some progress was made.

- Increased agricultural training should be conducted. Potential topics for agricultural training include:

    - permaculture methods and practices,
    - soil management and conservation related to greywater use,
    - plant growth, protection and disease control (including natural methods),
    - irrigation system management and maintenance,
    - management of household hazardous chemicals and environmental friendly alternatives,
    - compost preparation, and
    - rainfall harvesting practices.

- NCARTT, and possibly MOA could play a lead role in identifying training needs, and implementing such training. A combination of training workshops, and ongoing agricultural monitoring will be needed to promote the uptake of the knowledge. Local MOA agricultural officers might also play a role in conducting ongoing monitoring.

- Significant unanticipated results were achieved, most notably the support gained from Ministry of Planning and the European Union for the installation of units across the country, raising the total number of systems in Jordan from 25 to over 900. Awareness and support for greywater has also been raised among senior government officials, funders and INWRDAM member states.

Socio-economic Analysis

- While the IDRC project was to have targeted “peri-urban poor”, only one third of the beneficiaries can be defined as such, compared with the majority of MOP beneficiaries.

- If the second phase of the project is to contribute to poverty alleviation, then income level must be one of the primary selection criteria. While it is not necessary to target “the poorest of the poor” it is reasonable that the primary target group be low-income households (between 100 – 349 JD per month according to figure 4-2). These households combine the greatest ability to benefit and represent over 50% of the Jordanian population.

- The social benefits of the greywater system have far outweighed the costs of the system to beneficiaries. The primary benefits have been in the form of time savings and reduction of household workload, increased productivity of trees, and slight increase in skills and knowledge.

- In order to maximize the benefits to households, more training should be conducted with beneficiaries (both men and women), particularly in the areas of proper cleaning and maintenance of the system, sound agricultural practices such as soil management, plant protection and disease control, and information about appropriate crops for greywater irrigation. Training could also include topics such as environmental awareness, public health, water scarcity, water resources management, etc.

- Because the systems were provided free of cost, the economic benefits of the system outweigh the costs to individual beneficiaries. Economic benefits are primarily in the form of savings on water bills and septic tank pumping. In a future scaled up scenario where all or part of the costs are passed on to beneficiaries, a revised benefit/cost analysis would have to be conducted.

- It is recommended that more priority be placed on incorporating gender issues into all aspects of the project in the second phase.

Community Participation and Local Capacity

- The beneficiary selection criteria were not always clearly understood by those involved in the project, nor systematically applied in the selection process.

- It is recommended that a systematic selection process be developed and followed in order to ensure that the process is fair and equitable.

- It is also recommended that in order to contribute to poverty alleviation, low income households with a monthly household income of between 100 and 349 JD be targeted. This group combines the greatest ability to benefit, and represents over half of the Jordanian population.

- It is recommended that more emphasis be placed on the community/local capacity dimensions in the second phase of the project. A community engagement process should be mobilized prior to the selection of beneficiaries and the installation of systems.

Technical Dimensions

- The technical component of the project was very well carried out. The design of the systems has been continually improved upon.

- Given the prevalence of odour problems, every effort should be made to address this problem in Phase II. INWRDAM is aware of the problem and is making efforts to solve it.

- Beneficiaries should be encouraged to take responsibility for their own systems, rather than depending on the technicians to do it for them. Again, this will be achieved primarily through increased training and follow-up with beneficiaries.

- The confined trench (CT) systems are able to deliver greywater that meets the JSRW for restricted irrigation. While 2-barrel and 4-barrel systems vary in performance and are dependant on regular maintenance.

- Given that only 56% of units sampled complied with JSRW, community participation and training are essential to ensuring greywater compliance, improving quality of effluents and reducing odour, and possibly identifying operation and maintenance methods more acceptable to the community.

- It is recommended that SAR and EC of the greywater be measured regularly along with other parameters mentioned in the JSRW so that its impact on soil can be assessed more accurately.

- The majority of soil samples tested showed an increase in salinity. Thus environmental impact monitoring of greywater on soil is crucial for Phase II. It is therefore recommended that:

    - soil reference samples not irrigated with greywater as well as soil irrigated with greywater be collected from each site so that accurate comparisons of greywater impacts on soil are possible.
    - since there is an indication of some salinity effect, efforts be made to identify suitable preventive and mitigation measures from the start of commissioning of new greywater units,
    - the measurement of soil salinity be related to quality and quantity of greywater used in each monitored location so that scientifically viable conclusions are possible; and
    - new salt tolerant crops be identified as a precautionary measure in case other control measures are not sustainable or cost effective.

Financial Dimensions

- While the in-kind contribution of site preparation by beneficiaries was to have demonstrated their commitment, it does not seem to have been enough of an investment to promote a real sense of ownership among all beneficiaries.

- In Phase II, the team might consider requesting a small cash or material contribution from beneficiaries, in addition to the in-kind contribution of the site preparation, in order to increase the sense of ownership over the system. This could range from a

token amount of 5 to10 JD to a more significant amount of 50 to 100 JD. A loan program (perhaps through a local micro-credit organization, bank, or possibly through the MSD) could assist households to cover the costs, as many families do not have significant savings to draw upon. The idea of a cash contribution is recommended with caution, however, as it must remain affordable to the low-income group targeted. More discussion of this among project partners is necessary.

- Possible scenarios for viable financial plans for a wide scale roll-out of the system across the country should be studied in the next phase of the project.

1.0 INTRODUCTION

1.1 Project Background

The Greywater Treatment and Reuse Project in Tafila, Jordan was conducted over a 24 month period, from May 1, 2001 to April 30, 2003. The project was conducted by the Inter-Islamic Network on Water Resources Development and Management (INWRDAM), and funded by the International Development Research Centre (IDRC).

The goal of the project was "*to help the peri-urban poor in Jordan preserve precious freshwater, achieve food security, and generate income, while helping to protect the environment*". This was done primarily through the design, construction and installation of greywater treatment and reuse systems in a small number of households in Ein Al-Baida, Tafila, Jordan. The objectives of Phase I were as follows:

1. Increase greywater recovery and make it more convenient and safe to handle
2. Minimize environmental impacts associated with greywater reuse and ascertain whether greywater treatment is necessary and cost-effective
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In addition to the IDRC funded systems, INWRDAM has installed over 800 systems throughout Jordan, with funds from the Ministry of Planning (MOP), through the "Community Involvement in Reuse of Greywater to Improve Agricultural Output" project.

A second phase of the IDRC project was approved and began in February 2004 (referred to hereafter as Phase II). The project, to be implemented over a 42-month period will expand the number of greywater treatment and reuse units to 300 beneficiaries in a peri-urban community.

1.2 Scope of the Evaluation

The Post Project Evaluation (PPE) was a comprehensive review of the technical, social and economic results of the greywater systems implemented in Jordan to date. Its purpose was to inform Phase II in a manner that will contribute to its success and longer-term sustainability.

The evaluation covered the following topics:

- The achievement of project objectives;
- The socio-economic dimensions of the greywater systems implemented;
- The technical effectiveness of the greywater systems implemented;
- The viability of the systems to wider application throughout the country;

- Recommendations and lessons learned for improvement of the second phase.

A list of the key evaluation questions is set out in the evaluation matrix and is attached in Appendix A.

While the primary purpose of this study was to conduct an evaluation of the IDRC funded project, elements of the Ministry of Planning project were also examined, as the technology implemented was designed and tested through the IDRC funded project. The MOP project objective was "*More people throughout Jordan are aware of the potential of reusing wastewater and are taking steps to make better use of domestic wastewater".*

All comments, conclusions and recommendations in this report refer to the IDRC Phase I project. Comments are offered regarding the MOP project in so far as they offer insights for Phase II of the IDRC project.

1.3 Evaluation Methodology

The following research and analysis techniques were employed during the evaluation:

Documentation Review – Key project documents and supplementary documents were reviewed. A list of these documents is attached in Appendix B.

Semi-structured Interviews - Semi-structured interviews were conducted with project team members, government officials, community representatives and regional partners. Representatives from the two institutional beneficiaries were also interviewed. A complete list of people interviewed, and the interview protocols used, are attached in Appendices C and D.

Field Survey - A survey of 48 beneficiary households in four locations: Tafila, Karak, Irbid, Ma'an was conducted. The survey included background data on beneficiaries, social and economic costs and benefits of the system, problems experienced with the system, agricultural practices, and recommendations for improvement. A summary of the survey data is attached in Appendix E.

Focus Groups – Two focus groups were conducted in Tafila in order to validate initial findings. One focus group was held with 12 women, and the other with four men.

Scientific Soil and Water Analysis - INWRDAM, in cooperation with NCARTT, conducted soil and greywater analysis on samples from three sites (Tafila, Kerak, and Irbid). A summary of the results is attached in Appendix G.

1.4 Acknowledgements

The evaluators would like to express their gratitude for the high level of cooperation and support given to this study by the INWRDAM team. The contribution of the researchers who carried out the survey was invaluable to the success of this evaluation. A sincere thank you is also extended to the project beneficiaries who generously invited us into their homes and shared their thoughts and their time with us. The insights and time given to this evaluation by all participants was essential and most appreciated.

2.0 ORGANIZATION AND MANAGEMENT OF THE PROJECT

Background

The Permaculture and Greywater Treatment and Reuse Project in Tafila emerged from an IDRC supported workshop, held in Gaza in 1998, which examined the research needs related to Urban Agriculture in the Middle East and North Africa region. Based upon the results of the workshop, IDRC funded the Palestinian Agricultural Committee (PARC) to conduct a research project to implement small-scale household greywater systems in Palestine.

In 2001 IDRC funded INWRDAM to evaluate the CARE Permaculture Pilot Project (PPP) to assess the feasibility of greywater reuse in Jordan. The evaluation of the PPP recommended that a follow-up project be implemented to increase greywater recovery and encourage permaculture practices. Building upon the experience of the CARE and PARC projects, the project was designed in cooperation between INWRDAM and IDRC, and approved for funding by IDRC.

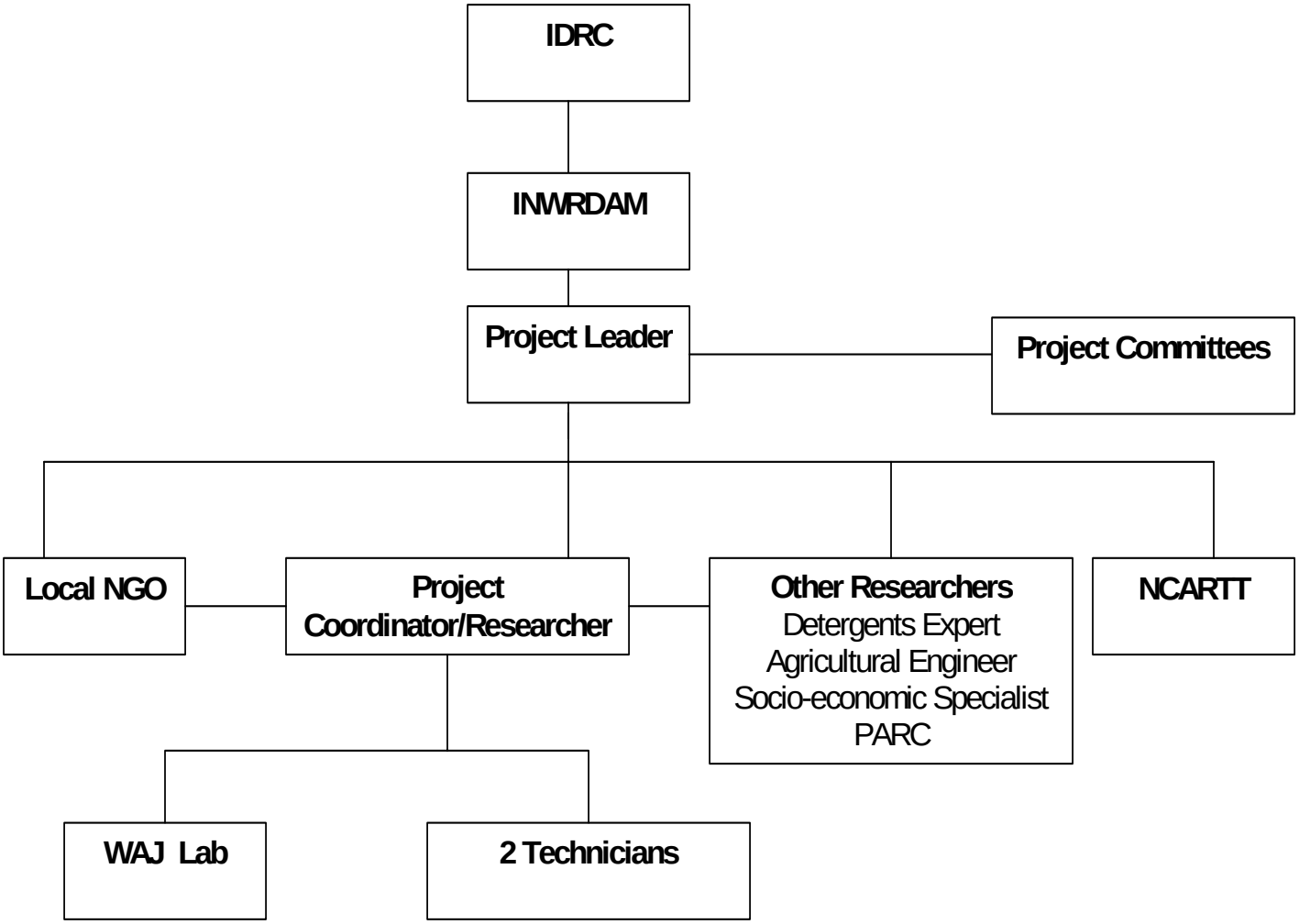
2.1 Project Structure

Figure 2-1 on the following page depicts the structure of the first phase of the project, as described by the Project Coordinator. The project was implemented under the direction of the INWRDAM Project Leader and the Project Coordinator, who managed all project activities. Several researchers were contracted to conduct specific components of the project, such as socio-economic research, agricultural monitoring and developing environmentally friendly detergents. Two local technicians were hired and trained to install and monitor the greywater systems.

2.1.1 Local Technicians

A local technician and an assistant were hired from the Tafila area, and were trained to install the greywater units and drip irrigation systems. The technicians, under the direct supervision of INWRDAM, were responsible for: promoting the greywater idea to potential beneficiaries, recommending potential beneficiaries, installing and maintaining the systems, training beneficiaries to properly operate and maintain the systems, and monitoring the systems. The technicians were pivotal in establishing and maintaining a relationship between INWRDAM and the local community in Ein Al-Baida.

Figure 2 – 1 Phase I Project Organigram



2.1.2 Government Involvement

In Phase I, government ministries were involved primarily through the two policy review committees, in which the Ministries of Public Works, Health and Water and Irrigation were involved. The Ministry of Agriculture (MOA), and its National Centre for Agricultural Research and Transfer of Technology (NCARTT) were responsible for monitoring the agricultural component of the project, and soil and plant analysis. An agricultural engineer from MOA was seconded to the project. The Ministry of Water and Irrigation (MW&I) was involved in the testing of water samples through the Water Authority of Jordan (WAJ) laboratories. Beyond this, there was little formal government involvement, either at national or local levels. Good relations were established with those ministries that were involved in the project.

Some government officials are concerned about the long-term health and environmental consequences of greywater use. For instance, there is a concern that greywater is being improperly used for unrestricted irrigation and may have harmful effects on the health of individuals. There is also a concern that the use of greywater may have negative effects on soil and plants in the long term.

In order to build government support, officials need to be engaged in the dialogue about the possibilities of greywater use in Jordan and their questions addressed. The Steering Committee that is planned for Phase II could contribute greatly to an increased dialogue. The evaluation team supports the establishment of a multi-stakeholder Steering Committee that includes such government ministries as Ministry of Agriculture, Ministry of Water and Irrigation, Ministry of Planning, Ministry of Health, Ministry of Social Development (MSD), and Ministry of Public Works and Housing.

Government offices at the local level could also play a bigger role than they did in Phase I. For instance, Ministry of Social Development and Ministry of Agriculture officials all expressed support for both the IDRC and MOP project and wish to be involved in future initiatives, particularly in beneficiary identification and selection, training, and perhaps monitoring. The Ministry of Agriculture might play an important role in agricultural training and extension. The Ministry of Social Development could play a role in identifying low-income communities and beneficiaries, as it did in the MOP project.

2.1.3 Gender and Community Participation Expertise

The research team had very strong technical skills and experience, however two areas of expertise that were missing from the team were gender and community organization/participation. These gaps may have hindered progress in achieving Objective 4: to “Strengthen Local Capacity”, which will be discussed in Section 3.1. From INWRDAM’s point of view, however, these areas were sufficiently covered by the socio-economic expert on the team.

Given that women are very involved in the cleaning systems and caring for the home gardens, more emphasis should be given to ensuring that gender issues are integrated into all phases of the project, and that gender-sensitive approaches are utilized. This concern has been addressed with the proposed involvement of the Society for Development and Rehabilitation of Women (SDRW) in the second phase of the project. Although the role of the society has not yet been defined, it could play an important part in ensuring that gender dimensions are incorporated systematically in the next phase.

Similarly, a community participation expert could have helped to involve beneficiaries more meaningfully and to increase local capacity in a sustainable way. This has also been addressed through the involvement of community participation specialists in Phase II.

2.1.4 Regional Partners

An informal network of several organizations working on greywater in the Middle East has been established. This network is comprised of INWRDAM, PARC, and the Middle East Centre for Transfer of Appropriate Technology (MECTAT). Several study trips took place between partners to share experiences and learn from one another. Travel between Palestine and Jordan has been difficult, however, which limited the involvement of the PARC expert. It is unclear how much communication took place between visits.

If this objective of a regional network is to be pursued, regular communication should take place between partners in order to share project results, discuss learnings and innovations, obstacles encountered and potential solutions. In addition to meetings and study trips, possibilities include; regular teleconferences, bulletins, and possibly online discussions.

It is recognized that this may be outside of the scope of this particular project, however INWRDAM might play a strong role in further developing this network, with the support of IDRC and others in the region.

2.2 Phase II Project Structure

The structure of Phase II has been modified in order to address some of the gaps identified above. Figure 2-2 on the following page depicts the following changes to the organization of the project, as set out in the project proposal:

- A Steering Committee composed of government officials will be formed to set direction and engage authorities in a dialogue about greywater reuse.

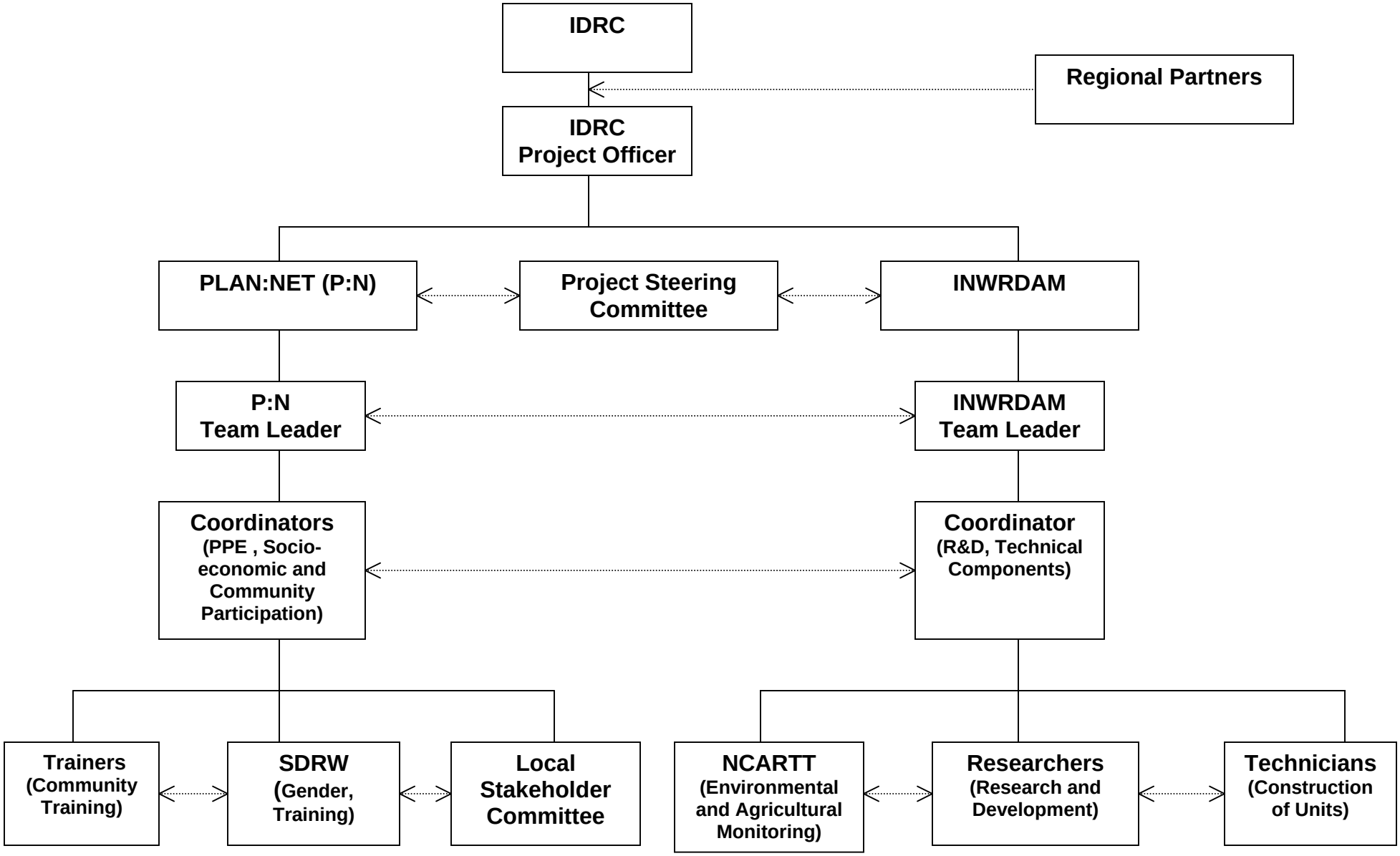
- A Local Stakeholder Committee (LSC) will be formed to contribute to the management of the project at the local level. This will be discussed further in Section 5.

- A formal agreement has been signed with NCARTT to conduct agricultural training and monitoring, as well as soil and plant testing and analysis.

- The Society for the Development and Rehabilitation of Women will conduct training sessions for women and other gender-related activities.

- Plan:Net Limited will be responsible for the Community Participation component of the project, and will assist in the development of a project-monitoring framework.

Figure 2 – 2 Proposed Phase II Project Organigram



2.3 Conclusions and Recommendations

Overall, the project was well structured and managed to meet its objectives. The success the project has achieved can be attributed in large part to the team's strong technical expertise, and collaboration among team members.

Despite this, a few gaps in the original Phase I project design have been identified, notably, limited government involvement, lack of community participation, and attention to gender issues. Building both government and community support is integral to the long-term success and sustainability of greywater reuse in Jordan.

The evaluation team endorses the changes to the project structure proposed for Phase II to address the identified gaps, and recommends that clear agreements be set out with all partners, outlining roles and responsibilities, in order to avoid potential conflict or misunderstanding.

3.0 ACHIEVEMENT OF OBJECTIVES

3.1 Achievement of Objectives

The project was carried out according to the agreement set out between INWRDAM and IDRC, and was on time and within budget. No significant problems were encountered during the course of implementation.

The table on the following pages summarizes progress against objectives as reported by INWRDAM in its progress reports, together with the evaluation team's comments and observations.

The Phase I project proposal was organized around objectives and activities, as opposed to project outcomes or results. Indicators and targets were not established against which to evaluate project performance. Where targets were stated in the proposal, they have been referred to and commented on below.

Objectives	Achievements Reported	Evaluators' Comments/Observations
Objective One: Increase greywater recovery and make it more convenient and safe to handle **Study Phase** Analyze and decide approach to: Increase the number of sources from which greywater is collected; Assess opportunities for collecting greywater automatically, instead of manually; Storage, if any, of greywater in storage tanks; Select a number of households in which to implement the system; Select a number of households in which physical improvements are not implemented; and Study social habits of new beneficiaries with respect to water use patterns. **Design Phase** Design site-specific greywater recovery systems for each selected household; Investigate the social acceptability of greywater recovery systems to each selected household; and Study social perceptions of the value and sustainability of the project. **Implementation/Construction Phase** Construct and implement site-specific greywater recovery systems for each selected household; and Incorporate local knowledge and expertise in greywater recovery and reuse process.	-all sources of greywater within a normal house are recovered -domestic water consumption data for the past 5 years for 50 selected potential households was updated and new data collected -beneficiaries were introduced to project objectives and planned goals in workshop 1 -number of houses were selected to investigate suitability for greywater recovery and reuse: all except one agreed to install sanitary modifications to recover greywater; -study team visited potential beneficiaries and validated critical information -comparison of households and public utilities' (mosque and secondary school) quality of greywater conducted -two greywater pre-treatment units were constructed and installed – one at the Society as a demonstration/working unit, and the other in a household -all potential beneficiaries showed strong interest and willingness to be part of project -25 households supplied with greywater recovery and pre-treatment units and drip irrigation systems (5 more than targeted for greywater units, and 19 more than targeted for irrigation system) -local people were consulted on best ways	This objective was met in full. Greywater recovery and treatment units and drip irrigation systems were installed in 25 households, exceeding the targets of 20 greywater units and 6 drip irrigation system. The extra expense associated with this was absorbed within the original project budget. There has been a significant impact on greywater recovery in the project location. Given the maximum theoretical rate of recovery is 80%, the recovery rate of 57% achieved by the project is quite positive in such a short time frame. According to the evaluation survey carried out, between 160 – 240 litres of greywater is being recovered per household per day. This is a significant increase from CARE PPP, in which the greywater collected ranged from 40 to 200 litres per day[1]. Approximately 90% of Phase I beneficiary households surveyed collected greywater before the project, compared to slightly over 50% of MOP beneficiaries. The system is far more convenient than "bucket under the sink" method that was used previously. All beneficiaries surveyed indicated that the system had resulted in a time savings for family members. (This is discussed more in Section 4.2.2).

[1] As reported in the Final Report of the Evaluation of Permacuture and Greywater Reuse Project submitted by INWRDAM, November 2000, p. 40.

Objectives	Achievements Reported	Evaluators' Comments/Observations
	to collect greywater, and where to put units -improvements to the treatment of greywater is ongoing process -local knowledge incorporated in improving operations and maintenance of the units	
Operation/Monitoring Phase Visit project periodically to assess how well the greywater recovery systems are working and establish friendly relations with local society.	-regular visits to the project site were conducted -all households were visited regularly and the greywater pre-treatment units were inspected -beneficiaries are now trained to conduct O&M, of the greywater and drip irrigation systems -Local technicians also trained and able to train more technicians in other villages in the installation of O&M of greywater units -after 2 years of operations, all greywater units are working with no mechanical or other problems	Regular monitoring visits were conducted by INWRDAM staff and the technicians.
Evaluation Phase Assess how much greywater is being recovered and compare with beginning of project; and Identify how convenient the recovery system is.	-water meters installed in four different households in order to measure amount of greywater passing through – average recovery rate of 57% -field surveys and questionnaires distributed: all households satisfied with automated greywater recovery system	
Objective Two: Minimize environmental impacts associated with greywater reuse and ascertain whether greywater treatment is necessary and cost-effective. **Study Phase** Greywater source control by examining opportunities to control quality at each source	- environment friendly liquid detergents were formulated	This objective was achieved in a number of ways: 1. The formulation of the environmentally friendly liquid shampoo and dishwashing detergents has been a positive output of the project. Two batches were produced and distributed to MOP and IDRC beneficiaries. They are not yet used regularly by

Objectives	Achievements Reported	Evaluators' Comments/Observations
(laundry, kitchen, bathroom, shower etc.), such as: Adopting the use of environmentally friendly detergents; Using simple screens and grease traps in kitchen; Washing dishes in one sink and rinsing in another; and Study social habits and perceptions with respect to detergents selection.	-dish washing liquid and shampoo are products of this project, and project beneficiaries showed willingness to use these products; detergent company in Zarka was contracted and supplied K-based liquid detergents -these detergents have now been introduced to many parts of the country through the MOP project -buyers in the local market were studied for social habits and perceptions	beneficiaries as they are not available on the market. 2. The 2-barrel system originally installed was based upon the design of PARC. The system has since been modified and improved upon. The 4-barrel system has enhanced water quality and the confined trench also shows promising results, however it has only been installed in a small number of households to date, therefore limited data is available to assess its performance.
On-Site Treatment Select the most appropriate type of treatment system (based upon results from the PARC project); and Study social perceptions for the need of greywater treatment.	-resulted in developing two simple and cost effective methods for greywater treatment: 1) 2 and 4 recycled polyethylene barrels 2) concrete structures -found that four barrel kits are suitable for treating greywater for family size of 6-12 people, and greywater flow below 500 liters per day -four socio-economic and environmental surveys were conducted to study social perceptions -there was also a study conducted to determine social habits in using the detergents -field observation conducted to investigate social perceptions for the need of greywater treatment	The technical skills and experience of INWRDAM staff and the technicians have contributed significantly to enhancement and evolution of the design. The drip-irrigation systems have also minimized the impact of greywater on soil by dispersing the water, rather than spot-irrigating. From INWRDAM and NCARTT's experience, drip irrigation is the most appropriate system for use in Jordan. Subsurface irrigation systems require frequent maintenance, and are not widely used in Jordan. Another possible positive environmental impact that is hypothesized is the reduction in groundwater contamination from septic tanks, although this has not been confirmed.
Design Phase Investigate the social willingness and ability to apply greywater recovery and reuse system; Design source control systems; and Design a small number of low-cost treatment systems in some of the households in which treatment will be conducted.		

Objectives	Achievements Reported	Evaluators' Comments/Observations
Implementation/Construction Phase Implement the source control systems; Construct and implement the treatment systems; and Train local people for the basic environmental concepts.		
Objective Three: Improve gardening/permaculture practices **Study Phase** Study users' preferences with respect to cropping patterns and their willingness to change; Study means for making greywater distribution more effective (hoses, pumping etc.); Study and confirm means for improved irrigation methods (use of mulches, drip irrigation etc.); Identify appropriate crops that are tolerant to greywater, are suited to the local climate and soil, and meet the needs of beneficiaries and the market; and Study social perceptions for the need for improved irrigation systems. **Implementation/Construction Phase** Implement improved greywater distribution systems; Improved irrigation methods; Better and different crops; Train women of techniques for food preservations; Train local people for integrated water management, permaculture and agricultural requirements for new cropping patterns; and Quantify the value-added for the improvements in both cropping patterns and distribution system.	-new crops were introduced, such as smooth leaf cactus and Sudan grass, a forage crop -new crops (such as pistachio nuts and artichoke) were tested for compatibility with greywater -user preferences were studied in two workshops -four households fitted with water meters to measure amount of greywater recovered -survey conducted in the 2nd quarter of the project to assist the needs of the local community for training -all project beneficiaries were provided with drip irrigation system -two year study will be conducted by NCARTT covering a group of three households and using three different sources	The primary achievement of this objective was the installation of drip irrigation systems for all 25 households. Before the installation, the majority of beneficiaries were irrigating with buckets. Now, on average approximately half of the beneficiaries' total land area is irrigated by the system (average 1.45 donum or 1450 square meters). All of the beneficiaries surveyed noted improved productivity of their trees. About half of those surveyed had planted different types of trees, and half had planted more of the same trees they were growing previously. Olive trees, fig trees and cacti are the most common tree/plant being irrigated by greywater. Other trees irrigated by greywater include: apricot, citrus, apple, pistachio and almond. Agricultural practices do not appear to have improved significantly among beneficiaries. Members of the survey team (two of whom are Agricultural Engineers) noted that beneficiaries' knowledge of sound agricultural practices is limited, and should be improved. In particular, the following areas were noted as

Objectives	Achievements Reported	Evaluators' Comments/Observations
		areas of weakness, and potential topics for training: Soil management Plant protection and disease control Types of trees/crops appropriate for greywater irrigation. While beneficiaries are pleased with the short term benefits, they are concerned about the long term impact of the greywater on their soil and trees. More effort should be made to provide agricultural training and monitoring in the next phase. NCARTT's role has been strengthened and formalized to address this concern.
Objective Four: Strengthen local capacity to safely and efficiently reuse greywater **Study/Preparation Phase** Inform local community about the project; Survey and Select household in which to implement improved infrastructure and permaculture practices; Discuss/teach/learn about best practices for water use habits to maximize source control; Clearly identify and communicate responsibilities (financial, construction, and other) of researchers, Ein Al-Baida Society, and household, for forthcoming construction and operation stages; and Build local capacity of the Society to self-monitor and evaluate greywater recovery and reuse process.	-policy makers, Ministry of Planning, professional organizations, the media and the local community are informed about the project through various field visits and professional activities -continuous process in place of contacts and dialogues with all households and the society, i.e. through workshops -Ministry of Social Development is now an ally in promoting the ideas of greywater reuse for poverty alleviation and takes active role in selection of sites and communities for similar projects	Some progress has been made toward this objective. Some beneficiaries have adapted their practices, such as avoiding putting fatty content in the kitchen sink to improve the quality of greywater recovered. However, according to INWRDAM's estimates, approximately 60% – 70% of beneficiaries are maintaining and cleaning the system properly. This poses a potential environmental and health risks for the 30% – 40% of households not adequately maintaining the system. Over the course of the project, nine training workshops were conducted, covering topics such as operation and maintenance of the system, water, and public health. Workshops were attended by men and women beneficiaries.

Objectives	Achievements Reported	Evaluators' Comments/Observations
Implementation/Construction Phase Build the capacity of selected women on integrated water and environmental management; Re-confirm water use, soap, dishing washing etc. best practices; Educate beneficiaries on O&M requirements for greywater recovery systems; Educate beneficiaries on O&M requirements for means to reduce environmental impacts, including screens, treatment units etc.; and Involve local people in the construction of greywater recovery and reuse system in order to build their local capacity. **Operating/Monitoring Phase** In concert with Ein Al-Baida Society, work with households to periodically monitor the project progress, household practices in source control, O&M and permaculture practices; and Train local people for the basic functions of greywater recovery and reuse. Evaluation Phase Assess social impacts, including gender impacts; and Quantify the benefits in the improvements of water quality.	-workshops conducted at the Society and at the Jordanian Engineering Association, with community leaders, women, and potential beneficiaries attending -field surveys and socio-economic and environmental surveys were conducted -knowledge of sustaining the greywater system was created and re-constructed through discourse between local people and the project team	Most (seven out of nine) beneficiaries surveyed felt that they have increased knowledge, particularly relating to water scarcity and reuse, since participating in the project. Seven out of nine beneficiaries also felt that they had increased skills, primarily relating to operation and maintenance of the greywater units and drip irrigation systems. While there has been an increase in capacity among beneficiaries, it has been a slight increase at best. Among women, understanding of the basic principles of how the system operates is weak. Beneficiaries appear to be highly dependant on INWRDAM and the technician for the maintenance of their systems and show little initiative to maintain their own systems. If problems arise, many call the technician rather than trying to solve the problem themselves. If beneficiaries are either unable or unwilling to adequately maintain their systems, this could pose a threat to the sustainability of greywater use. There is general consensus among the project team, key informants and beneficiaries that more emphasis should be placed on training beneficiaries in the next phase of the project.

Objectives	Achievements Reported	Evaluators' Comments/Observations
		Efforts need to be made to ensure that women are also trained effectively. Training methods, locations, and timing might need to be altered to meet the needs of women. This will be discussed further in the gender analysis in Section 4.5. While the capacity to operate and maintain the systems is clearly central to this project, capacity should be thought of more broadly than this. For example, training might also be conducted on agricultural practices, environmental awareness, public health, water scarcity, water resources management, etc.
Objective Five: Promote changes in policies to encourage greater greywater reuse in Jordan **Study Phase to Operation/Monitoring Phase** Participate in on-going review of changes to water re-use bylaws; and Prepare an evaluation of the system after completion of the two-year project. **Implementation/Dissemination Phase** Disseminate the overall findings of project, summarized in the evaluation report at a national level workshop in Jordan.	-National Committee on Building Codes provided with a modified version of the chapter of the building code related to sanitary connections. As a result, a special committee was established in March 2003 at MW &I to study the technical aspects of the proposed modifications to this chapter of building code -MW&I subcommittee on wastewater reuse set up a monitoring program that collected greywater from 8 households in the project area and made a monthly evaluation of the results, which were conducted until July 2003 -national workshop about greywater reuse conducted at JEA in October, 2002, which was attended by more than 100 professionals from NGOs, CBOs, and the private sector	The National Committee on Building Codes recommended change of codes in rural areas, however decided that the issue needed further study for its application to cities because of a concern that the proposed changes would affect the performance of wastewater treatment systems. The proposed changes have not yet been accepted by the Ministry of Public Works and Housing. A second committee was struck to try to introduce the concept of greywater into legislation, as it currently does not exist. This committee has had some difficulty in progress. More data is needed to provide convincing evidence of safety and benefits of greywater use. Given that policy change can take a long time, progress on this objective is reasonable. The Phase II Steering Committee will also help

Objectives	Achievements Reported	Evaluators' Comments/Observations
		to bring more policy makers on board. The project has contributed to an increased profile and awareness of greywater in Jordan among high level officials.
Objective Six: Self-monitor the impacts of the projects This activity is to be conducted periodically throughout the project. **Study Phase** Train women and the Society on project self-monitoring and evaluation. **Design Phase to Dissemination Phase** Attempt to establish greywater users association as a form of decentralized management; and Study social attitudes for women taking leadership roles in the local society.	-close contact with all beneficiaries established through training workshops and regular field visits to project site -women were the majority of participants in all training workshops -unable to establish a greywater users association because the number of users was too small. Since the project started though, it has created a considerable impact on the local level towards greywater reuse for enhancing social productivity and poverty alleviation -MOP has granted INWRDAM a project to provide approx. 700 households throughout Jordan with greywater recovery and reuse units. More than 450 of these units were implemented by summer 2003. -project team leader made presentation about greywater and UA potentials for Jordan in May, 2003, to top officials of the MOA, which is now interested in the findings and has started initiatives for promoting UA. -role of women as leaders in the local community with respect to greywater reuse was studied.	Self-monitoring systems were established and well-carried out by INWRDAM throughout the course of the project. Water samples were collected and tested monthly in cooperation with the Water Authority of Jordan. Soil samples were collected and tested every six months. The results of the tests, however were not communicated to those beneficiaries from whom samples were taken. In the next phase, beneficiaries should be notified of the results so that they can make informed decisions about whether or not to continue using greywater. INWRDAM staff conducted weekly field visits throughout the course of the project. The technicians made regular visits to beneficiaries and reported the results to INWRDAM. Beneficiaries were also asked to contact the technicians or INWRDAM in case of urgent problems. Through the monitoring that took place, feedback from beneficiaries was incorporated into the design of the systems. For example, cloth filters were added to the units after it was observed that beneficiaries were using cloth screens to prevent clogging.

Objectives	Achievements Reported	Evaluators' Comments/Observations
		The regular monitoring missions conducted by IDRC staff were felt to be extremely useful by Project staff. Suggestions made were incorporated into project activities and the design of the systems. For example, two barrels with gravel media were incorporated into the kit, following advice from the IDRC Project Officer.
Objective Seven: Evaluate the impact of the project since it was implemented Conduct a complete evaluation, including water use habits, environmental and socio-economic impacts of this project and compare results with the PPP evaluation; Quantify the benefits and costs for relevant components of greywater recovery and reuse system; and Assess the role of the project in poverty alleviation.		

3.2 Unanticipated Results

Perhaps the most significant unanticipated result of this project was the interest in greywater that was generated from the Ministry of Planning and others. MOP funded INWRDAM to install more than 800 systems throughout the country over a period of eight months. As well, INWRDAM was requested by CARE to install approximately 80 units for a European Union funded project. Thus, the total number of greywater users in Jordan has increased significantly from 25 to over 900, allowing a far greater number of people to benefit from the system and more data to be generated in order to study the performance and impact of greywater use. This project has also increased awareness of greywater among top level officials such the Deputy Ministers of MW&I, MSD and MOA, local level government offices of MOA and MSD, and local NGOs.

INWRDAM has also contributed to raising the profile of greywater, both in Jordan and in other parts of the world. For example, all of INWRDAM's member states (Bangladesh, Egypt, Iraq, Jordan, Lebanon, Malaysia, Mali, Niger, Oman, Pakistan, Sudan, Syria, Tunisia, Turkey and Yemen) have been informed of the project. International donors, such as the European Union and GTZ are also aware of the project, as are relevant government ministries.

3.3 Conclusions and Recommendations

All objectives set out by INWRDAM were achieved. In particular, those activities related to the design, modification and installation of the greywater units and drip irrigation system, were well carried out.

Accomplishment of the objectives related to strengthened local capacity, and improvement of permaculture/gardening practices, were not achieved to the same degree, though some progress was made. The identified weaknesses have been identified by INWRDAM and addressed in the design of the second phase.

Increased agricultural training should be conducted. Potential topics for agricultural training include:

- permaculture methods and practices,
- soil management and conservation related to greywater use,
- plant growth, protection and disease control (including natural methods),
- irrigation system management and maintenance,
- management of household hazardous chemicals and environmental friendly alternatives,
- compost preparation; and
- rainfall harvesting practices.

NCARTT, and possibly MOA could play a lead role in identifying training needs, and implementing such training. A combination of training workshops, and ongoing agricultural monitoring will be needed to promote the uptake of the knowledge. Local MOA agricultural officers might also play a role in conducting ongoing monitoring.

Significant unanticipated results were achieved, most notably the support gained from the Ministry of Planning and the European Union for the installation of units across the country, raising the total number of systems in Jordan from 25 to over 900. Awareness and support for greywater has also been raised among senior government officials, funders and INWRDAM member states.

4.0 SOCIO-ECONOMIC ANALYSIS

Background

A comprehensive survey was conducted with 9 out of 23 total IDRC Phase I beneficiary households (a sample size of 39%) and 39 MOP beneficiaries. In total, 48 households were surveyed out of 900 total greywater beneficiaries in Jordan, representing a sample size of 5%. This section examines the socio-economic dimensions of the greywater systems.

4.1 Socio-economic Profile of Beneficiaries

Figure 4-1 below summarizes the key socio-economic data collected during the evaluation. The aggregate totals are included for comparative purposes.

Figure 4-1 Beneficiary Socio-economic Data

	IDRC Phase I (n=9)	Aggregate (n=48)
Average Family Size:	10.6	9.4
Female adults	3.1	3
Male adults	3.3	2.8
Children	4	3.2
Occupation of Head of Household:		
Retired	55%	63%
Government officials	33%	27%
Private Sector	11%	4%
Driver	0%	6%
Average Monthly Income:		
Head of Household's Income	268 JD	192 JD
Income from other sources	199 JD	144 JD
Total Income	467 JD	336 JD
Average number of children per household in:		
School	4.6	3.5
University	0.9	1.3
Total	5.5	4.8
Land and home ownership:		
Owners	100%	100%
Tenants	0%	0%
Average land size in donum	2.84	3.1

The poverty line in Jordan ranges from 119 JD[2] to 177 JD[3] per household per month, depending on the data source.

[2] Based on the 1998 "Poverty and Unemployment in Jordan" study conducted by the Royal Scientific Society, as cited in the Phase II Project Proposal.

[3] The Jordanian Government's National Poverty strategy, published in May 2002 uses the World Bank estimate of 313.5 JD per capita per year, based upon 1997 statistics. If this number is multiplied by average family size of 6.8, and divided by 12 months, this suggests the poverty line would be 177.65 JD per household per month.

The latter number (177 JD) will be used in this analysis, as this is the poverty line used by the Jordanian Government in its most recent Poverty Strategy[4]. On a per capita basis this equates to 0.86 JD per day.

Among Phase I beneficiaries, the average household income (including all sources) is 467 JD/month, significantly above the poverty line. According to Figure 4-2 below these households fall into the high end of the middle-income category. However, one third of households do not have sources of income outside of the head of household's, and have an average income of 268 JD/month. These families fall within the low-income category, though above the poverty line.

On a per capita basis, the average daily income of Phase I beneficiaries (including all sources) is 1.46 JD, again above the official poverty line. The one third of households with only the head of household's income are just below the daily poverty line, at .84 JD per capita per day.

The aggregate picture looks somewhat different. The average monthly income is 336 JD (or 1.19 JD/capita/day), placing households at the higher end of the low-income category. 40% of these households are also without additional sources of income and are only marginally above the poverty line at 192 JD per month. Using a per capita analysis, the daily income is 0.68 JD, placing them below the daily poverty line.

Figure 4-2 Income Categories in Jordan[5]

Income Groups	Range of Incomes (JD/ Month)	% of Population in each Group
Very high income	Above 700	10.7%
High Income	500-699	13.4%
Middle Income	350-499	18.9%
Low Income	100-349	53%
Very Low Income	Below 100	3.9%

The average family size (10.6 among IDRC households) is significantly larger than the national average of 6.8, indicating that expenditures are likely fairly high. The survey team was not able to collect precise data regarding monthly expenditure, however it appears that households spend everything they earn and are able to save little. The average number of children in school and university is between five and six, indicating significant educational expenses.

All of the beneficiaries own their houses and land. The average land size for both groups is around three donum (3000 square metres), a relatively large land size.

[4] 177 JD equals approximately CAD $345 based on exchange rate of 1.952.

[5] The figures in this table are taken from the income and expenditure survey conducted in 1997 by the Statistical Department. While these numbers are seven years old, they are the most recent numbers available.

4.2 Costs and Benefits at the Household Level

4.2.1 General Satisfaction

Overall, beneficiaries are satisfied with the system, and are benefiting from its use. As shown in the table below, the majority of beneficiaries rate the system as "excellent" and "very good".

Figure 4-3 Beneficiary Satisfaction

	IDRC Phase I (n=9)	MOP (n=39)
Please rate the system:		
Excellent	56%	64%
Very Good	33%	18%
Good	11%	15%
Poor	0%	3%
Very Poor	0%	0%
Is your family better off a result of using the system?		
Much Better Off	22%	49%
A Little Better	78%	41%
No Difference	0%	10%
A Little Worse	0%	0%
A Lot Worse	0%	0%

The vast majority of beneficiaries feel that their families are better off as a result of using the system. One might expect that there would be more of a benefit to those who have been operating the system for a longer period of time, as they have had more growing seasons to reap agricultural benefits. This however is not the case. Rather, almost half of MOP beneficiaries, who have been using the system for less than half the time of IDRC beneficiaries, feel their families are "much better off" as a result of using the system, compared with only 22% of IDRC beneficiaries. This might be attributed to the higher relative benefit of small improvements in agricultural productivity and savings to low-income versus middle-income households.

4.2.2 Benefits

Beneficiaries cited the following benefits from using the system. Unless otherwise noted, data given is for IDRC beneficiaries. Aggregate data can be found in Appendix E.

Agricultural Benefits

All beneficiaries have observed improvements in the production of their trees since installing the greywater unit and irrigation system. Olive trees in particular look healthier, and are yielding more and bigger olives. Over half the households have planted more trees and crops since installing the system. Agricultural products are used primarily for household consumption, though a small number of households (two out of nine) sell their products.

Time Savings

All of the beneficiaries surveyed report a reduction in household workload, resulting in time savings. This occurs primarily from the drip irrigation system versus manual irrigation, and time saved by pumping septic tanks less frequently. These savings accrue to both women and men. Though cleaning the units takes between a half hour and one and a half hours per week this is not perceived by IDRC beneficiaries as additional workload. 10% of MOP beneficiaries, however, feel that there is an increased workload. The reasons for this difference in perception are not known.

Skills and Knowledge

Three-quarters of beneficiaries feel that they have increased skills and knowledge as a result of their participation in the project. New irrigation techniques, awareness of water scarcity and reuse, were cited as the knowledge gained; skills in system operation and maintenance, irrigation and gardening have also increased.

While there has been an increase in skills and knowledge, the research team perceived this increase to be nominal. For example, knowledge of good agricultural practices, and women's understanding of the basic operating principles of the system remains weak.

4.2.3 Social Costs

There appear to be no social costs for any of the beneficiaries. The distribution of a new technology to some but not all community members does not seem to have caused strained relations among neighbours.

There have been some complaints by those who have not received the system, however this has been managed by the technicians and local NGOs, and has not caused significant problems.

Technical problems and disadvantages with the system will be discussed in Section 6.

4.3 Institutional Beneficiaries

Officials from the Girls' School and Mosque in Ein Al-Baida are very pleased with the systems. Both institutions have earned between 25 – 50 JD per season from the sale of agricultural products. The school has used this additional money to support several poor students in attending courses and paying fees for them to join the Environmental Club.

Both institutions have also seen savings in their water bills. The installation of the systems in these two public places has raised awareness of the project, and of water scarcity among students, worshippers, and visitors to both places.

The school has had some trouble with the pump, and has not been able to fix it themselves, as they have not received training on how to maintain the system.

4.4 Social Acceptability

Community members largely accept both the idea of greywater reuse and the associated technology. While at the beginning of the project, community members expressed doubt and some refused to install the system in their houses, it appears that the project has overcome this problem, as there is now high demand for the system.

Local NGOs have received many requests for systems and have registered names of households interested in installing the system. According to the Director of the Ein Al-Baida Society they have registered more than 1000 names of interested people. It should be noted that INWRDAM was not aware of this, and the evaluation team was not able to verify this firsthand.

The “demonstration effect” from the systems has been strong. All of the IDRC beneficiaries have been asked about the system by their friends, family and neighbours, and all have recommended the system to others. Similarly, 95% of MOP beneficiaries have recommended it to others.

Although the survey team only spoke with a small number of neighbours, all of them would like a system. Similarly, the Neighbours Survey conducted by INWRDAM in 2003 found that 87% of those surveyed wanted to install systems in their homes.

4.5 Gender

While a formal gender analysis of the project was not carried out, the following observations can be made based upon the survey, focus group and interview results.

4.5.1 Costs Versus Benefits

The project has affected both men and women in a positive way. No negative effects on men, women or children were observed. Rather, all have enjoyed a decrease in household workload and time savings as a result of owning the greywater system. For men, this is primarily from pumping septic tanks less frequently, and for women and children this results from no longer collecting greywater and irrigating manually.

The time needed to clean the system is estimated at between one half hour and one and a half hours. The majority of beneficiaries did not perceive this as adding to their workload.

While the savings accrued (discussed in Section 4.6) are perceived by beneficiaries as benefiting men primarily, the entire family likely profits, as the extra money is spent on expenses such as food, education and household items.

As mentioned above, there has been an increase in the skills and knowledge of beneficiaries. During the women's-only focus group the survey team observed that women's knowledge of the operation and benefits of the system, and of good agricultural practices was quite limited. For example, two women have removed the gravel from their units in order to reduce odour, not understanding that the gravel is needed for effective treatment of the greywater. Such lack of understanding of the basic principles of operation could have negative health and environmental repercussions.

It appears that priority was given to training men rather than women during Phase I. None of the 12 women who attended the focus group had received any training related to the system. Their husbands had not attended any training either, however the technicians showed them how to take care of the system when it was installed. However, as INWRDAM points out, nine training sessions were held over the course of the project, which men and women alike attended.

4.5.2 Gender Roles and Division of Labour

The gendered roles and division of labour relating to the operation and maintenance of systems are not clear.

According to the Permaculture Pilot Project (PPP) evaluation, women were responsible for the manual separation of greywater, and irrigation of their home gardens. Based on this, it was thought that women would take primary responsibility for the greywater units and irrigation systems. This, however, does not seem to be the case. As the table below shows, there is significant variability between families and between the IDRC and MOP projects around who takes care of the system.

Figure 4 – 4 Responsibility for System

Who takes care of the system?	IDRC	MOP	Aggregate
Husband	11%	38%	34%
Wife	11%	8%	8%
Husband and Wife	11%	5%	6%
Children	44%	13%	19%
Husband and Children	0%	13%	11%
Wife and Children	0%	3%	2%
All	22%	18%	19%

In 44% of IDRC households, children take care of the system, compared with 34% of MOP households where husbands take care of the system. Women alone take care of the system in only a small percentage of households (between 8% and 11%). (It is likely that "children" refers to grown children, however data on the gender and age of the children was not collected.) Similarly, there are no norms when it comes to who is responsible for the home garden; responsibility is shared among family members.

Assuming the finding in the PPP evaluation was correct, it would appear there has been a shift in gender roles. One possible explanation for this is that men have taken more of an interest in gardening since the installation of the systems, because of the increased availability of water and resulting improvement in the productivity of gardens. It may also be that since women do not have adequate training, the responsibility has fallen to their husbands; a further indication that more training needs to be held for women to increase their understanding and thus, their benefits. This does not seem to be a source of concern for either men or women in the community. These observations are preliminary, however, and should be studied further in the next phase.

4.5.3 Gender Differences in Eligibility

Both samples contained one female-headed household each. If this is representative of the beneficiary groups, it may mean that neither project reached female-headed households, or that there are very few such households to begin with. The baseline survey to be carried out should collect information about the number of households headed by women, to ensure that these households are not overlooked.

4.6 Economic Costs and Benefits

A formal economic benefit-cost analysis was not carried out during the course of this evaluation. In this section, the stream of economic benefits and costs will be described and the benefit/cost analysis conducted previously by INWRDAM will be commented on.

4.6.1 Economic Benefits to Households

The system has resulted in small financial benefits, mostly in the form of savings, for households. The average savings on water bills for beneficiaries of both projects has been approximately 50%, or an average of 9 JD per quarter (37 JD/ year). Savings from the reduction in septic tank pumping ranges from 45 JD per year in Tafila to 275 JD per year in Kerak. The difference in savings is due to the varying topography of the locations. In Kerak, where the terrain is rocky and septic tanks fill up quickly, participating households have gone from pumping their tanks once or twice per month to once per year, resulting in significant annual savings.

A small number of households (22% of IDRC, and 14% of MOP) sell some of their increased agricultural yield, earning an additional 20 – 200 JD per season, depending on the size of the garden. The vast majority of beneficiaries (90%) use the increased production for household consumption. However, the amount of increased yield is still relatively small, and not yet offsetting of food purchases in a significant way. 28% of MOP beneficiaries also give these crop increases as gifts, though no IDRC beneficiaries reported doing so. Although this does not have a direct financial benefit, gifts often serve as an investment in extended family contexts.

4.6.2 Economic Costs to Households

In both the IDRC and MOP funded projects, the greywater units and irrigation systems were provided free to beneficiaries. Some beneficiaries, though not all, made in-kind contributions in the form of site preparation. This contribution is estimated by INWRDAM at 40 JD depending primarily on topography, and the type of system installed. Approximately one quarter of beneficiaries paid some money for the preparation of the site, ranging from 6 to 40 JD. Those MOP beneficiaries living in Karak paid more to dig the site, because of the rocky terrain. As well, site preparation cost more for those beneficiaries with either the confined trench system or the treatment units.

Thus far, the cost of maintaining and repairing the system has been minimal. Approximately 40% of IDRC beneficiaries have spent between 2 and 10 JD to change filters, pumps and drippers and to extend the drip irrigation hoses to cover more surface area. Though not mentioned by beneficiaries, electricity bills have likely increased slightly.

4.6.3 Benefit/Cost Analysis

In 2003, INWRDAM prepared a benefit/cost analysis of the system for eight households (See Appendix F). In general, the analysis seems reasonable.

Based upon a five-year period, the benefit-cost ratio ranges from between 0.75 to 5.8, with an average ratio of 2.9. One quarter of the systems over this period net a loss. Over a ten-year period the range is between 0.98 and 8.2, the average ratio is 4.3. In this scenario only one household nets a loss.

Using the B/C analysis prepared INWRDAM, the following average ratios have been calculated, based on the type of system utilized, and the number of years operated.

Figure 4-5 B/C Ratio by Type of System

Type of System	Average B/C Ratio 5 Years	Average B/C Ratio 10 Years
2-barrel (n=3)	3.9	5.5
4-barrel (n=3)	2.5	3.9
Unit (n=2)	1.9	3.2

The 2-barrel systems have the highest benefit-cost ratio, likely due to the low cost of installation. However, water quality tests have also shown that the quality of the greywater from the 2-barrel systems has generally been the poorest. The unit systems are significantly more expensive to install, and also have the lowest benefit/cost ratio. Thus, the 4-barrel system would seem to offer the best return on investment for beneficiaries.

One observation offered, is that the estimated septic tank pumping savings used by INWRDAM is quite high. Data from the recent survey suggest that this number is closer to 45 JD/year than the 90 to 180 JD/year used in the original B/C Analysis. Similarly, the value of the crops utilized by households appears high. A revised analysis with a more conservative estimate of savings accrued from septic pumping, suggests that the average ratio over a 5 year period is closer to 2.2 and over 10 years is 3.6, slightly less than that suggested by INWRDAM (see Appendix F).

4.7 Conclusions and Recommendations

While the IDRC project was to have targeted “peri-urban poor”, only one third of the beneficiaries can be defined as such, compared with the majority of MOP beneficiaries.

If the second phase of the project is to contribute to poverty alleviation, then income level must be one of the primary selection criteria. While it is not necessary to target “the poorest of the poor” it is reasonable that the primary target group be low-income households (between 100 – 349 JD per month according to figure 4-2). These households combine the greatest ability to benefit and represent over 50% of the Jordanian population.

The social benefits of the greywater system have far outweighed the costs of the system to beneficiaries. The primary benefits have been in the form of time savings and reduction of household workload, increased productivity of trees, and slight increase in skills and knowledge.

In order to maximize the benefits to households, more training should be conducted with beneficiaries (both men and women), particularly in the areas of proper cleaning and maintenance of the system, sound agricultural practices such as soil management, plant protection and disease control, and information about appropriate crops for greywater irrigation. Training could also include topics such as environmental awareness, public health, water scarcity, water resources management, etc.

Because the systems were provided free of cost, the economic benefits of the system outweigh the costs to individual beneficiaries. Economic benefits are primarily in the form of savings on water bills and septic tank pumping. In a future scaled up scenario where all or part of the costs are passed on to beneficiaries, a revised benefit/cost analysis would have to be conducted.

It is recommended that more priority be placed on incorporating gender issues into all aspects of the project in the second phase. Some suggestions for doing so are:

- gender training be held for staff, technicians, stakeholder committee,

- gender specific indicators be developed in the monitoring plan,
- a baseline survey including both gender disaggregated and gender specific data,
- a specified percentage of stakeholder committee members be women,
- in mixed-settings, women's learning styles, and comfort levels be taken into consideration when designing training workshops,
- meetings and workshops be held at times that are convenient to both men and women; and
- separate meetings/training for men and women be considered.

These, and other gender dimensions should be included as specifically as possible in the plans developed for the various components of Phase II. A separate gender plan may also be necessary.

5.0 COMMUNITY PARTICIPATION AND LOCAL CAPACITY

Background

Although there was no specific community participation/development component in Phase I, the following section offers comments and analysis in order to inform the next phase of the project.

5.1 Site Selection Process

Ein Al-Baida was selected as the site of the IDRC Phase I project in order to build upon the experience and results of the CARE Permaculture Project. Therefore, site selection criteria were not established.

For the MOP project, the following site selection criteria were developed:

1. Locations preferably at higher than 600 meters above sea level (related to appropriate levels of rain fall and soil types)
2. Minimum rain fall of 200 mm/year
3. Suitable soil for complementary irrigation
4. Settled rural or peri-urban community
5. No public sewer systems installed
6. Planted trees on nearby land plot
7. No surface water supply in form of public irrigation canals or natural springs

5.2 Beneficiaries

5.2.1 Selection Criteria and Process

The following were the stated criteria for beneficiary selection in Phase I:

1. Must show interest and willingness to participate in the project
2. House/ property must have access to domestic water supply and access to electrical power
3. Must have minimum domestic water consumption of 25 m3/quarter
4. Must have an arable land plot of not less than 1000 m2 adjacent to the house
5. Must sign an agreement with the project indicating his/her agreement to comply with project aims and objectives and agree to make in-kind contributions

The original project proposal also stated that low-income households would be selected for participation[6]. However, this criterion was not carefully applied. This

[6] Permaculture and Greywater Treatment and Reuse in Tafila, Jordan Proposal, INWRDAM, p.11.

is evidenced by the fact that, as mentioned earlier, only one third of the beneficiaries fall into the low-income category.

This may have occurred because 10 of the 25 households were selected based upon their participation in the CARE Permaculture Pilot Project. As well, in the early stages the project team had difficulty convincing people to participate, and the team was eager to install some systems in order to demonstrate their utility to community members. Therefore, willingness and ability to participate became more important than income. It might also be because the technicians were not adequately trained or instructed to use income level in recommending beneficiaries.

Personal interests also played a role in the selection process. For example, some systems were installed in the homes of relatives of the Director of the Ein Al-Baida Voluntary Society, although they did not meet the eligibility requirements. As well, at least half of those who attended the focus group were neighbours or relatives of the local technician. From a research perspective this selection criteria may be reasonable, as INWRDAM was able to gain access to the systems to assess performance and make any necessary modifications. However, from a community development and poverty reduction perspective, this type of “ad hoc” process can lead to inequities and conflict within a community.

From INWRDAM’s perspective, the selection criteria were utilized to the extent that it was possible and practical, particularly given the small number of beneficiaries, and the technical nature of the project.

5.2.2 Beneficiary Participation

Beneficiaries were not involved in the design, management or monitoring of project activities. Beneficiaries were primarily involved as recipients of a new technology, and in providing feedback to the team, some of which was incorporated into the design of the units.

There was no mechanism in place to build the capacity of beneficiaries in a significant way. Several training sessions were conducted on proper operation and maintenance of the systems, however almost all the stakeholders interviewed feel that far more training is necessary. One MOP official recommended that in future greywater projects, 60% of project activities should focus on training and awareness, and 40% on technical implementation.

As mentioned in Section 3.1, there is a high level of dependency among beneficiaries on the technicians and INWRDAM for the maintenance of their systems. If the technicians were to stop following up with beneficiaries, it is unclear whether or not beneficiaries would have enough interest or skill to maintain the systems properly on their own. Without a sufficient sense of

ownership of the system by beneficiaries, there is a possibility that some systems could fall into disrepair or be discarded altogether.

The sense of ownership might be increased in a number of ways:

- A more rigorous selection process, carefully selecting only those most committed to actively participating,
- Increased investment from the household, either through in-kind or cash contributions; and/or
- Increased training, building awareness of the benefits of a well-functioning system, and the skills to properly operate and maintain it.

5.3 Community Organizations

5.3.1 Ein Al-Baida Voluntary Society

INWRDAM developed a formal relationship with the Ein Al-Baida Voluntary Society in the early stages of the project; a contract was signed between the two parties. The Society assisted INWRDAM in conducting a survey of potential beneficiaries, selecting some beneficiaries, and conducting training sessions. After some time, the relationship became strained, and broke down after disagreements arose over selection of beneficiaries.

While it is difficult to determine exactly what led to the conflict, it seems that the Director of the Society insisted on providing some of his relatives with the systems. INWRDAM agreed to install a few, however stopped doing so when several of the proposed beneficiaries did not meet the selection criteria. The Director also wanted the technician to seek his approval before conducting any activities, which INWRDAM deemed unnecessary and inappropriate. INWRDAM eventually carried on with project activities without the Society's involvement. The Director of the NGO wrote a letter of complaint to the Governor accusing INWRDAM of breaking their agreement with the Society. Since then the two parties have not had any contact.

Several lessons can be drawn from this experience. By working through a Stakeholder Committee that is representative of the local population, favouritism and preferential treatment can often be mitigated. Developing fairly strict selection criteria for beneficiaries, and applying them in a systematic and transparent process may also help to avoid such problems in the next phase.

A clearer understanding on the part of the Society of their roles and responsibilities might also have alleviated some of these difficulties.

5.3.2 Benefits to Community Organizations

Community organizations played an important role in raising awareness of both the IDRC and MOP projects in the communities, and convincing people to participate in the projects.

Community organizations have benefited slightly from their involvement in the two projects. Representatives from four community organizations involved in either the MOP or IDRC project were interviewed. Three of the four said that as a result of their involvement in the project, there has been an increased interest in the organization from community members. Two organizations have increased their membership since becoming involved. No other benefits were observed.

Building local capacity to participate in the management, monitoring, maintenance of greywater is a key piece in the sustainability of such a project, and any future scaled-up project.

5.4 Conclusions and Recommendations

The beneficiary selection criteria were not always clearly understood by those involved in the project, nor systematically applied in the selection process.

It is recommended that a systematic selection process be developed and followed in order to ensure that the process is fair and equitable.

In the second phase, more emphasis should be placed on the community/local capacity dimensions of the project. A community engagement process should be mobilized prior to the selection of beneficiaries and the installation of systems.

The following criteria are proposed in selecting the site for Phase II, based upon the experience of both the IDRC and MOP projects:

- Peri-urban community,
- Sufficiently established to have a governmental and community organization presence. This will be necessary in order to organize the community effectively,
- A sufficient number of low-income households with home gardens who are willing and able to participate,
- Moderate rainfall in the winter, drought in the summer (minimum 200 mm/year),

- Not served by existing public sewer system, and unlikely to be in the near future,

- Need for water – no easy access to other water resources, such as natural springs, wells, irrigation canals, etc,

- Appropriate soil and climate for agricultural production and complementary irrigation,

- Accessible for research purposes. Although this should not be the defining factor, a site within easy travelling distance to Amman will decrease the amount of time spent traveling to the site allowing for more time to be dedicated to project activities; and

- The site selection process may also take into consideration the sites selected by the International Fund for Agricultural Development (IFAD), Agricultural Management Project.

6.0 TECHNICAL DIMENSIONS

Background

This section presents a discussion of the technical effectiveness of the greywater units and irrigation system from the perspective of the beneficiaries.

6.1 Design of the systems

Both the greywater units and trickle irrigation systems appear to be technically sound. The design of the units has been modified several times.
Building upon the 2-barrel system designed by PARC, INWRDAM made some modifications and improvements to the design. The 4-barrel system was later designed, and has resulted in improved water quality. The confined trench also shows promising results, however to date only a small number have been installed.

These modifications have been made to continue to improve the performance, efficiency and quality of the systems, while keeping the costs down.

As mentioned in Section 3.1, the drip irrigation system appears to have worked well, and is favoured by both INWRDAM and NCARTT. Based upon the information provided, the evaluators support the use of this system in Phase II.

6.2 Operations and Maintenance

The majority of systems are working well. Approximately 20% of all beneficiaries have made small repairs, such as changing the dripper, valves, or extending the drip irrigation system to cover more surface area of their gardens.

Beneficiaries and other community members prefer the 4-barrel systems to the 2-barrel systems, though the reasons for this are not clear. The majority of beneficiaries are satisfied with the location of the system, which is close to their homes, and easy to access.

The primary problems identified by the beneficiaries are, in order of frequency: odours, cleaning and maintenance and clogging of irrigation system. Odour was cited as a problem more than 75% of the time.

The primary method of dealing with these problems is by cleaning the system regularly. However, according to INWRDAM estimates, approximately 30 – 40% of beneficiaries are not cleaning their systems adequately or regularly. These beneficiaries either do not understand the importance of regular cleaning, do not know how to clean the systems properly, or both.

As mentioned in Section 3.1, under Objective 4, nine training sessions were held during the project. It seems, however, that the training has not been as effective as it might have been. Women in particular feel that they have not had enough training to operate and maintain their systems adequately. Ongoing training should include; method of cleaning, appropriate cleaning detergents (if any), and frequency of cleaning needed. Beneficiaries should also understand the potential health and environmental risks of poor greywater quality. Regular monitoring should be conducted to ensure that adequate operation and maintenance is occurring, and to reinforce the training.

6.3 Greywater Quality

6.3.1 Background

A total of 23 greywater samples were collected from 6 Phase I and 17 MOP households who participated in the evaluation survey. It was not possible to collect 25 samples as originally suggested in the proposal due to time limitations and the breakdown of some NCARTT equipment needed to analyze important parameters.

The greywater samples were collected from 3 households using 2-barrel systems, 16 households using 4-barrel systems, 2 households using confined trench systems and the 2 households who use rectangular and circular systems.

The geographic distribution of greywater sampling was as follows:

- Tafila Governorate: a total of 12 greywater samples were collected from 12 households (6 Phase I and 6 MOP project beneficiaries in Ruwem and Busera).
- Karak Governorate: a total of 8 samples from 8 households were collected.
- Irbid Governorate: a total of 3 samples were collected from 3 households.

Greywater samples were collected by INWRDAM and were analyzed at NCARTT and WAJ laboratories. Greywater quality was assessed based on Jordanian standards recommended for restricted irrigation using reclaimed wastewater (JSRW).

6.3.2 Greywater Analysis Results

Table 1 attached in Appendix G shows the results of the greywater quality lab tests. 13 out of the 23 units (56%) complied with JSRW and the rest did not. The majority (5 out of 6) of Phase I households were found to comply with JSRW, while only 8 of the 17 MOP households met the standards. Family size did not seem to affect the quality of the greywater. The confined trench systems yielded better greywater quality than the 2 and 4-barrel systems.

The quality of greywater effluents from systems that did not meet the wastewater standards was likely due to irregular or lack of maintenance and high concentrations of organic pollution of the influents, particularly total suspended solids, chemical and biochemical oxygen demand. These units will be investigated and improved during Phase II.

A general observation is that Phase I households conduct better and more regular maintenance of the greywater treatment systems than MOP beneficiaries, resulting in a higher quality of greywater from Phase I units. This is likely due to the fact that Phase I beneficiaries received more training and follow up than MOP beneficiaries.

For an individual analysis of the results for each household, see Appendix G.

6.4 Soil Quality Assessment

6.4.1 Background

Soil samples were collected from eight selected locations irrigated with greywater. Three reference samples from three locations not irrigated with greywater were collected. All samples were collected from two depths; 0-25 cm and 25-50 cm. The sample locations included both Phase I and MOP sites and were distributed as follows.

- Tafila Governorate: four soil samples (including one reference sample) were collected from Ein Al-Baida (Phase I), and two samples (including one reference sample) were collected from Ruwem.
- Karak Governorate: five samples were collected including one reference sample.

Soil samples were collected by INWRDAM with support from NCARTT staff and were analyzed at NCARTT labs. The soil quality was assessed based on Food and Agriculture Organization of the United Nations (FAO) guidelines for interpretation of water impact on plant productivity. Soil analysis includes parameters that reflect soil salinity, measured as electrical conductivity and sodium absorption rate, as these are the main indicators that could reflect the impact of irrigation water quality.

The interpretation of soil analysis results was conducted based on values of salinity measured as electrical conductivity (EC dS/m) and sodium absorption ratio (SAR). This interpretation is based on whether the soil salinity has increased due to irrigation with greywater or not. FAO recommendations on irrigation water indicate that soil productivity decreases with increase in salinity and that at a value of soil salinity measured as SAR of more than four, the soil productivity could be lowered for some salt sensitive crops. Most plants recommended for restricted irrigation are not salt sensitive, such as olive trees and cactus.

The purpose of conducting soil analysis is to have better understanding of the impact of greywater on soil salinity and take measures for future environmental monitoring that could control or avert long-term potential negative impacts.

6.4.2 Soil Analysis Results

Tables 2 and 3 in Appendix G. show the results of the soil analysis. Salinity increased slightly in all 7 of the 8 locations tested in comparison to the reference samples. Salinity expressed as SAR, of soils irrigated with greywater was in the range of 1.3 to 3.68. This is an indication of negative impact of the wastewater on soil under prevailing soil management practices. More information is needed to confirm this trend more accurately and to make reference to SAR of the reference soil for each location monitored.

FAO guidelines show that if SAR of irrigation water is in the range of 3 to 6 and soil salinity is less than 1.2 dS/m there will be a slight to moderate restriction on the use of such water for irrigation. High SAR values might affect sensitive crops while olive trees, the main crop in the project, are not sensitive to SAR.

Many factors could increase soil salinity and sodicity, these include: greywater chemical composition, especially EC and SAR, soil properties, especially texture, exposed period to greywater irrigation, and agricultural practices. Increase in soil salinity recorded in this study would not cause problems or loss of yield for olive trees and cactus, the crops recommended by this project. Soil salinity in the form of EC could be averted by leaching with rainwater and by improving soil properties through using animal manure and plant residue.

It is observed that background soil salinity differs between locations in the project area due to natural soil variability. The following sections show the results of soil analysis from different locations.

Ein Al-Baida (Phase I)

Salinity of SAR values ranged from 1.96 to 2.3 for top soil and from 1.3 to 3.1 for deeper soils among the three Ein Al-Baida samples. This represents a significant increase in salinity in comparison to the reference soil in this area, which ranged from a value of 0.80 dS/m at the surface to 0.51 dS/m at a depth between 0.25 and 0.50m. However, this reference soil may not be representative of other sites in this location.

Soils from the household of Mr. Ghazi Sqoor who is using a 2-barrel unit has shown EC values for soil irrigated with greywater of 2.24 to 1.26 and SAR values of 1.96 and 1.53 for top and deeper soils, respectively. This increase in salinity is significant compared to baseline data from the reference sample.

Soils from the household of Mr. Hamad Awabdeh who is using a confined trench unit has shown EC values for soil irrigated with greywater increased from 0.80 to 0.97 and 0.51 to 0.70 which is an increase of 21% for surface soil and 37% for deeper soil, respectively. Change in SAR has increased from 0.96 to 2.25 and decreased from 1.46 to 1.3. This can be attributed to accuracy limits of the test method, but these findings will be confirmed by further monitoring in the future.

Soils from the household of Mr. Mahmoud Salem who is using circular concrete unit has shown almost the same EC values for top and deeper soil, but SAR values ranged between 2.31 and 3.11 for top and deeper soils, respectively. This is the highest salinity increase measured in this location.

Soils from Ruwem (MOP)

Soils from the household of Mr. Abdalla Henefat, who is using 4-barrel unit, showed EC values for soil irrigated with greywater increased from 2.11 to 3.42 in top soil (an increase of 62%) and decreased from 1.77 to 1.15 for deeper soil (a decrease of 54% for deeper soil). Change in SAR has increased from 0.96 to 2.25 and from 1.46 to 1.3. The increase in EC does not necessarily mean an increase in SAR as the latter is dependant on the ratio of sodium ion to magnesium and calcium ions.

Karak (MOP)

Soils from the household of Mr. Ahmad Al-Amer who is using a 4-barrel unit has shown EC values for soil irrigated with greywater increased from 1.40 to 1.97 and from 1.97 to 2.31, which is an increase of 41% for surface soil and 17% for deeper soil, respectively. SAR values for soil compared to reference soil increased from 1.06 to 3.54 and 2.03 to 3.68 for top and deeper soil respectively.

Soils from the household of Mr. Othman Owedat who is using a 4-barrel unit has shown EC values for soil irrigated with greywater increased from 1.40 to 1.91 and decreased from 1.97 to 0.96 for top and deeper soils, respectively. SAR values for soil increased from 3.48 to 3.60 for top and deeper soil respectively. This is a significant increase during a period of one year of using the greywater. However, this is not a confirmed conclusion of the impact of greywater on soil in this location and more monitoring should be carried out.

Soils from the households of Mr. Atala Naser Al-Amer who is using a 4-barrel unit has shown EC values for soil irrigated with greywater increased from 1.40 to 1.48 and decreased from 1.97 to 0.97 for top and deeper soils, respectively. SAR values for soil increased from 1.20 to 1.97 for top and deeper soil respectively. This is a moderate increase in SAR values. It is recommended that SAR quality of greywater be investigated so that more direct correlation is possible on its impact on soil.

Soils from the households of Mr. Khalid Saleh who is using a 4-barrel unit has shown EC values for soil, irrigated with greywater, decrease from 1.40 to 0.99 and decrease from 1.97 to 0.72 for top and deeper soils, respectively. SAR values for soil have decreased from 1.54 to 1.46 for top and deeper soil, respectively. The decrease in salinity may be related to accuracy limits possible for SAR and other parameters.

6.5 Conclusions and Recommendations

The technical component of the project was very well carried out. The design of the systems has been continually improved upon, based on the knowledge of the researchers, technicians, and beneficiaries.

Given the prevalence of odour problems, every effort should be made to address this problem in Phase II. INWRDAM is aware of the problem and making efforts to solve it.

Beneficiaries should be encouraged to take responsibility for their own systems, rather than depending on the technicians to do it for them. Again, this will be achieved primarily through increased training and follow-up with beneficiaries.

The confined trench (CT) systems are able to deliver greywater that meets the JSRW for restricted irrigation, while 2-barrel and 4-barrel systems vary in performance and are dependant on regular maintenance.

Given that only 56% of units sampled complied with JSRW, community participation and training are essential to ensuring greywater compliance, improving quality of effluents and reducing odour, and possibly identifying operation and maintenance methods more acceptable to the community.

It is recommended that SAR and EC of the greywater be measured regularly along with other parameters mentioned in the JSRW, so that its impact on soil can be assessed more accurately.

The majority of soil samples tested showed an increase in salinity. Thus environmental impact monitoring of greywater on soil is crucial for Phase II. It is therefore recommended that:

- soil reference samples not irrigated with greywater as well as soil irrigated with greywater be collected from each site so that accurate comparisons of greywater impacts on soil are possible,

- since there is an indication of some salinity effect, efforts be made to identify suitable preventive and mitigation measures from the start of commissioning of a new greywater unit,

- the measurement of soil salinity be related to quality and quantity of greywater used in each monitored location so that scientifically viable conclusions are possible; and

- new salt tolerant crops be identified as a precautionary measure in case other control measures are not sustainable or cost effective.

7.0 FINANCIAL DIMENSIONS

7.1 Financial Plan

The costs of the research, design, installation and maintenance of the systems were covered by the project budget. INWRDAM estimates that the actual cost of the materials was approximately 30% more than the budget. This was absorbed by INWRDAM.

The costs of the various systems and components are shown in the table below.

Figure 7-1 Cost of System Components

Components/Systems	Amount in CAD $
Greywater separation	75
2-Barrel units	310
4-Barrel units	500
Confined trench units	650
Drip irrigation systems for 1000m2/ unit	100
Rectangular units [7]	1200
Circular units	1500

The concrete rectangular and circular units are the most expensive of the units. Only two such units were installed in the first phase, and none are planned for the second phase. The 2-barrel units, though they are the least expensive, had the poorest water quality in general. The 4-barrel and confined trench are thought to achieve the best balance between cost, ease of use and performance.

There was no financial plan in place to recover, or pass on any of the costs to beneficiaries. The systems were provided for free, though beneficiaries were asked for to contribute by preparing the site for the installation. INWRDAM estimates the value of this at 40 JD. Not all households provided in-kind contribution; instead the technician prepared the site for them. It is not clear why this happened.

7.2 Affordability and Willingness to Pay

The average cost of the 4-barrel and confined trench system is $575. Including greywater separation and irrigation, the average cost of the entire system is $750 (approx 400 JD). This equates to approximately one month's income of a medium-income family (see Figure 4-2). Clearly, the system at its current cost is not affordable to the poor.

According to a study conducted by INWRDAM in 2003, almost 70% beneficiaries are willing to contribute to the cost of the system. The amount of money beneficiaries are willing to pay for the installation of the greywater is as follows:

[7] Estimate taken from B/C analysis

Figure 7-2 Willingness to Pay[8]

Percent of Beneficiaries	Amount in JD
30.4%	Unable to pay
4.3%	50
47.8%	100
17.4%	200

This was verified with a small number of beneficiaries in focus group discussions, during which some people said that they would be willing to pay up to 100 JD. Some however, do not feel they can afford to pay anything toward the capital costs of the system.

In the next phase, INWRDAM will attempt to bring the costs down, while maintaining the quality of treatment. An important component of this will be ensuring that all materials and components are available locally, which is currently not the case. In fact, because of the rise in the value of the Euro, the cost of the Italian made pumps that are utilized have gone up significantly, which may strain the budget.

If the numbers in the table above are representative of other peri-urban households throughout Jordan, then even if the cost of the system is cut in half, to 200 JD, the system will be unaffordable to over 80% of people. The threshold of affordability appears to be 100 JD. This number is stated with caution, however, as the sample was very small. Such information should be collected, and disaggregated according to income levels.

There is also a sense among some community members that they deserve the system for free. Because the system has now been installed at no cost in over 900 households across the country, there is some sense of entitlement to the system. While this indicates growing acceptance of greywater reuse and of the technology itself, it is worrisome from a sustainability perspective. If potential beneficiaries do not attach enough of a value to contribute to the cost of the technology, then they may not feel enough of a sense of ownership to adequately maintain the system, threatening the sustainability and success of the project.

It is doubtful that in areas where the system has already been installed for free, neighbours would be willing to pay for it in the near future.

7.3 Conclusions and Recommendations

While the in-kind contribution of site preparation by beneficiaries was to have demonstrated their commitment, it does not seem to have been enough of an investment to promote a real sense of ownership among all beneficiaries.

In Phase II, the team might consider requesting a small cash or material contribution from beneficiaries, in addition to the in-kind contribution of the site preparation, in order

[8] From: "Greywater Treatment and Reuse Project in Tafila, Jordan, Fourth Technical Progress Report", INWRDAM, May 28, 2003.

to increase the sense of ownership over the system. This could range from a token amount of 5 to10 JD to a more significant amount of 50 to 100 JD. A loan program (perhaps through a local micro-credit organization, bank, or possibly through the MSD) could assist households to cover the costs, as many families do not have significant savings to draw upon. The idea of a cash contribution is recommended with caution, however, as it must remain affordable to the low-income group targeted. More discussion of this among project partners is necessary.

For there to be a wide scale and sustainable uptake of this technology in the future, and for it to contribute to poverty alleviation and water conservation, there are several possible scenarios:

1. The system components be made available on the market for those who are willing and able to pay for the system. This would decrease the number of people to whom the system is affordable, unless the capital costs decrease significantly. As mentioned earlier the threshold of affordability is estimated at approximately 100 JD. Credit could be provided to those who cannot afford to cover the capital costs on their own.

2. The government might subsidize the systems. This is unlikely to be affordable on a large scale. Current government policies discourage subsidies and promote cost recovery, rendering this scenario unlikely.

3. The system could be publicly owned, in which the outlay of money comes from the government, and costs are recovered through user-fees.

4. International donors might fund projects to install systems. While this option might help to promote the idea in Jordan, it is clearly not sustainable in the long term.

Possible scenarios for viable financial plans for a wide scale roll-out of the system across the country should be studied in the next phase of the project.

APPENDICES

Appendix A: Work Plan
Appendix B: List of Documents Reviewed
Appendix C: List of Key Informants
Appendix D: Interview Protocols
Appendix E: Survey Instrument and Survey Data
Appendix F: Benefit/Cost Analyses
Appendix G: Greywater and Soil Analyses

APPENDIX A

EVALUATION WORK PLAN

Post Project Evaluation of Phase I - Greywater Reuse in Tafila

Work Plan

April 29, 2004

1. INTRODUCTION

The Post Project Evaluation (PPE) is to be a comprehensive review of the technical, social and economic results of the greywater projects implemented to date. Its purpose is to inform Phase II in a manner that will increase its initial success and longer-term sustainability.

There will be four interrelated aspects to this evaluation:

- The technical effectiveness of the greywater systems implemented,
- The socio-economic dimensions,
- The interface between these two, and
- The viability of these, as applied in Phase I, to the wider application of greywater treatment systems throughout the country and beyond.

A preliminary listing of the key evaluation questions is set out in the evaluation matrix attached.

The Post Project Evaluation will document:

1. relevant macro demographic, socio-economic and water flow/use data;
2. the design expectations of the greywater systems;
3. actual performance data drawn mainly from the random sampling of greywater system installations;
4. an analysis of performance against expectations that addresses constraints;
5. overall conclusions about the technical, socio-economic, cultural, and environmental merits of the systems; and
6. recommendations to influence the approaches, methods, scheduling, management, organization and location of future greywater system development in Jordan.

2. METHODOLOGY

2.1 Research Methodologies

The evaluation will include the following research and analysis techniques:

- Documentation Review (including project documentation as well as background and baseline data)
- Formal survey of 50 beneficiary households in four locations
- Focus Groups with beneficiaries
- Semi-structured interviews with key informants
- Field Observation
- Scientific soil, plant and water sampling

The application of these methods to specific evaluation questions is outlined in the evaluation matrix attached.

2.2 Stakeholders

A preliminary list of stakeholders is as follows:

Location	Stakeholder Groups
Ein AlBeda:	Greywater Beneficiaries (10) Mosque Emam Principle of girls secondary school Local technician n.2 Mokhtar Ministry of Agriculture NGOs
Other locations in Tafila:	Greywater Beneficiaries (10) Rueem Voluntary Society Mokhtar Ministry of Agriculture Governor Local Technician NGOs
Karak	Greywater Beneficiaries (15) Ministry of Social Development Ministry of Agriculture Mokhtar Local technician NGOs
Irbid	Greywater Beneficiaries (10) Ministry of Social Development Irbid Office Mokhtar Local Technician NGOs
Ma'an	Greywater Beneficiaries (5)
Amman	Other Greywater Project Officials Ministry of Planning Ministry of Health IFAD officials Ministry of Agriculture WAJ CARE NCARTT
Other	Partners: PARC MECTACT WEDO IDRC

In total, 50 out of 800 beneficiary households will be surveyed. This makes up more than 5% of all greywater systems in use in Jordan. The following criteria will be used to select the sample of beneficiaries to be surveyed:

- Geographical distribution of units by governorates. Ten samples from Phase I location in Tafila, 15 samples from other locations in Tafila Governorate, 15 samples from Karak Governorate, 10 from the North of Jordan.
- Socio-economic characteristics (income and gender);
- Technology used; water quality and environmental affects on soil (4-barrels and CT).
- Length of time using the system

The list of beneficiaries from phase one to be surveyed has been identified, however the sample for the other 3 locations has not yet been determined.

2.3 Activities to be Conducted

The evaluation will be carried out in three stages: Preparation and Mobilization, Data Collection and Data Analysis and Reporting.

Preparation and Mobilization

The preparatory phase includes:

- Preliminary discussions *(INWRDAM, P:N, IDRC)*
- Preparation of Workplan by P:N for input by IDRC and INWRDAM
- Review of project documentation *(P:N)*
- Coordination of logistical arrangements *(P:N and INWRDAM)*

Data Collection

One of the primary methods to be used to collect data from beneficiaries is through a formal survey. It is proposed that the survey team will be composed of INWRDAM personnel and P:N personnel. The survey will be conducted simultaneously in the four sites. Depending on the number or researchers available, it is anticipated that this will take approximately 2 to 3 days.

- Preparation of Survey Tool *(P:N to develop, INWRDAM to comment)*
- Translate Tool into Arabic *(P:N)*
- Train researchers on the use of the tool (P:N)
- Test tools on a small number of households *(Researchers)*
- Revise tools *(P:N and INWRDAM)*
- Deployment of researchers to their assigned areas, conduct survey and record data.
- Tabulation of Data *(Researchers)*
- Analysis and Findings Workshop with researchers to share data, develop findings, build a consensus and identify information gaps using the evaluation matrix as a guide. *(P:N to lead*)

- Focus group with beneficiaries in 1 - 2 sites to validate findings, and to deepen analysis. If possible and deemed important, 2 separate focus groups will be held simultaneously with male and female beneficiaries. *(P:N, INWRDAM)*
- Interviews with other stakeholders and key informants will also be conducted *(P:N*)
- Soil and Water testing from a sampling of household beneficiaries will be carried out (*INWRDAM)*

It appears that a significant amount of data has already been collected by INWRDAM. Where possible, this data will be expanded upon, and updated as needed. This data will include, but is not limited to the following:

- Number of household members
- Water supply in the area, network, tanks, wells, etc
- Monthly consumption of water per HH - before/after comparison
- Land size
- Percentage of land irrigated by the system
- Homeowners, or tenants
- Length of time using system
- Location of household
- Income/ expenditure data
- ** Any other data that INWRDAM has collected in the past that would be useful for comparative purposes.*

Data Analysis and Reporting

Upon completion of the data collection, the data will be tabulated, and analyzed. A brief field report with preliminary findings will be prepared, and a debriefing session held with the project team.

A draft evaluation report will then be written and submitted for comment by INWRDAM and IDRC. Based upon comments the report will be finalized. While reporting will be the primary responsibility of P:N, they will also rely heavily on the analysis of the technical data, analysis and write-up supplied by INWRDAM.

3. RESPONSIBILITIES

Plan:Net Limited (P:N) and INWRDAM will collaborate on the evaluation, with P:N playing the lead role. P:N would be responsible for the preparation of the evaluation report and all socio-economic aspects of the work, while INWRDAM will assist and advise on the technical aspects. An independent and approved laboratory will be contracted for greywater sampling and analysis. INWRDAM will also provide support to P:N for general administration and logistics with respect to fieldwork; including, if necessary, the identification of beneficiaries for random selection and field surveys.

4. SCHEDULE OF ACTIVITIES

Date	Activity
Saturday May 1	Preparation. Meet to finalize fieldwork plan and logistics, review survey, test survey, and modify. Make arrangements for focus groups, and interviews. Choose beneficiaries.
Sunday May 2	HOLIDAY Depart for Karak in evening (6.30pm). Train research team on use of survey.
Monday May 3	Conduct Surveys and Key Informant Interviews in Tafila
Tuesday May 4	Conduct Survey and Key Informant Interviews in Ma'an and Karak. Depart for Amman in evening
Wednesday May 5	Conduct Survey and Key Informant Interviews in Irbid.
Thursday May 6	Research Team Tabulates data.
Friday May 7	Weekend
Saturday May 8	Analysis and Findings Workshop with research team
Sunday May 9	P:N conducts key informant interviews in Amman
Monday May 10	P:N conducts key informant interviews in Amman
Tuesday May 11	P:N to work on analysis and field report 2 Focus Groups (one with men, one with women) in Tafila
Wednesday May 12	P:N to work on analysis and field report 2 Focus Groups (one with men, one with women)in Irbid
Thursday May 13	Debriefing with INWRDAM
Friday May 14	M.B. Departure
May 17 – June 14	Supplementary data collection Data Analysis and Reporting P:N to report on socio-economic, gender issues INWRDAM to report on technical data. P:N to compile report
June 14	Draft Report submitted to INWRDAM and IDRC for comment.
July 15	Final Report Submitted

This schedule outlines the activities to be carried out, and the corresponding timeframe. This schedule will be modified as necessary.

GREYWATER REUSE –EVALUATION MATRIX

Key Topics	Key Questions	Sources	Methods
A. Mandate, organization and Management of the Project	• Was the project well designed? • Was it carried out according to agreements between all parties? • Was the project well organized? • Was the project well managed? • To what extent did the project meet its objectives, as set out in the project proposal? • What unanticipated results were achieved, if any? • Were monitoring systems established? • Were they carried out? • What problems were encountered? • How were they solved? • Were any changes to project activities made as a result? • What improvements could be made for Phase II?	INWRDAM IDRC Project Reports Monitoring Reports	Interviews Document Review
B. Beneficiary involvement	• How were the project locations selected? • Was sound criteria used in project selection? • Were beneficiaries involved in the project? How were they involved? • Was sound criteria used in beneficiary selection? • Was the process of beneficiary selection fair, equitable? • How could the process of site and beneficiary selection be improved?	Beneficiaries INWRDAM	
C. Social costs and benefits of greywater reuse for beneficiary	**Benefits** • Have the social benefits anticipated	Beneficiaries Comparison with	Survey Focus Group

households	and identified by the project been achieved? For example: - food production related benefits (more food, different food, better food?) - time savings? - household work load? - nutritional benefits? - health improvements? - improved status - improved relationships (within HH, and community)? • Have these benefits been experienced differently by women, men and children? **Costs** • Have the social costs been articulated by the project and have these costs been appropriately mitigated? • Have there been any unanticipated social costs for HH using the system? If so, what have they been? - increased household workload? - health problems? - decreased nutritional intake? - strained social relationships? - other? • Have these social costs been experienced differently by men, women and children?	baseline data where possible.	Document Review Informal Discussions with women, Women's society?
D. Social Acceptability of the system	• Is there any social stigma attached to owning a system? • Do beneficiaries recommend the system to others? • Has there been a "Demonstration Effect" from the systems (particularly those in the	Beneficiaries, NGOs Local Officials INWRDAM's Neighbour Survey	Survey Focus Groups Interviews Document Review

	school and mosque)? • What are the social perceptions of the system? • Is the greywater system known about in the wider community? Is it accepted? Are there any negative views?		

E. Social costs and benefits of greywater reuse at the community level	• Have community groups been involved in the project? How have they been involved?
	• Has their involvement been on a well reasoned basis?
	• Have there been any benefits to greywater reuse at the community level? –increased awareness and understanding of water conservation
	- training
	- skills
	- organizational capacity
	- spin off activities
	• Have there been any costs to the community for their involvement in the project?
	• Did the social benefits outweigh the social costs?
	• Have targeted socio-economic groups have benefited from the greywater systems?
	
	Local capacity
	• Were beneficiaries and local stakeholder groups adequately involved in the project?
	  • Was the training carried out with beneficiaries effective?
	  • Has there been a change in water-related practices as a result of these
		Local Officials
		NGOs
		Voluntary Society	

	training sessions? • Which socio-economic groups have benefited most from greywater systems? • Is the system affordable to the poor? • If not, what would need to be done to make it affordable to the poor?		
F. Economic impacts of the systems on beneficiary households	**Economic Benefits** • Were targets set for economic gains of HH? If so, were these achieved? • Have there been economic gains for HH as a result of greywater reuse? What have they been? - increased income - increased savings - new economic activity • How has increased savings/income been used? Have men and women benefited differently? How? **Economic Costs** • Have there been economic costs for HH related to the system? What have they been? - cost of installation - cost of maintenance - other • Who pays for these costs? • How are they paid? • Do the economic benefits outweigh the social costs? • Limited benefit-cost analysis of 25 HH *(verify and advance b/c previously done by INWRDAM. Extend to other project beneficiaries?)*	Beneficiaries Project Records	Survey, Focus Group Document Review

G. Economic impacts of the systems on the community	• Have there been any positive economic impacts for the community? What have these been? • Have there been any negative economic impacts for the community? What have they been? • How have various groups and organizations within the community benefited differently? • Which socio-economic groups have benefited most from greywater systems?	NGOs Local Officials Voluntary Society	
H. Financial Sustainability Dimensions of the Project	• Was there financial plan in place for the installation and maintenance of the systems? • What was it? • Did it work? • What was the cost of installing and maintaining the system? • Who paid for these costs? • What is the willingness and ability (real demand) of families and communities to participate in greywater capture and reuse projects - both social acceptability of greywater reuse, the financial capability to pay for the systems and their upkeep?	Project Data, Project Reports INWRDAM	Document Review Interviews
I. Government Involvement	• Has planned government involvement in the project happened? • How were various levels of government involved? • How should they be involved for greywater systems to be expanded throughout the country? • Which local decision-making structures/processes are most relevant to	INWRDAM Government officials (National, Govornorate, Municipal)	Interviews

	the implementation of greywater system initiatives? • What is the balance of responsibilities between governments at the local, regional and national levels, and those of the participating families and communities? • Have changes in policy been implemented as a result of the project?		
J. Technical Dimensions	**Operations and Maintenance of system** • What problems have HH encountered with the systems? • How have these problems been addressed by users? • Is there negative impact of the system on environment - odors - pest - mosquitoes - other • What training needs exist to maximize use of systems? • Are households adequately maintaining their systems? • Which systems are favoured? (the two barrel versus four barrel versus the CT) Why? • Does housing type and occupancy patterns influence the performance of the systems? How? • Does the proximity of system installations to each other influence household uptake and use? How? • How does topography, location and		

	climate influence adoption of the system? ***Greywater recovery*** • Were any targets for greywater recovery set? If yes, were they met? • Has there been an increase in greywater recovery? • Is it more convenient than before? • Is it safer? **Efficiency of trickle irrigation systems** • What irrigation coverage can be expected from the trickle irrigation systems? How well have these expectations been met, to date? What factors have constrained the "trickle effect"? • What are the expected set-up and running costs for the system? What have been the actual set-up and running costs, on average? What factors have influenced cost? • How efficient are the installed drip irrigation systems in terms of their relative benefits and problems: odor, clogging, maintenance. **Water and Soil Quality** • Has the greywater met acceptable standards? • What is the quality of the greywater? • Has the irrigated soil met acceptable		

	standards? • What is the quality of the soil? **Gardening/Permaculture Practices** • **Has there been improved productivity of home garden through improved agricultural techniques that would allow participants to maximize their benefits?** • Have there been improvements in gardening/permaculture practices among participating households? • What have these improvements been? **- cropping patterns** **- organic framing** **- pest control management** • Have these improvements led to improved productivity of home gardens?		
K. Lessons Learned	• What can we learn from phase I and other greywater projects in Jordan and the MENA region to increase the success and sustainability of this project?	Project Officials INWRDAM IDRC Regional Partners	Interviews

Appendix B

List of Documents Reviewed

LIST OF DOCUMENTS REVIEWED

Adoption of Greywater Treatment and Reuse Technology in a Cluster of Six Towns in Lebanon. Ghousgassian, Boghos, Middle East Center for the Transfer of Appropriate Technology (MECTAT).

Duckweed Wastewater Treatment and Reuse for Fodder (West Bank, Palestine) – Project Description. Implemented by Water and Environmental Development Organization (WEDO).

Final Report of the Evaluation of Permacuture and Greywater Reuse Project, INWRDAM, November 2000.

Gender Resources for Urban Agriculture Research: Methodology, Directory & Annotated Bibliography: Cities Feeding People Series, Report 26. Hovorka, Alice J., International Development Research Centre, 1998.

Greywater Treatment and Use for Poverty Reduction in Jordan (Phase II) Project Proposal, INWRDAM, December 8, 2003.

Greywater Treatment and Reuse Project in Tafila, Jordan, *First Technical Progress Report*, INWRDAM, November 1, 2001.

Greywater Treatment and Reuse Project in Tafila, Jordan, Second Technical Progress Report, INWRDAM, May 8, 2002.

Greywater Treatment and Reuse Project in Tafila, Jordan, Third Technical Progress Report, INWRDAM, November 4, 2002.

Greywater Treatment and Reuse Project in Tafila, Jordan, Fourth Technical Progress Report, INWRDAM, May 28, 2003.

Greywater Treatment and Use for Poverty Reduction in Jordan (Phase II) Project, IDRC Project Monitoring Report, IDRC, July 2002.

Greywater Treatment and Use for Poverty Reduction in Jordan (Phase II) Project, IDRC Project Monitoring Report, IDRC, October 2002.

Greywater Treatment and Use for Poverty Reduction in Jordan (Phase II) Project, IDRC Project Monitoring Report, IDRC, July 27th to August 7th, 2003.

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Greywater Treatment and Reuse (West Bekaa, Lebanon) – Project Description, Implemented by Middle East Centre for the Transfer of Appropriate Technology (MECTAT).

Greywater Treatment and Reuse for Peri-Urban Horticulture (West Bank, Palestine) – Project Description, Palestinian Agricultural Relief Committee (PARC).

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Outcome Mapping – Building Learning and Reflection into Development Programs. Earl, Sarah et. al., IDRC, 2001.

Overview of CFP Water Activities: Cities Feeding People Program Initiative, IDRC. February 11, 2004.

PERMACULTURE AND GREYWATER TREATMENT AND REUSE IN TAFILA, JORDAN PROPOSAL, INWRDAM.

Poverty Alleviation for a Stronger Jordan – A Comprehensive National Strategy. The Hashemite Kingdom of Jordan, Jordan Poverty Alleviation Program, May 2002.

Proposal for Evaluation Study of CARE's Permaculture Pilot Project, INWRDAM.

Water Management in Islam, Faruqui, Naser I., Asit Biswas and Murad Bino, (editors), IDRC, 2001.

World Development Report, World Bank, 1999/2000.

Appendix C

List of Key Informants

LIST OF KEY INFORMANTS

Organization	Name and Title
Ein Al-Baida, Tafila Mosque	Imam Jebril Darweesh Al-Badaineh
Ein Al-Baida Girls Secondary School, Tafila	Mona Khaleel Al-Qatameen, Principle
Rueem Voluntary Society, Tafila	Abdullah Ehneifat (Abu Ahmad) Basema Al Rawashdeh
Ein El Baida Society	Ahmad Al-Omran, Director
Al-Amer Villages NGO, Karak	Ahmad Abed Allah Al-Amer, Treasurer Treasurer
Natfeh Charity NGO, Irbid	Mr. Abed Al-Rahman Abu Kheir, Director
Ministry of Social Development Karak Office Irbid Office Amman	 Mohamad Firass Al-Zinabat Director of Kasser Office Ms Khouloud AlSubeihi Development Officer Ma'an AlQdah
Ministry of Agriculture Tafila Office Karak Office Amman NCARTT	 Eng. Hussein Al-Qatameen Mr. Khaled Al-Nawayseh, Director of the Agriculture Department Eng. Raed Khatatbeh. Dr. Ahmad Bolad
Ministry of Planning and International Cooperation	Dr. Mout'az Al-Qutop
Ministry of Water and Irrigation /WAJ	Eng. Zkaria Al-Tarwneh
Ministry of Agriculture	Eng. Mousa Al-Abadi
Palestinian Agricultural Relief Committee	Jamal Burnat
MECTACT	Boghos Ghougassian
INWRDAM	Dr. Murad Bino, Project Leader Eng. Shihab Al-Beiruti, Project Coordinator Yousef Hijazin, Technician Fathi Al- Awabedeh, Technician Adel Mohamd Nori Omar, Technician
International Development Research Centre	Mark Redwood, Program Officer

Appendix D

Interview Protocols

INTERVIEW PROTOCOL – INWRDAM

I. Management and Organization of the Project

1. Please tell me about the organizational structure of the project.
2. How could the structure of the project have been improved?
3. How was the project managed?
4. What main problems were encountered throughout the course of the project?
5. How were these problems solved?
6. Were self-monitoring systems established?
7. Were they carried out?
8. Were any changes to project activities made as a result of the monitoring?
9. What improvements could be made for Phase II?

II Achievement of Objectives

1. To what extent did the project meet its goal: "*to help the peri-urban poor in Jordan preserve precious freshwater, achieve food security, and generate income, while helping to protect the environment*"
2. To what extent did the project meet its objectives?
3. Given the timeframe, were these goals and objectives realistic?
4. What unanticipated results were achieved, if any?
5. Given the timeframe, were these goals and objectives realistic?

III. Stakeholder Involvement

A) Beneficiaries

1. How were the project locations selected?
2. What criteria were used?
3. How were the beneficiaries selected?
4. What criteria were used?
5. How were beneficiaries involved in the project?
6. Was the process fair, equitable?
7. How should the process be improved?

B) Community Organizations

1. Were community organizations involved in the project?
2. How were they selected?
3. How were they involved? What role did they play?
4. How could community organization involvement be improved?

C) Government

1. Has planned government involvement in the project happened?
2. How were various levels of government involved?
3. Were they effective?
4. Were any problems encountered? If so, what were they?
5. What improvements should be made?
6. Were any problems encountered? What were they?
7. How should they be involved for greywater systems to be expanded throughout the country?

III. Financial Sustainability

1. Was there a financial plan in place for the purchase, installation and maintenance of the systems?
2. What was it?
3. Was it carried out?
4. Is it working?
5. What problems were encountered?
6. What improvements should be made?
7. What problems were encountered?
8. What was the cost of the purchase, materials, installation and maintenance of the system?
9. Who paid for these costs?
10. What kind of financial strategy would have to be developed to expand greywater systems across the country?

IV. Lessons Learned

1. What suggestions do you have for improvements in Phase II?

Interview Protocol - Local NGOs

I. Organization

1. Has your organization been involved in the greywater project?

2. What role has your organization played in the greywater project?

3. Has the organization benefited from its involvement in the project?

   - ☐ Increased awareness
   - ☐ Increased training
   - ☐ Increased skills
   - ☐ Better organized
   - ☐ More interest from:
     - ☐ community members
     - ☐ other organizations
     - ☐ government officials
   - ☐ New activities
   - ☐ Increased income
   - ☐ Other

4. Have there been any disadvantages to your organization's involvement in the project? If so, what have they been?

II. Broader Community

5. Have people heard about the system? How?

6. Has the community benefited from involvement in the project? How?

7. Has the project caused any problems in the community? If so, what have they been?

8. How do community members feel about the project?

9. Would more people like to participate in the project? Why?

10. Have different groups benefited differently? (economic groups, men, women, etc)

11. What suggestions for improvement can you make?

INTERVIEW PROTOCOL - TECHNICIANS

1. How long have you been involved in the project?
2. What is your role in the project?
3. In your opinion, what are the benefits of the system? (you, beneficiaries, community, INWRDAM, others, environmental)
4. In your opinion, what are the disadvantages of the system? (you, beneficiaries, community, INWRDAM, others, environmental)
5. Do beneficiaries have any problems with their systems? If so, what are they?
6. How do they solve these problems?
7. Are beneficiaries adequately maintaining their systems?
8. Have beneficiaries received adequate training?
9. Have other people in the community expressed an interest in the systems?
10. Do you have any suggestions for improvements
    - of the system
    - of beneficiary involvement
    - of community involvement?
11. Is there anything else you would like to tell us?

Interview Protocol - Local Government Officials

1. Has your office been involved in the greywater project?
2. How has your office been involved in the greywater project
3. Has the community benefited from involvement in the project? How?
4. Has the project caused any problems in the community? If so, what have they been?
5. How do community members feel about the project?
6. How have people heard about the system?
7. Have different groups benefited differently? (economic groups, men, women, etc)
8. If the project were expanded, what role could there be for local government?
9. What suggestions can be made for the next phase of the project?

Interview Protocol - Government Officials in Amman

1. What impact have greywater reuse and treatment systems had on the communities involved, and the country as a whole?
2. How has your ministry been involved in greywater projects?
3. What role has it played?
4. Do you support the expansion of greywater initiatives in Jordan? Why or why not?
5. What role could your ministry play in any such expansion?
6. Is there anything else you would like to tell us?

Informal Interview Guide Neighbours Questions

1. Do you know about your neighbours' greywater system?
2. If yes, what do you think about it? Why?
3. What do you think are the benefits to the system?
4. Do you have any problems with the system? (Find out degree of problem)
5. Has your neighbour recommended the system to you?
6. Would you consider installing a system in your house? Why or why not?
7. Is there anything else?

Regional Partners Protocol

1. How have you been involved in greywater projects?

2. What are the benefits of greywater projects?
   - for the Region
   - for the Country
   - for Organizations Involved
   - for Individuals Involved (on project team)
   - for Communities Involved
   - for Beneficiaries Involved

3. What are the disadvantages, if any?
   - for the Region
   - for Country
   - for Organizations Involved
   - for individuals involved (on project team)
   - for Communities involved
   - for Beneficiaries

5. What are the strengths of the greywater treatment and drip irrigation technologies used (Social, Environmental, Economic, Technical)?

6. What are the weaknesses of the greywater treatment and drip irrigation technologies used (Social, Environmental, Economic, Technical)?

7. Based upon your experience in your context, is the system affordable to the poor? If not, should it be? Why or why not? How could it become affordable to the poor?

8. Do you have any suggestions for improvement of the second phase of the project in Jordan?

9. What are the potential impacts of greywater projects in the Middle East?

10. Is there anything else you would like to add?

INTERVIEW PROTOCOL – IDRC

1. Please tell me about the history of the project.
2. How could the management of the project have been improved?
3. Was the project well managed by INWRDAM?
4. What main problems were encountered throughout the course of the project?
5. How were these problems solved?
6. To what extent did the project meet its objectives?
7. What unanticipated results were achieved, if any?
8. Were accountability systems established (such as monitoring)?
9. Were they carried out?
10. Were any changes to project activities made as a result of the monitoring?
11. Was the project on budget?
12. Was the project on time?
13. How does this project fit with IDRC's mandate?
14. How does this project fit with IDRC's priorities in the region?
15. What improvements could be made for Phase II?
16. What are some of the potential larger impacts of this project?

Appendix E

Survey Instrument and Survey Data

SURVEY INSTRUMENT

Name of Researcher: _____
Name of Household Member(s) _____
Date _____
Status of Respondent: Male ☐ Female ☐ Head of Household ☐
Location of household: _____
Telephone Number: _____
Project ID. Number: _____

- Researchers to introduce themselves, explain they are from INWRDAM.
- Purpose of research to find out about the community perceptions of the greywater project.
- Ask permission to carry out survey, which takes approximately 20 minutes.
- Explain that all responses will be kept confidential.

Background Information

1. Total Persons in HH _____
2. Female Adults ___ Male Adults ____ Children ____
3. Occupation of Head of Household _____ Income per month _____
4. Are there other sources of income? Yes ___ No___
5. What are the sources? _____
6. Total monthly income from other sources: _____
7. Total expenditures per month ____
8. How many kids in school ____ University _____, if any?
9. Homeowners ___ Other ____
10. Land owners ___ Other _____
11. Land size _____ donum ____ square meters
12. Monthly consumption of water per HH – before ____after _____
13. Did you use greywater before the system was installed? Yes ____ No ___
14. How long have you been using the system? _____ Years ____ Months
15. Who takes care of the system? _____
16. Has it affected your daily routine? Yes ___ No ____

    If yes, positively_____ negatively _____

Involvement

17. How did you find out about the project?

☐ Neighbours
☐ Family
☐ Friends
☐ Community organization
☐ Other

18. Why did you decided to participate in the project?

Social Benefits and Costs

19. Please rate the system

☐	☐	☐	☐	☐
excellent	**very good**	**good**	**poor**	**very poor**

20. Is your family better off as a result of using the system?

☐	☐	☐	☐	☐
much better	**a little better**	**no difference**	**a little worse**	**a lot worse**

21. If so, what have they been?

a) increased tree or crop production yes ☐ no ☐

b) different trees or crops yes ☐ no ☐

c) time savings yes ☐ no ☐

d) decrease in household work load yes ☐ no ☐

If yes, for whom? women ☐ men ☐ children ☐

e) eating better food yes ☐ no ☐

f) health improvements yes ☐ no ☐

g) improved status yes ☐ no ☐

h) improved relationships with others yes ☐ no ☐

i) increased knowledge yes ☐ no ☐ If yes, please describe:

j) increased skills yes ☐ no ☐ If yes, please describe:

k) other _____

22. Have these benefits been experienced differently by women, men and children?

23. Have your friends, neighbours or family members asked about the system?

24. Have you recommended the system to others? yes ☐ no ☐

25. Are there any disadvantages to using the system? yes ☐ no ☐

If so, what are they?

a) maintenance of the system yes ☐ no ☐

b) increased household workload yes ☐ no ☐

If yes, for whom? women ☐ men ☐ children ☐

c) health problems yes ☐ no ☐

d) decreased nutritional intake yes ☐ no ☐

e) strained relationships within the family yes ☐ no ☐

f) strained relationships within the community yes ☐ no ☐

f) other yes ☐ no ☐

26. Are the social costs experienced differently between men, women and children?

27. Is there any social stigma attached to owning a system?

Economic Questions

28. Have you benefited financially from the system? yes ☐ no ☐

29. If yes, how?

a) increased income yes ☐ no ☐
If yes, approximately how much per month? _____

b) increased savings yes ☐ no ☐
If yes, approximately how much per month? _____

c) new sources of income yes ☐ no ☐
If yes, approximately how much per month? _____

30. How have you used the increased savings/income?

Bought food ☐
Paid for Education ☐
Other ☐

31. Have men and women benefited differently? yes ☐ no ☐ How?
_____

32. How much did you pay for the system (per month or year?)

a) Install ____
b) Maintain _____

33. Where did you get the money?

Savings ☐
Bank loan ☐
Family loan ☐
Money lender ☐
Government ☐
Other ☐ _____

Problems with the system

34. What problems have you had with the system? Please list.

35. How have you dealt with these problems?

36. How are you maintaining your system?

37. Have you had to repair the system? yes ☐ no ☐

If yes, what parts? _____

How much did it cost? _____

Agriculture

38. How did you irrigate before you installed the system? _____

39. Where did the water come from before the system was installed? _____

40. Do you still use water from this source? yes ☐ no ☐

41. If yes, approximately what percentage of your irrigation water still comes from this source? ____%

42. How often do you use the system to irrigate? _____

43. How often does the pump go on per day? _____

44. Approximately what percentage of your land is irrigated by the system?

_____ donum _____square meters

45. Have you changes your gardening practices as a result of the system?

If yes,
a) grow different crops yes ☐ no ☐
b) more crops yes ☐ no ☐

What kind of crops? _____

46. What do you do with these crops?

a) Sell them yes ☐ no ☐ ___ %
b) Consume them yes ☐ no ☐ ___ %
c) Give them as gifts yes ☐ no ☐ ___ %

47. What crops are you irrigating with greywater?

48. What crops are you irrigating with greywater?

49. Do you raise livestock? yes ☐ no ☐

50. If yes, what kind? _____

51. How many? _____

52. What water source do you use? _____

53. Are there any improvements you would like to suggest for the project?

54. Is there anything else you would like to tell us?

Observations

System

Garden

House

Family members

Researchers Comments

SURVEY DATA

"Survey Data.xls"

Appendix F

Benefit/Cost Analyses

BCAnalyses.xls

Appendix G

Greywater and Soil Analyses

Table 1: Greywater Analysis Results

No	Project	Sampling location (beneficiaries)	No of persons/ household	Date of sampling	Type of treatment	pH (units)	NO3 mg/l	Total-N mg/l	TSS mg/l	COD mg/l	BOD5 filtered mg/l	Comments	Lab
					STD	**6-9**	**45**	**70**	**150**	**500**	**300**		
1	Tafila-MOP	Sami Al-Zaydaneen	10	07/07/2004	2-barrels	7.92	1.32	1.68	28	18	7	OK	WAJ
2	Tafila-MOP	Abdallah Al-Hnefat	11	07/07/2004	4-barrels	7.81	0.92	9.62	30	68	19	OK	WAJ
3	Tafila-Phase 1	Mousa Al-Hawadi	10	07/07/2004	2-barrels	7.89	0.13	66.40	88	331	146	OK	WAJ
4	Tafila-Phase 1	Mahmoud Al-Awabdeh	8	13/06/2004	circular unit	7.80	NA	6.71	5	329	147	OK	NCARTT
5	Tafila-Phase 1	Adnan Al-Awabdeh	11	13/06/2004	4-barrels	7.30	NA	19.21	40	388	162	OK	NCARTT
6	Karak-MOP	Mahmoud Al-Amer	3	26/07/2004	4-barrels	7.88	0.22	15.45	152	542	193	OK	WAJ
7	Tafila-Phase 1	Hamad Al-Awabdeh	9	13/06/2004	confined trench	7.00	NA	12.75	46	438	210	OK	NCARTT
8	Irbid-MOP	Abdallah Al-Talfhah	11	20/06/2004	confined trench	6.70	NA	22.60	53	552	240	OK	NCARTT
9	Tafila-MOP	Khalil Al-Shmaasat	5	07/07/2004	4-barrels	6.26	0.63	79.61	91	500	244	OK	WAJ
10	Karak-MOP	Ahmad Mefleh Al-Amer	10	26/07/2004	4-barrels	7.86	<0.2	18.66	149	740	257	OK	WAJ
11	Tafila-Phase 1	Ali Al-Fakhara	24	13/06/2004	rectangular unit	7.10	NA	26.50	51	738	280	OK	NCARTT
12	Karak-MOP	Othman Al-Amer	12	26/07/2004	4-barrels	8.01	<0.2	52.48	94	877	293	OK	WAJ

No	Project	Sampling location (beneficiaries)	No of persons/ household	Date of sampling	Type of treatment	pH (units)	NO3 mg/l	Total-N mg/l	TSS mg/l	COD mg/l	BOD5 filtered mg/l	Comments	Lab
13	Karak-MOP	Ahmad Abdullah Mefleh	12	26/07/2004	4-barrels	7.98	<0.2	8.57	114	379	324	OK	WAJ
14	Tafila-Phase 1	Gazi Al-Skoor	10	13/06/2004	2-barrels	5.80	NA	33.79	68	1367	386	off with low pH and high COD	NCARTT
15	Karak-MOP	Nahar Al-Amer	3	26/07/2004	4-barrels	7.63	<0.2	23.64	86	520	429	not complying	WAJ
16	Tafila-MOP	Mohammad Abdul Raheem	7	07/07/2004	4-barrels	6.81	0.49	112.21	262	702	434	high TSS, COD and BOD	WAJ
17	Tafila-MOP	Saleh Al-Tabashat	9	07/07/2004	4-barrels	6.44	0.85	28.33	155	1029	438	high TSS, COD and BOD	WAJ
18	Karak-MOP	Atallah Al-Amer	5	26/07/2004	4-barrels	7.86	<0.2	16.38	111	1125	600	not complying	WAJ
19	Tafila-MOP	Ahmad Al-Hasasnah	7	07/07/2004	4-barrels	5.00	0.75	36.53	166	834	665	not complying	WAJ
20	Karak-MOP	Salim Al-Amer	12	26/07/2004	4-barrels	7.81	0.28	25.31	160	1219	672	not complying	WAJ
21	Karak-MOP	Khaled Al-Lahaweya	11	26/07/2004	4-barrels	8.02	<0.2	17.78	63	1872	750	not complying	WAJ
22	Irbid-MOP	Omar Al-Talfhah	8	20/06/2004	4-barrels	6.20	NA	64.67	187	845	NA	not complying	NCARTT
23	Irbid-MOP	Ali Al-Talfhah	7	20/06/2004	4-barrels	6.70	NA	30.77	82	1553	NA	not complying	NCARTT

Observations

The evaluation survey documented observations on the care of the greywater treatment units by beneficiaries, as well as the length of time the treatment unit had been installed. This information was taken into consideration when interpreting the lab results. The following is an assessment of the greywater analysis results and circumstances related to these results.

Beneficiary Number 1 uses a 2-barrel unit and is from the MOP project. The results of the tests are questionable in that they are too good to be true. It is possible that the household is letting tap water flow through the system for irrigation purposes.

INWRDAM has observed such conduct from a small number of beneficiaries in Ma'an and among those who use 2-barrel systems. INWRDAM has tried to to convince them that these units are for greywater treatment and not for irrigation directly from tap water. It has been observed that because the 2-barrel unit has low holding capacity, tap water can run through it quickly while 4-barrel and confined trench or concrete units have much larger holding capacity and beneficiaries will not be able to flush it with tap water easily. These types of practices should be addressed in Phase II.

Beneficiary Number 2 (4-barrel unit) is the Director of the Ruwem Voluntary Society and he is very interested in the project and conducts regular O&M of his unit. The results show very good greywater quality effluent. This beneficiary has a large size garden with plenty of olive trees.

Beneficiary Number 3 uses 2-barrel unit and the effluent complies with JSRW. Initially the unit had problems during 2002 and investigations indicated that kitchen greywater could be disconnected. The family says they receive a lot of relatives and have to prepare a lot of food regularly. The results indicate good system conditions. This could be due to less pollution in the influent. This beneficiary has large olive trees and irrigates part of these with greywater.

Beneficiaries Number 4, 5, 7 and 11 are all beneficiaries of Phase I project. These units' effluent complies with JSRW. These beneficiaries received extensive training and these circular, 4-barrels, confined trench and rectangular units were first installed at their households. Beneficiaries No 4 and 5 are the households of the Phase I project main technician (Mr. Fathi Al-Awabdeh) and his assistant (Mr. Aymen Al-Awabdeh), respectively. Soil samples from beneficiary Number 4 showed slight increase in salinity, but this could be due to either greywater application or high background salinity. This will be investigated further during Phase II.

Beneficiaries Number 6 and 9 effluent complies with JSRW. They have relatively small family sizes using 4-barrel units and are interested in these systems and say they conduct regular O&M.

Beneficiary Number 8 effluent complies with JSRW. This beneficiary is from MOP project and originally received a 4-barrel unit, but after a few months he had problems of odor and bad effluent quality. Then INWRDAM replaced the original 4-barrel unit with a confined trench unit and no further complaints of odor were observed. He is one of the most interested MOP beneficiaries.

Beneficiaries 10, 12 and 13 effluent complies with JSRW. These are all MOP beneficiaries and use 4-barrel units. All are large family size but these units operate with minimum problems.

The rest of the beneficiaries' units' effluent do not comply with some parameters of JSRW and these units will be investigated and improved during Phase II.

Table 2:
Soil Analysis Results for Tafila (Phase I and MOP sites)

Household Name	Depth/cm	pH units	EC dS/m	P mg/l	K mg/l	N%	Ca meq/l	Mg meq/l	Na meq/l	Total Cations	Na%	SAR
Gahzi Sqoor (greywater)	00-25	7.8	2.24	78.4	288.4	0.090	9.00	9.00	5.88	23.88	24.62	1.96
Gahzi Sqoor (greywater)	25-50	7.6	1.26	36.3	207.0	0.073	7.00	6.00	3.90	16.90	23.10	1.53
Hamad Awabdeh (greywater)	00-25	7.9	0.97	20.0	358.1	0.073	5.00	5.00	2.91	12.91	22.56	1.30
Hamad Awabdeh (greywater)	25-50	7.7	0.70	14.1	207.0	0.050	2.00	4.00	3.90	9.90	39.42	2.25
Hamad Awabdeh (reference)	00-25	7.7	0.80	15.1	334.9	0.062	4.00	4.00	2.91	10.91	26.69	1.46
Hamad Awabdeh (reference)	25-50	7.8	0.51	12.2	241.9	0.050	3.00	1.50	1.43	5.93	24.18	0.96
Mahmoud Salem (greywater)	00-25	7.7	1.05	21.4	288.4	0.050	5.00	4.00	4.89	13.89	35.21	2.31
Mahmoud Salem (greywater)	25-50	7.8	1.04	10.6	90.7	0.039	4.00	2.00	5.39	11.39	47.31	3.11
Abdala Henefat (greywater)	00-25	7.7	3.42	115.7	1023.3	0.185	13.00	15.00	7.86	35.86	21.91	2.10
Abdala Henefat (greywater)	25-50	7.9	1.15	68.7	1034.9	0.095	5.00	2.00	2.91	9.91	29.39	1.56
Abdala Henefat (reference)	00-25	8.0	2.11	135.3	1720.9	0.196	9.00	6.00	3.41	18.41	18.52	1.24
Abdala Henefat (reference)	25-50	7.5	1.77	32.9	579.1	0.078	5.00	7.00	4.89	16.89	28.96	2.00

Table 3:
Soil Analysis Results for Karak (MOP sites)

Household Name	Depth/cm	pH units	EC dS/m	P mg/l	K mg/l	N%	Ca meq/l	Mg meq/l	Na meq/l	Total Cations	Na%	SAR
Ahmad Mefleh Al-Amer (greywater)	00-25	7.8	1.97	53.5	325.9	0.120	7.00	9.00	10.00	26.00	38.46	3.54
Ahmad Mefleh Al-Amer (greywater)	25-50	7.4	2.31	33.4	170.4	0.084	8.00	12.00	11.65	31.65	36.81	3.68
Ahmad Mefleh Al-Amer (reference)	00-25	7.8	1.40	79.7	614.8	0.202	5.00	9.00	2.80	16.80	16.69	1.06
Ahmad Mefleh Al-Amer (reference)	25-50	7.6	1.97	40.5	337.0	0.110	6.00	9.00	5.57	20.57	27.08	2.03
Otman Owedat Al-Amer (greywater)	00-25	7.6	1.91	115.7	514.8	0.200	4.00	6.00	7.78	17.78	43.77	3.48
Otman Owedat Al-Amer (greywater)	25-50	7.7	0.96	50.9	470.3	0.095	4.00	6.00	8.06	18.06	44.63	3.60
Atala Naaser Al- Amer (greywater)	00-25	7.4	1.48	25.3	314.8	0.100	3.00	4.00	2.25	9.25	24.34	1.20
Atala Naaser Al- Amer (greywater)	25-50	7.6	0.97	21.7	170.3	0.073	4.00	5.00	4.19	13.19	31.75	1.97
Khalid Saleh (greywater)	00-25	7.2	0.99	42.5	303.7	0.087	4.00	4.00	3.08	11.08	27.81	1.54
Khalid Saleh (greywater)	25-50	7.4	0.72	27.2	125.9	0.056	3.00	3.00	2.53	8.53	29.63	1.46