Jan Spit CS Delft

Reconnaissance Study

Towards innovative sanitation facilities and treated Effluent Reuse for rural areas in Egypt

FINAL (version 1.2)

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Contents

Acronyms

- ABR - Anaerobic Baffle Reactor (=Baffled Septic Tank)
- AC – Affiliate Company
- APP - Advisory Panel Project on Water Management
- BOD - Biochemical Oxygen Demand
- BORDA - Bremen Overseas Research and Development Association
- BOT - Build-Operate-Transfer
- CBO - Community-Based Organization
- CDA - Community Development Association
- COD - Chemical Oxygen Demand
- CW – Constructed Wetland
- DALY - Disability-adjusted Life Years
- DEWATS - Decentralized Water Treatment System (Borda, Bremen)
- DHK – Demonstration, Feasibility (*Haalbaarheid*) Knowledge (Subsidy Netherlands Government)
- DRI - Drainage Research Institute
- EAWAG - Swiss Federal Institute of Aquatic Science & Technology
- EEAA - Egyptian Environmental Affairs Agency
- EKN – Embassy of the Kingdom of The Netherlands
- EGP = LE Egyptian Pound = “Livre Egyptienne” (1 € = EGP 8.93, 1 EGP = € 0.11 - rate on 21.05.2013)
- ESRISS - Egyptian-Swiss Research on Innovations in Sustainable Sanitation
- GIZ - German International Cooperation (former GTZ)
- HCWW - Holding Company for Water and Wastewater
- ISSIP - Integrated Sanitation and Sewerage Project
- NWP – Netherlands Water Partnership
- MOHP - Ministry of Health and Population
- MWRI - Ministry of Water Resources & Irrigation
- NGO – Non Government Organization
- NOPWASD - National Organization for Potable Water and Sanitary Drainage
- Panel - Egyptian/Dutch High Level Water Panel
- PSI – Private Sector Investment
- PPP - Public-Private Partnership
- RBC - Rotating Biological Contactor
- SANDEC - Department for Sanitation in Developing Countries (Eawag)
- ToR - Terms of Reference
- UASB - Upflow Anaerobic Sludge Blanket
- WB - World Bank
- WSP - Waste Stabilization Ponds
- WUA - Water Users’ Association

- WW - Wastewater
- WWTP - Wastewater Treatment Plant

0. Executive summary

Background. In 2012, the members of the Egyptian/Dutch High Level Water Panel ('The Panel') selected the project idea *'Feasibility of Promoting the Application of Innovated Sanitation Facilities and Treated Effluent Reuse for Rural Areas in Egypt'* as the most relevant and promising project idea. Subsequently the Egyptian Government and the Dutch Water Mondiaal Deltateam requested Jan Spit - Water and Sanitation Consultant - to prepare phases 1 and 2 of the proposed Programme Outline.

Activities. From 18 May through 23 May 2013, we, Professor Ashraf El-Sayed Ismail and Jan Spit had a closer look at this idea. We visited projects in Bani Suef and Fayoum and discussed rural sanitation options and approaches with HCWW (Holding Company for Water and Wastewater), AC/HCWW (Affiliate Companies of the HCWW), APP (Advisory Panel Project on Water Management), ESRISS (Egyptian-Swiss applied research project on innovations in sustainable sanitation) and the EKN (Embassy of the Kingdom of the Netherlands) in Cairo. In addition we contacted several Dutch parties active in Egypt such as Ecofyt, Wereldwaternet, Waterboard Aa en Maas, Wageningen UR etc. and discussed the findings with representatives of NWP (Netherlands Water Partnership) and Water Mondiaal (Ministry of Foreign Affairs).

The following text box provides some information on the general situation on rural sanitation.

Rural Sanitation Facilities in Egypt (Source: ToR Appendix 2)   *For the majority of villages in rural Egypt, wastewater collection and treatment has lagged behind development of the water supply system. Most households in these villages have access to latrines or flush toilets connected to infiltration trenches or septic tanks, but the lack of adequate sanitation systems to remove the large quantities of wastewater, remains a serious problem. The situation is particularly dire in the Nile Delta and Nile Valley area where high population densities and an elevated groundwater table create unsanitary conditions. Most of rural areas have access to improved latrines connected to a septic system; others have simple unlined pits, and few households do not have any latrines at all. In addition, much of the septage evacuated from latrines and septic pits is discharged directly into nearby canals and drains, via pumps, evacuated trucks or direct gravity connections.*

Findings in the field. Only if villages cannot be linked to the sanitation cluster system (*'Cluster Approach*[1]*'*), stand alone rural sanitation systems are being developed. This bias towards large systems (*'connect to the cluster, unless'*), the attitude that the government will and shall provide everything for everybody, strict effluent standards (*'all or nothing' approach*) and the choice of less appropriate technologies do not favor the development of rural sanitation. On the other hand we observed that NGOs (Non Government Organizations) trigger community and private sector involvement. We also observed that operation by the Ministry of Local Governments was successful at a Wastewater Treatment Plant (WWTP) implemented by the Ministry of Water Resources and Irrigation (MWRI).

[1] National Rural Sanitation Strategy, 2008 page 3-8, item 4.a *"It shall also propose the method of wastewater collection, conveyance and treatment of small human settlement that cannot linked to sanitation cluster system".*

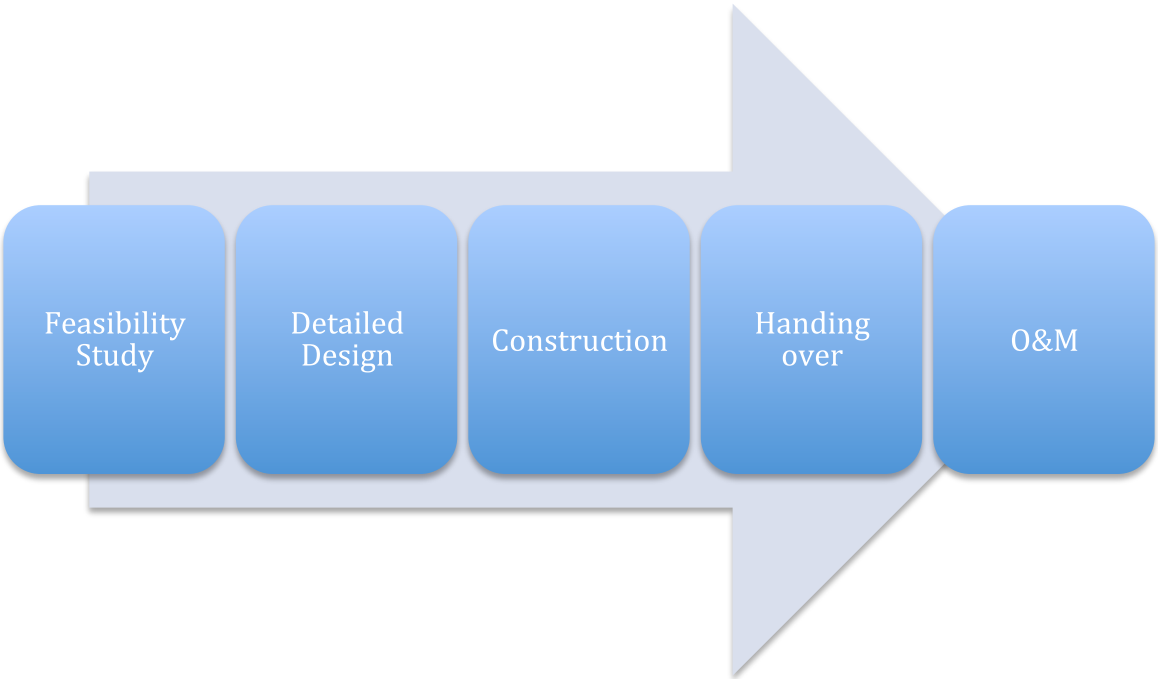
Regarding the reuse of effluent we found that, in the schemes we visited, the effluent is reused indirectly from drains and not directly from the effluent pipe of the WWTP.

Question 1 to the panel:
Does the panel agree with these preliminary findings?:

1. *There are few examples of successful rural sanitation in Egypt;*
2. *Indirect reuse by pumping water from drains (if available) is common practice and probably easier to implement than direct reuse.*

Review and adjust the programme outline. The '*Feasibility of Promoting the Application of Innovative Sanitation Facilities and Treated Effluent Reuse for Rural Area in Egypt'* (see Appendix 2) is based on the principles of a turnkey project: after a feasibility study, detailed design and construction, the system is handed over to community and operator. See Figure 1.

Figure 1: Implementation scheme as proposed in the ToR



Without doubt, this 'technical' project approach leads to very interesting technical innovations. Based on our observations in the field, the research of ESRISS during the past years and our experiences elsewhere, we think that the proposed approach can be further improved by involving a future operator ('*delegated service provider*') and community in an earlier stage of the project. In this way we are working towards an *'enabling environment'* as suggested by ESSRIS (see Figure 2). A possible organization setup is presented in the '*Sustainable Sanitation Pyramid*' (Figure 3).

Figure 2: Enabling environment rural sanitation and reuse in Egypt (source: Small Scale sanitation in Egypt: challenges and ways forward, ESRISS Report Series Phase 1, 6 December 2012)

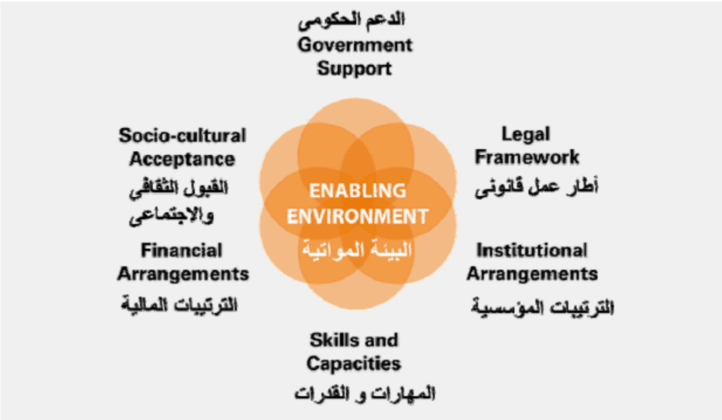
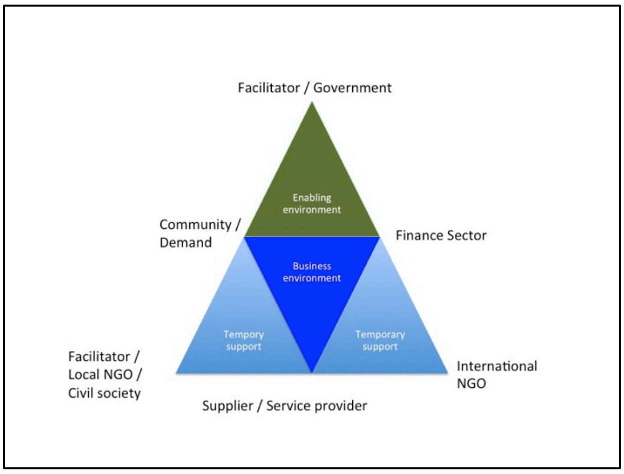


Figure 1: Components of an enabling environment (adapted from Lüthi et al, 2011)

Figure 3: Sustainable Sanitation Pyramid



The pyramid model has six stakeholders that make sustainable sanitation happen:

- A **facilitator** being the AC/HCWW, HCWW and/or Local governorate: setting 'the rules of the game' and overseeing the project;
- The **community** that requires the services and provides funds for the wastewater collection system and O&M;
- The **finance** sector. For the time being we assume that the Egyptian Government finances the wastewater treatment plant;
- A **service provider** that has the delegated task of designing, constructing, operating and maintaining wastewater collection, treatment and reuse system including sludge management. It is important that this service provided has a long-term commitment (at least contracts of 5 years);
- **Temporary support** by a facilitator, a local NGO like Together, which organizes the involvement of the community;

- **Temporary support** by an international NGO (or company, water board, water utility, etc.) that supports especially the service provider in adequate technical set-up of the system and supports the finance sector in developing innovative funding.

Question 2 to the panel:
Does the panel agree with this review?:

1. *A different approach is needed to make rural sanitation in Egypt a success than proposed in the project proposal;*
2. *An approach towards an enabling environment and as outlined in Sustainable Sanitation Pyramid is worth elaborating.*

Criteria for project area selection. Although the Egyptian Government developed a scoring/prioritization system years ago, we were requested to prepare a set for pilot area selection. This resulted in a straightforward set of project area selection criteria based on:

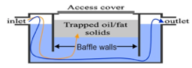
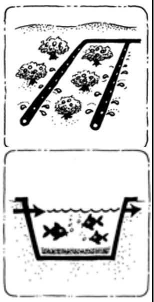
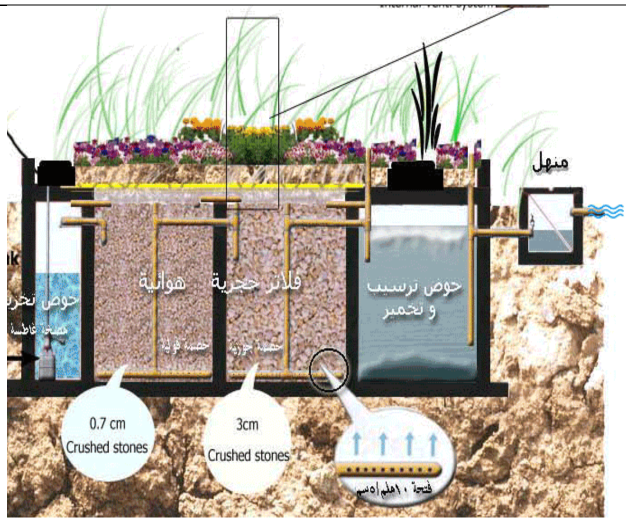
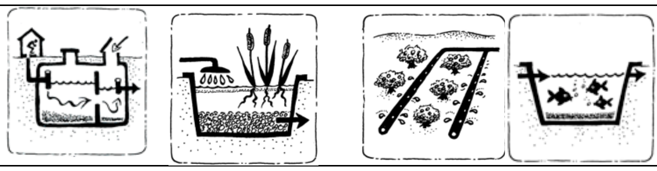
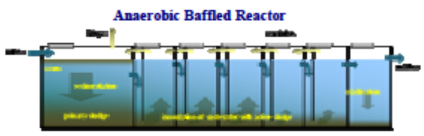
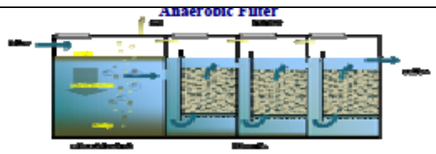
- **'Motivation' (M):**
  - Is the community willing to donate land for a WWTP and ready to pay fees to cover operation and maintenance?;
  - Is the HCWW or AC/HCWW willing to allocate funds for the construction of the WWTP?;
- **'Capacity' (C):**
  - Is the community capable to pay for the collection system and operation and maintenance fees?
  - Does the Community Development Association (CDA) have a good track record and is it capable of managing funds and dealing with defaulters?
  - Is there an entity that can act as service provider?
- **'Opportunity' (O):**
  - Is the village far away from the future sewer and will it never be connected to a cluster WWTP?;
  - Is the village far from an irrigation channel and is there a need for reuse of effluent or is there a private investor interested in obtaining treated effluent for irrigating new land?

Villages having the highest 'T' score come first. A 'T' score is defined by: T= M * C * O.

Question 3 to the panel:
Does the panel agree with these criteria and methodology?:

1. *Project areas should be selected based on their Motivation (M), Capacity (C) and Opportunity (O);*
2. *Scoring could be based on a 'T-score' = M * C * O.*

Innovative and sustainable rural sanitation/wastewater reuse approaches that could be applied in Upper Egypt. The Approach is illustrated in the following table.

Water	System	Illustration
Wastewater collection	Shallow sewerage (& Grease Trap, if applicable)	 
Grey water	Constructed wetland followed by irrigation or fish farming	
Grey water	Anaerobic Upflow Filter followed by irrigation/ fish farming 	
Wastewater	Septic tank followed by constructed wetland and irrigation / fish farming	
Wastewater	Anaerobic Baffle Reactor and disposal in drainage and reuse from drain	
Wastewater	Anaerobic Upflow Filter and disposal in drainage and reuse from drain	

Question 4 to the panel:
Does the panel agree with the following technical approach?

1. *Before discharge into (shallow) sewers grease traps are to be considered (if*

required);
2. *Grey water treatment/reuse (if applicable) in constructed wetland or anaerobic upflow filters followed by irrigation or fish farming;*
3. *Wastewater Treatment/Reuse (if applicable) by septic tanks/constructed wetland followed by irrigation or fish farming;*
4. *Wastewater Treatment by Anaerobic Baffle Reactor or Anaerobic Upflow Filter followed by disposal into drains.*

The **potential added value of the Dutch Water Sector** in implementing the approach is substantial and ranges from organizational involvement to technical assistance and cooperation with Egyptian industries to production of wastewater management equipment.

The **potential funding sources** for setting up a business case can be found at the sustainable water fund, private sector investment programme PSI, Partners for Water, DHK and others.

The **feasibility study** to be executed could be a pilot with the following phasing:
- Refine and elaborate the proposed approach aiming at creating an enabling environment based on the 'rural sanitation pyramid';
- Select a region where the programme will be implemented so that efforts can be concentrated;
- Assure financing of the treatment works for the first 10 villages (2,000 inhabitants each). Assuming treatment costs US$250 per household of 5, AC/HCWW, HCWW, or another party needs to be prepared to invest US 1 million;
- Develop a methodology in 10 villages and test it on a pilot base;
- Develop an outline for treated wastewater reuse scheme and test it on a pilot base;
- Develop an outline for faecal sludge management and reuse of faecal sludge and test it on a pilot base.

Question 5 to the panel:
Does the panel agree with this outline of the following phase?:

1. *Refine and elaborate a methodology based on the rural sanitation pyramid?*
2. *Select a region;*
3. *Assure financing of treatment works for a number of villages;*
4. *Develop and test a methodology for wastewater collection and treatment, treated wastewater reuse and faecal sludge management and reuse.*

1. Introduction

Background. The members of the Egyptian/Dutch High Level Water Panel ('The Panel') selected the project idea 'Feasibility of Promoting the Application of Innovated Sanitation Facilities and Treated Effluent Reuse for Rural Areas in Egypt' as the most relevant and promising project idea. Subsequently the Egyptian Government and the Dutch Water Mondiaal Deltateam requested Jan Spit - Water and Sanitation Consultant - to prepare phases 1 and 2 of the Programme Outline. The Terms of Reference (ToR) of the Consultant are presented in Appendix 1 and the Programme Outline in Appendix 2. The Advisory Panel Project on Water Management (APP) organized the activities in Egypt and requested Professor Ashraf El-Sayed Ismail, PhD., Deputy Director of the National Water Resource Center/ Drainage Research Institute, to work with Jan Spit.

Activities. From 18 May through 23 May 2013 we conducted the following activities to arrive at the required output:

- Review and adjust the programme outline (See § 2);
- Conduct several meetings with relevant authorities and experts and conduct field visits to Bani Suef (20 May 2013) and Fayoum (21 May 2013) for a quick scan of potential project areas and prepare criteria for project area selection (See § 3);
- Identify /propose innovative and sustainable rural sanitation/wastewater reuse approaches that could be applied in Egypt (Focusing in Upper Egypt where land is available for reuse, see § 4)
- Assess the potential added value Dutch Water Sector in implementing (See § 5);
- Assess potential funding sources for setting up a business case (See § 6);
- Prepare an outline for the feasibility study (See § 7).

The itinerary of the activities in Egypt is presented in Appendix 3.

Findings in the field. We present the details of the finding in the field in detail in Appendix 4. The main findings are:

- Only if villages cannot be linked to the sanitation cluster system ('Cluster Approach[2]'), stand alone rural sanitation systems are being developed. This bias towards large systems ('*connect to the cluster, unless*'), the attitude that the government will and shall provide everything for everybody, strict effluent standards ('*all or nothing' approach*) and the choice of less appropriate technologies do not favor the development of rural sanitation. On the other hand we observed that NGOs (Non Government Organizations) trigger community and private sector involvement. We also observed that operation by the Ministry of Local Governments was successful at a Wastewater Treatment Plant (WWTP) implemented by the Ministry of Water Resources and Irrigation (MWRI);

[2] National Rural Sanitation Strategy, 2008 page 3-8, item 4.a *"It shall also propose the method of wastewater collection, conveyance and treatment of small human settlement that cannot linked to sanitation cluster system".*

- The dominant role of the National Organization for Potable Water and Sanitary Drainage (NOPWASD) in all implementation works. NOPWASD has limited capacity and follows an traditional approach which does not favor rural sanitation;
- There are two interesting new developments:
    - The 5-year Egyptian-Swiss applied research project on innovations in sustainable sanitation (ESRISS). The summary of the latest ESRISS report and its assessment of the rural sanitation environment is copied into Appendix 5;
    - The Egyptian government started to reassess the current procedures for treated wastewater reuse in agriculture;
- During our field visits we noted that:
    - The concept of an NGO operating a WWTP is very interesting: the NGO is good in communication with the community and in involving the community in the scheme. Technically spoken the system could be simpler: it consists of 4 separate steps (sedimentation, reed bed, disinfection and desludging). In theory the effluent could be excellent. The effluent is discharged into a drain;
    - The concept implemented by MWRI and operated by the Ministry of local governments is very promising technically wise: a simple combined system in one unit (sedimentation followed by anaerobic upflow filter) provides an (primary treatment) effluent quality that matches the quality of the drain into which it is discharged;
    - There is no intention and felt need to reuse effluent in the systems we visited, as there is fresh water available for irrigation.

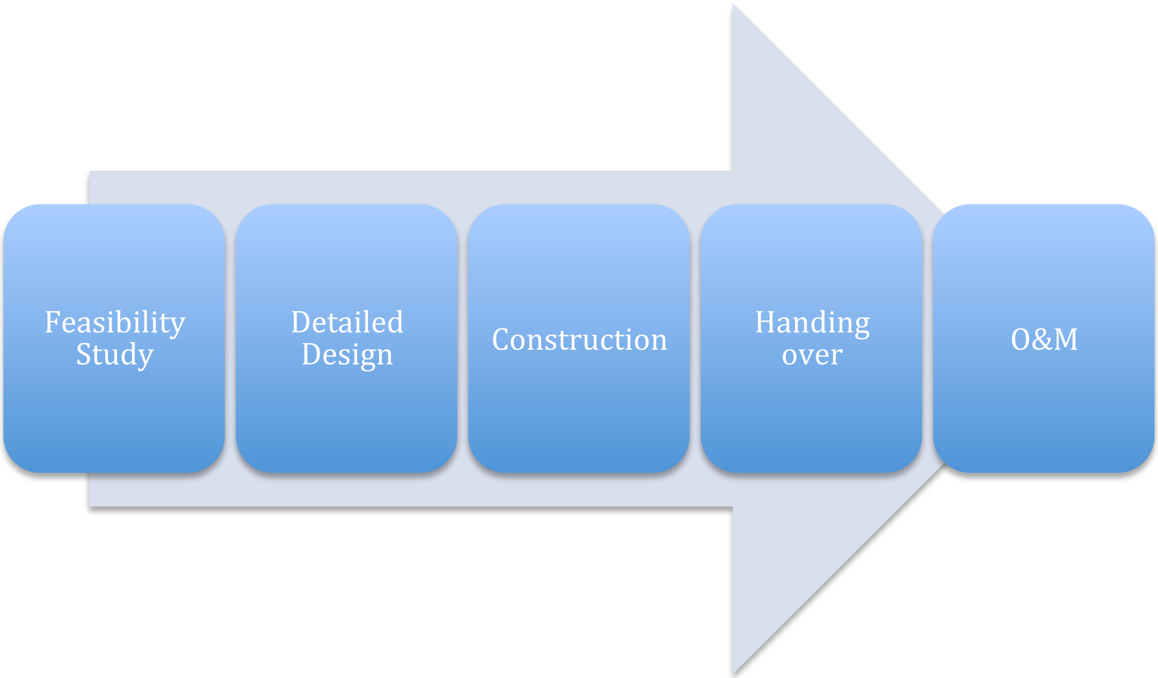
2. Review outline

Required activity of the mission: *"Clarify, adjust and confirm with the relevant stakeholders the programme outline in Appendix 3 which was prepared by the HCWW".*

Clarification. Mr. Ashraf El-Sayed Ismail prepared the programme outline in Appendix 3. Contrary to what is mentioned in the ToR, the programme outline has been prepared by APP, supported by the HCWW.

Contents. The '*Feasibility of Promoting the Application of Innovative Sanitation Facilities and Treated Effluent Reuse for Rural Area in Egypt'* (see Appendix 2) is based on the principles of a turnkey project: after a feasibility study, detailed design and construction, the system is handed over to community and operator. See Figure 4.

Figure 4: Implementation scheme as proposed in the ToR



Adjustment. Our observations in the field, combined with the research of ESRISS during the past years and our experiences with rural wastewater in other parts of the world lead to the conclusion that another approach is required. It is without doubt that this 'technical' approach will lead to very interesting technical innovations. However, sustainable rural sanitation and reuse requires certain conditions, or an 'enabling' environment. An example of an enabling environment presented in Figure 5.

Figure 5: Enabling environment rural sanitation and reuse in Egypt (source: Small Scale sanitation in Egypt: challenges and ways forward, ESRISS Report Series Phase 1, 6 December 2012)

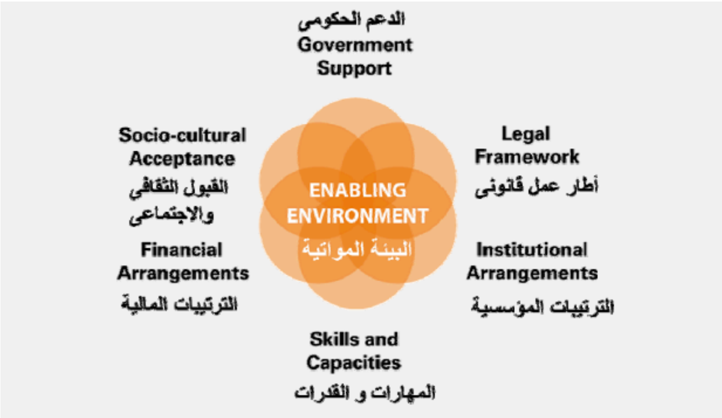


Figure 1: Components of an enabling environment (adapted from Lüthi et al, 2011)

We had an interesting 'chicken and egg' discussion with ESRISS: in ESRISS's view the enabling environment should be in place before any successful rural sanitation scheme can start. In our view, the programme outline should and could be designed in such a way that, while working on rural sanitation, an enabling environment is created. Our outline for this approach towards an enabling environment is presented in § 4.

Confirmation. Unfortunately, the short duration of our mission and the busy schedule of the HCWW decision makers did not allow us to discuss the proposed approach in detail and develop further.

3. Potential project areas and criteria for final project area selection

Although the Egyptian Government developed a scoring/prioritization system years ago, we were requested to prepare a set for pilot area selection: Required activity of the mission: "*Prepare criteria for project area selection"*.

As outlined in § 2, the success of a rural sanitation project in Egypt is likely to depend on a complicated number of factors that also influence each other. To assist in a systematic assessment of potential project areas, we distinguish between 'Motivation', 'Capacity' and 'Opportunity'. The background of this approach is explained in Appendix 6.

Motivation. 'Motivation' deals with the way in which the stakeholders involved (Policy makers, AC/HCWW, HCWW, Community, CDAs, Ministries, Regional Authorities, NGOs, contractors, operators, service providers, etc. **want** rural sanitation to be improved and **want** to reuse the effluent. We refer to our findings in the field (Appendix 4), literature review, our own experiences in rural sanitation and the assessments of ESRISS (Appendix 5) and have identified the following keys issues on the **motivation side:**

- **Political commitment:** Is there enough political support for rural sanitation improvement and reuse or is it only lip serve?;
- **Commitment of HCWW and/or AC/HCWW to support rural sanitation.** At the moment, there is growing attention for rural sanitation, but this needs to be translated into financial allocations for rural sanitation;
- **Commitment of the community for improved sanitation.** Usually the community is not really motivated by 'improved health' as a result of improved sanitation. It is more likely that the community is triggered by:
    - Finances: high expenses for emptying the existing wastewater tanks;
    - Nuisance: high subsurface water table levels, flooding, smell, flies etc.

Hence, to make 'motivation' tangible we propose to use two criteria:

- Is the community donating land for a WWTP?
- Is HCWW or AC/HCWW allocating funds for the construction of the WWTP?

Capacity has three dimensions:

- **Financia**l aspects (ability to pay):
    - The ability of the community to pay for the collection system and operation and maintenance fees and to purchase land for the WWTP (if required);
- **Managerial aspects:**
    - The ability of a CDA to collect fees and to manage funds and to deal with defaulters;
- **Knowledge** aspects:
    - The ability to plan, design, construct and supervise construction of appropriate rural sanitation systems. Based on ESRISS and our own observations we conclude that, at the

moment, HCWW need external assistance on this. This can be organized and need not be a 'go/no go';
    - The ability to operate and maintain a rural sanitation system. Based on ESRISS and own observations we conclude that neither HCWW, nor NGOs are capable/interested in operating and maintaining small sanitation schemes. In our view a service provider needs to be found. The presence of a service provider can be important selection criterion. However, one could envisage to select/train/educate a service provider during the course of the project.

Hence, to make 'capacity' tangible we propose to use two criteria:

- Is the community willing to pay for the collection system and operation and maintenance fees?
- Does the CDA has a good track record (for instance in previous projects) and is it capable of managing funds and dealing with defaulters?
- Is there an entity that can act as service provider?

Opportunity deals with the aspects that stimulate or impede sanitation and reuse:

- Intrinsic aspects that HCWW cannot influence such as '**distance to future sewer**'. If a village is close to a (future) sewerage cluster, HCWW will be less inclined to improve wastewater treatment;
- Extrinsic aspects that a village cannot influence. For example (1) the distance to an irrigation channel: if a village is close to an irrigation channel, there will be less interest in reuse of treated wastewater or (2) the presence a private investor that is interested in obtaining treated wastewater for irrigating new land. Such an investor will stimulate the interest for reuse.

Hence, to make 'opportunity' tangible we propose to use two criteria:

- Is the village far away from the future sewer and will it never be connected to a cluster treatment plant?;
- Is the village far from an irrigation channel and is there a need for reuse of effluent or is there a private investor interested in obtaining treated effluent for irrigating new land?

Scoring/ Prioritization

We propose to select / prioritize potential project areas by using the following model that 'predicts' the success of an intervention as a multiplication of, 'Motivation' (M) and 'Capacity' (C) and 'Opportunity': T score = M * C * O.

This is illustrated in the Table 1.

Table 1: Example scoring table

Description	Motivation	Capacity	Opportunity	Score
Village A	• Land donated • HCWW and AC/HCWW funds for WWTP Motivation 100%	• Community willing to pay • Strong CDA • Service provider available Capacity 100%	• Close to future sewer • Far away from irrigation channel Opportunity 0%	0%
Village B	• Land donated • HCWW and AC/HCWW funds for WWTP Motivation 100%	• Community willing to pay • Strong CDA • Service provider likely to be found Capacity 50%	• Far away from future sewer • Far away from irrigation channel Opportunity 100%	50%
Village C	• Land donated • HCWW and AC/HCWW funds for WWTP Motivation 100%	• Community willing to pay • Weak CDA • Service provider likely to be found Capacity 10%	• Far away from future sewer • Far away from irrigation channel Opportunity 100%	10%

The conclusion in this example would be:

- Village A: ‘no go’;
- Village B: ‘first priority’;
- Village C: ‘second priority’.

4. Outline suitable approach

Required activity of the mission: "*Identify /propose innovative and sustainable rural sanitation/wastewater reuse approaches that could be applied in Upper Egypt*"

4.1. Enabling environment made practical: FIETS principles

In an attempt to make the envisaged 'enabling environment' more tangible, we can learn from the distinction made by the Dutch WASH Alliance, which have been adopted by the Netherlands Ministry of Foreign Affairs in the conditions for the 'Sustainable Water Fund'. This assumes that rural sanitation projects will have a sustainable character if the following is taken into account:

- **Financial sustainability:** Does the approach provide financial concepts, which diminish dependency on external subsidies and make optimal use of business approaches and private sector involvement, therewith, strengthening the Egyptian structural finance? Referring to § 3 we might assume that the project is financially sustainable if:
  - HCWW and/or AC/HCWW provides funds for investment WWTP;
  - Community provides land for the WWTP, funds for the wastewater collection system and funds for O&M;
- **Institutional sustainability**: Does the program/project integrate rural sanitation in national policies with NGOs in close collaboration with local stakeholders working as capacity builders, facilitators and watchdogs representing the voice of ordinary people and complementing governmental efforts, working from a rights based approach? Obviously this is not the case (yet) in Egypt and needs to be worked on and beyond the scope of the project (?). Referring to the findings in ESRISS and our experiences elsewhere this could be made tangible in a project by:
  - Technical backing by HCWW and/or AC/HCWW;
  - A dedicated service provider to provide for O&M. Preferably following a Design/Construct/Build/Operate/Maintain concept. If the service provider makes a bad design, he will have O&M problems; if he provides a bad service, he will not get paid;
  - Alternatively: Community Based O&M. In this respect a lot can learned from the GIZ regarding their experiences with the "dual management model"; Alternatively: O&M by Ministry of local governments;
- **Environmental sustainability**: Does the sanitation program/project adopt and mainstream Integrated Water Resource Management and ecosystem approach principles and does it build climate resilient solutions?. Is the sanitation system safe from a health point of view? This is warranted by a proper technology selection. See below;
- **Technological sustainability**: Does the program/project seek and apply locally appropriate technologies and innovative ICT-solutions, which are context-specific, affordable and demand-driven? This is warranted by a proper technology selection. See below;
- **Social sustainability**: Are the interventions demand-driven and needs-based, being sensitive to local and cultural incentives and focuses the PPP specifically on women as change agents? Unfortunately the scope of the present mission does not allow us to elaborate this for the Egyptian context. This is something to be sorted out later.

4.2. Technical options

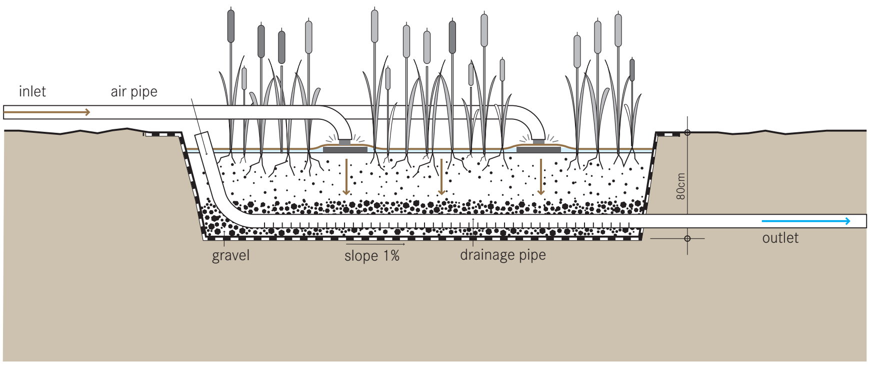
4.2.1. Grey water reuse

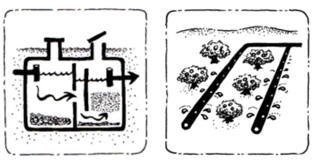
For new developments, tourist areas and remote areas grey water reuse should be a key consideration in areas where water scarcity is pronounced. The low-cost treatment options discussed here negate health risks and improve the quality of grey water. The consensus is clear that wastewater use under controlled conditions is now an accepted and responsible method of achieving water savings. The 2006 WHO Guidelines for the Safe Use of Wastewater, Excreta and Grey water clearly state that grey water contains nutrients and water, which make them valuable resources' (vol. 4: 8).

Methods to facilitate the reuse of grey water in Egypt are the vertical flow constructed wetland and the anaerobic upflow filter

A Vertical Flow Constructed Wetland is a filter bed that is planted with wetland plants. See Figure 6. Wastewater is poured or dosed onto the wetland surface from above using a mechanical dosing system or a siphon. The water flows vertically down through the filter matrix. The important difference between a vertical and horizontal wetland is not simply the direction of the flow path, but rather the aerobic conditions. A constructed wetland produces effluent that is clean from day 1 onwards.

Figure 6: Vertical Flow Constructed wetland (Tilley, 2008)



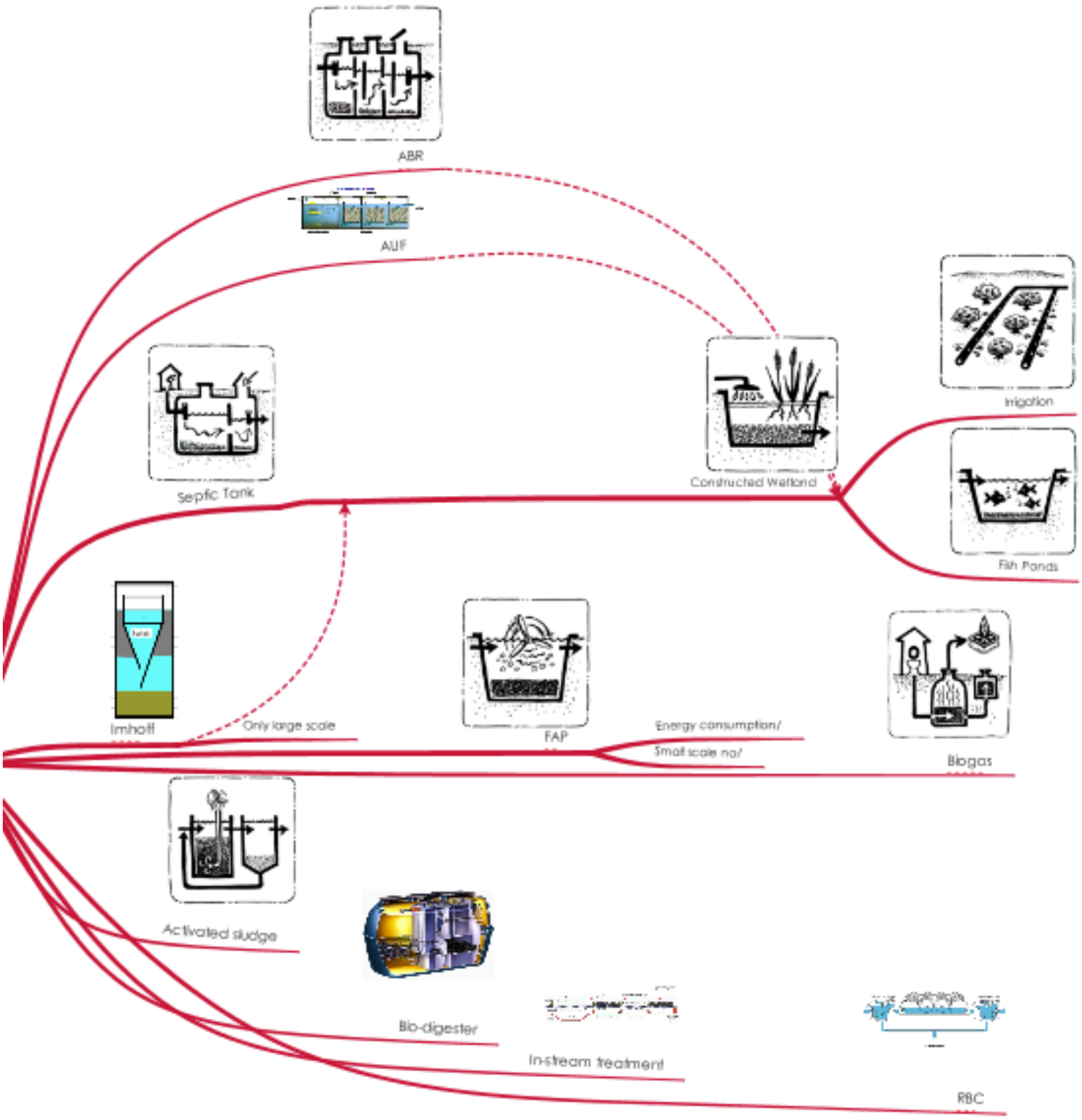


An Anaerobic Upflow Filter is an appropriate system to treat the grey water. It is discussed in § 4.2.4.

4.2.2. Wastewater treatment

In Figure 7 we present the options than can be considered in rural Egypt. In this section we only discuss the most appropriate option: Anaerobic Baffle Reactor (ABR) and Anaerobic Upflow Filter (AUF) followed by constructed wetlands and Irrigation or Fish Ponds.

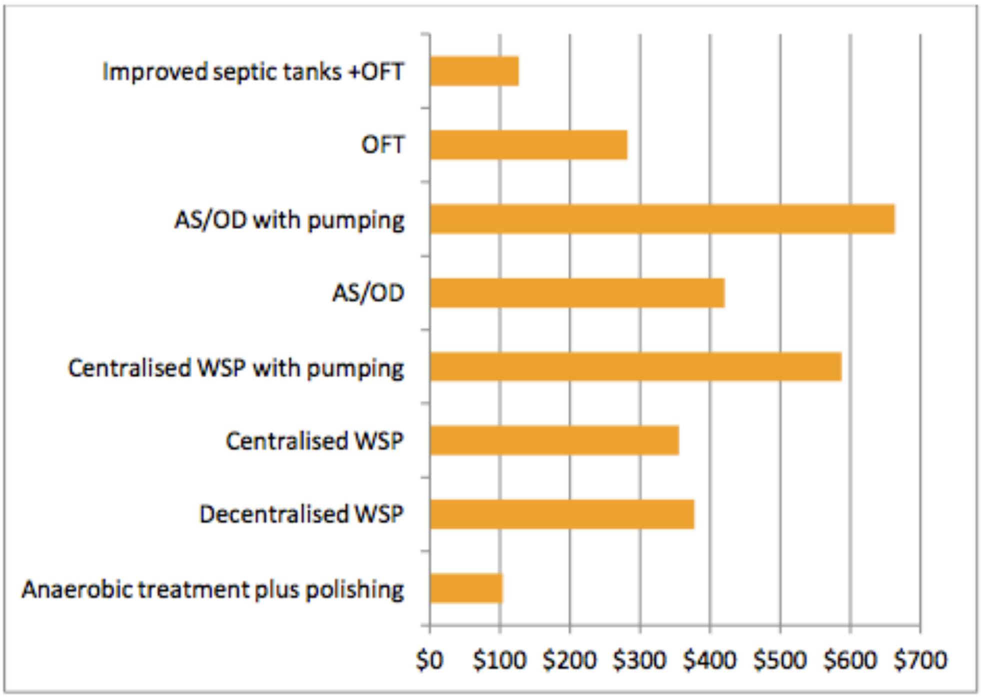
Figure 7: Overview possible treatment systems



ABR is also the most cost effective method when it comes to health aspects. Figure 8 shows the cost effective ness of different systems per Disability-adjusted Life Years (DALY) avoided. DALY is a way to express health risk that combines both mortality and morbidity to calculate the overall impact of a disease or disease group.

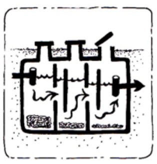
Figure 8: Cost effectiveness of interventions per DALY (Source: Estimating Relative Benefits Of Differing Strategies For Management Of Wastewater In Lower Egypt Using Quantitative Microbial Risk Analysis (Qmra) World Bank Water Partnership Program, Final Report, February 2012)

Figure 8: Cost effectiveness of interventions (excluding household septic tanks) US$ per DALY avoided



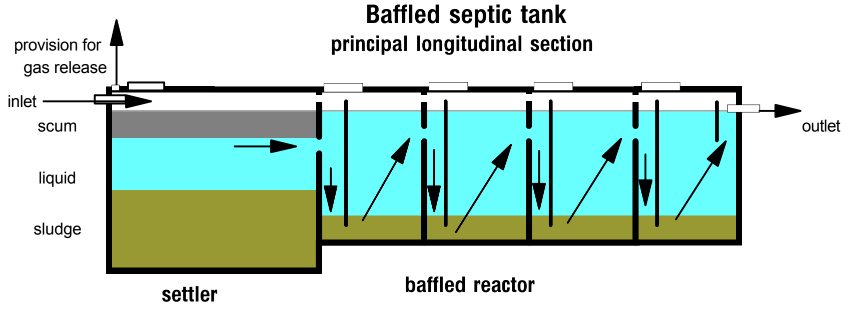
OFT – On-farm treatment; AS/OD = Activated Sludge or Oxidation Ditch; WSP = Waste Stabilization Pond

4.2.3. Anaerobic Baffle Reactor



The Anaerobic Baffle Reactor is the most appropriate ‘stand alone’ treatment system. When would be followed by a Vertical Flow Constructed Wetland, the added benefits of the Constructed Wetland would be nullified. For those cases a simple septic tank (see § 4.2.6. is sufficient. An Anaerobic Baffle Reactor (ABR) is an improved septic tank because of the series of baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment.

Figure 9: Anaerobic Baffle Reactor (Sasse, 1998)



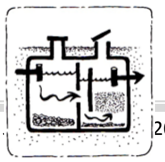
The majority of settleable solids are removed in the sedimentation chamber at the beginning of the ABR, which typically represents 50% of the total volume. The up- flow chambers provide additional removal and digestion of organic matter: BOD may be reduced by up to 90 %, which is far superior to that of a conventional septic tank. As sludge is accumulating, desludging is required every 2 to 3 years. Critical design parameters include a hydraulic retention time (HRT) between 48 to 72 hours, up-flow velocity of the wastewater less than 0.6 m'/h and the number of up-flow chambers (2 to 3).

Adequacy. This technology is easily adaptable and can be applied at the household level or for a village up to 2000 inhabitants. This technology is also appropriate for areas where land may be limited since the tank is installed underground and requires a small area. It should not be installed where there is a high groundwater table as infiltration will affect the treatment efficiency and contaminate the groundwater. Typical inflows range from 2,000 to 200,000L/day. The ABR will not operate at full capacity for several months after installation because of the long start up time required for the anaerobic digestion of the sludge. Therefore, the ABR technology should not be used when the need for a treatment system is immediate. To help the ABR to start working more quickly, it can be 'seeded', i.e. active sludge can be introduced so that active bacteria can begin working and multiplying immediately. Because the ABR must be emptied regularly, a vacuum truck should be able to access the location.

Health Aspects/Acceptance. Although the removal of pathogens is not high, the ABR is contained so users do not come in contact with any of the waste- water or disease causing pathogens. Effluent and sludge must be handled with care as they contain high levels of pathogenic organisms. To prevent the release of potentially harmful gases, the tank should be vented.

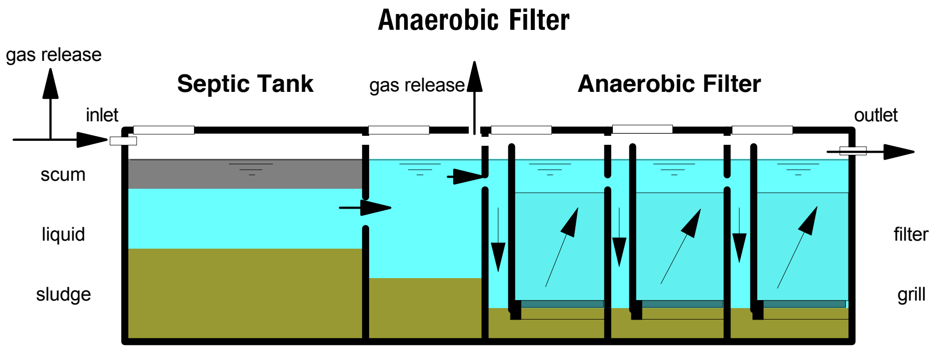
Maintenance. ABR tanks should be checked to ensure that they are watertight and the levels of the scum and sludge should be monitored to ensure that the tank is functioning well. Because of the delicate ecology, care should be taken not to discharge harsh chemicals into the ABR. The sludge should be removed using a vacuum truck to ensure proper functioning of the ABR.

4.2.4. Anaerobic Upflow Filter



An **Anaerobic Upflow Filter** (UAF) is a fixed-bed biological reactor. As wastewater flows through the filter material, particles are trapped and organic matter is degraded by the biomass that is attached to the filter material. See Figure 10. This technology consists of a sedimentation tank (or septic tank) followed by one or more filter chambers. See Appendix 4 for the AUF visited during our field visit in Fayoum.

Figure 10: Anaerobic Upflow Filter (Sasse, 1998)



Filter material commonly used includes gravel or specially formed plastic pieces (see Figure 11). The application of crushed rocks (see Figure 12) is not recommended as these rocks may be subject to decomposition due to the low pH of the wastewater and/or might clog. Typical filter material sizes range from 12 to 55 mm in diameter. Ideally, the material will provide between 90 to 300 m^2 of surface area per 1 m^3 of reactor volume. By providing a large surface area for the bacterial mass, there is increased contact between the organic matter and the active biomass that effectively degrades it. The Anaerobic Filter can be operated in either upflow or down flow mode. The upflow mode is recommended because there is less risk that the fixed biomass will be washed out. The water level should cover the filter media by at least 0.3 m' to guarantee an even flow regime. Studies have shown that the HRT is the most important design parameter influencing filter performance. A Hydraulic Retention Time (HRT) of 0.5 to 1.5 days is a typical and recommended. A maximum surface-loading (i.e. flow per area) rate of 2.8 m^3/m^2.d has proven to be suitable. Suspended solids and BOD removal can be as high as 85% to 90% but is typically between 50 % and 80 %. Nitrogen removal is limited and normally does not exceed 15% in terms of total nitrogen (TN).

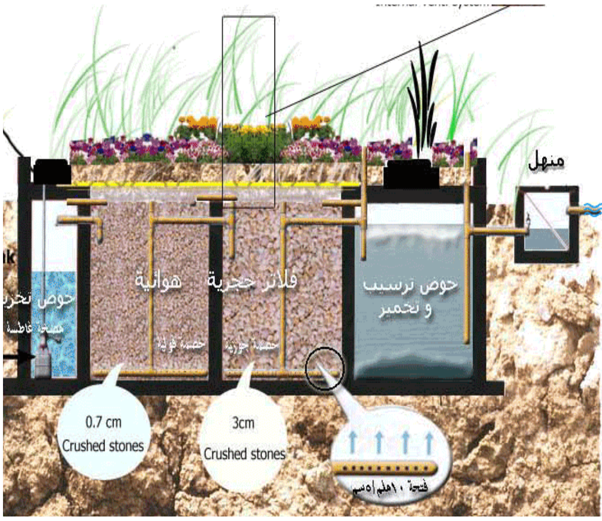
Adequacy. This technology is easily adaptable and can be applied at the household level or a small neighbourhood. An Anaerobic Filter can be designed for a single house or a group of houses that are using a lot of water for clothes washing, showering, and toilet flushing. It is only appropriate if water use is high, ensuring that the supply of wastewater is constant. The Anaerobic Filter will not operate at full capacity for six to nine months after installation because of the long start up time required for the anaerobic biomass to stabilize. Therefore, the Anaerobic Filter technology should not be used when the need for a treatment technology is immediate. Once working at full capacity it is a stable technology that requires little attention. The Anaerobic Filter should be watertight but care should be taken for construction in areas with high groundwater tables or where there is frequent flooding. Depending on land availability and the hydraulic gradient of the sewer (if applicable), the Anaerobic Filter can be built above or below ground.

Figure 11: Plastic Filter Media (Sasse, 1998)

Health Aspects/Acceptance. Because the Anaerobic Filter unit is underground, users do not come in contact with the influent or effluent. Infectious organisms are not sufficiently removed, so the effluent should be further treated or discharged properly. The effluent, despite treatment, will still have a strong odour and care should be taken to design and locate the facility such that odours do not bother community members. To prevent the release of potentially harmful gases, the Anaerobic Filters should be vented. The desludging of the filter is hazardous and appropriate safety precautions should be taken.

Maintenance. Active bacteria must be added to start up the Anaerobic Filter. The active bacteria can come from sludge from a septic tank that has been sprayed onto the filter material. The flow should be gradually increased over time, and the filter should be working at maximum capacity within six to nine months. With time, the solids will clog the pores of the filter. As well, the growing bacterial mass will become too thick and will break off and clog pores. A sedimentation tank before the filter is required to prevent the majority of settleable solids from entering the unit. Some clogging increases the ability of the filter to retain solids. When the efficiency of the filter decreases, it must be cleaned. Running the system in reverse mode to dislodge accumulated biomass and particles cleans the filters. Alternatively, the filter material can be removed and cleaned. For ease of removal, it is recommended to use reinforce concrete slabs to cover the Filter in future to ensure easy operation and maintenance.

Figure 12: Crushed stone AUF (Burnat, 2010)



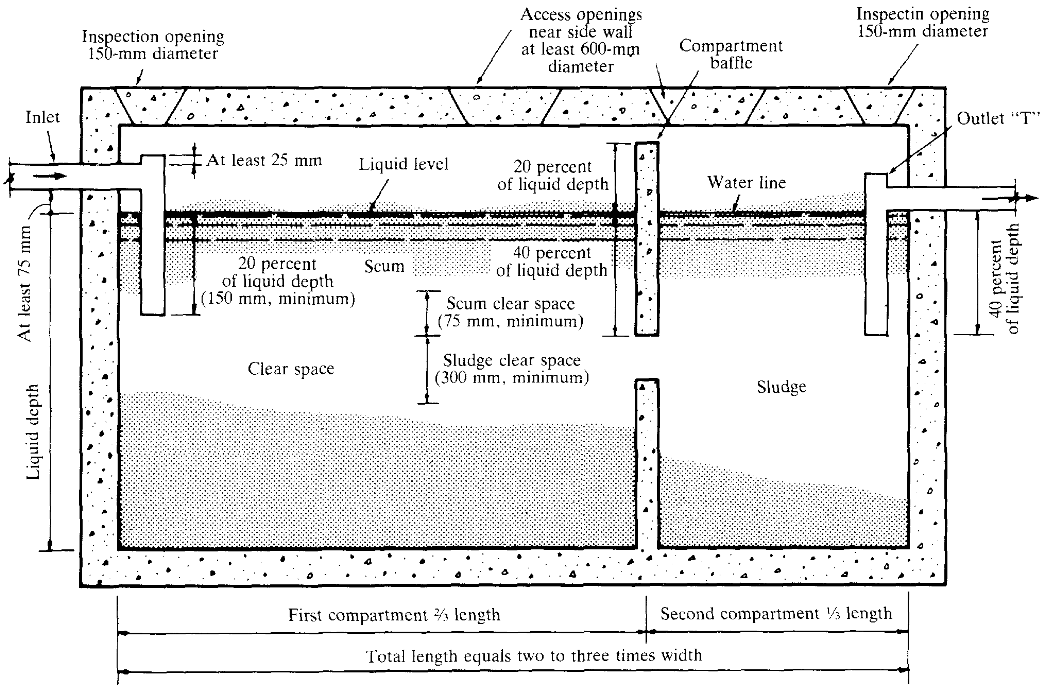
4.2.5. Septic Tank – Constructed Wetland - Reuse

If polishing in Constructed Wetland is required before irrigation, a **Septic Tank (ST)** is sufficient. A Septic Tank is a watertight chamber made of concrete, fiberglass, PVC or PE, for the storage and treatment of black water only or a combination of black and grey water. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate.

A Septic Tank (Figure 13 and Figure 14) should typically have at least two chambers. Liquid flows into the tank and heavy particles sink to the bottom, while scum (oil and fat) floats to the top. The first chamber should be at least 50% of the total length and when there are only two chambers, and it should be two-thirds of the total length. The first chamber is used to settle the solids. Wastewater enters the first chamber of the tank, allowing solids to settle and scum to float. The settled solids are anaerobically digested, reducing the volume of solids. The liquid component flows through the dividing wall into the second chamber, where further settlement takes place, with the excess liquid then draining in a relatively clear condition from the outlet into the constructed wetland. A 'T-shaped' inlet will further dissipate the rate of the incoming effluent that prevents the settling solids below from being disturbed. The baffle, or the separation between the chambers, is to prevent scum and solids from escaping with the effluent. A 'T-shaped' outlet pipe will further reduce the scum and solids that are discharged. With time, the solids that settle to the bottom are degraded anaerobically. As the system relies on bacteriological action for decomposition, therefore placing any chemicals or inorganic materials (such as pesticides, herbicides, paints or solvents) and detergents with high concentrations of bleach or caustic soda should not enter the system, as they will prevent the bacteria and system from functioning. Excess water, oils and grease may also prevent the decomposition rate and render the system ineffective (noticed by increase in bad smell which relates to poor decomposition) and could also block the inlet pipe. The septic tank works under anaerobic conditions, which means bacteria operating in a non-oxygen environment. Oxygen should not be allowed to enter, as it will destroy the bacteria used for decomposition and result in the septic tank working less efficiently. However, during the decomposition dangerous gases are created such as carbon dioxide and methane therefore a ventilation pipe with a screen (to prevent vectors entering and existing the tank) needs to be fitted either on entry point of the inlet tank or on the second chamber of the septic tank.

Figure 13: Specification conventional septic tank (Kalbermatten, 1982)

Figure 14-1. *Schematic of Conventional Septic Tank*
(millimeters)



Note: If vent is not placed as shown on figure 13-2, -3, and -4, septic tank must be provided with a vent.

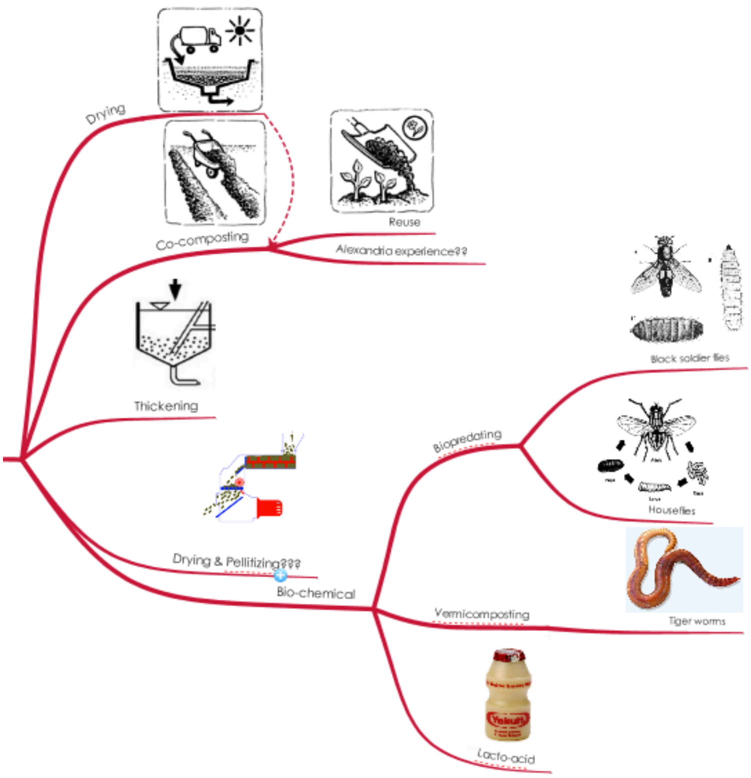
Generally, Septic Tanks should be emptied every 2 to 5 years, although they should be checked yearly to ensure proper functioning. Placing any non-biodegradable products into the system will just fill the tank and require it is be emptied more frequently. The design of a Septic Tank depends on the number of users, the amount of water used per capita, the average annual temperature, the pumping frequency and the characteristics of the wastewater. The retention time should be designed for 48 hours to achieve moderate treatment.

Figure 14: HDPE Septic Tank (Spit, 2012)

4.2.6. Sludge treatment and potential for reuse

Figure 15 presents possible options for sludge treatment. For the time being we propose sludge drying, which is commonly used and known by AC/HCWW. The appropriateness of the other options can be investigated further if and when need and interest arises.

Figure 15: Faecal Sludge Management Options



5. Dutch added value

Required activity of the mission: "*Assess the potential added value of the Dutch Water Sector in implementing*"

The scope for added value of de Dutch Water Sector is inexhaustible:

- **Implementation of integrated approaches.** Several Dutch NGOs such as WASTE and the Dutch WASH Alliance have implemented (parts of) the integrated approach as described in § 2. WASTE (see: www.waste.nl) could assist in setting up a service contract with a service provider, for instance together with Vitens Evides International (VEI) (see: www.vitensevidesinternational.com which has a reputation when it comes to service providing in the drinking water sector;
- **Monitoring.** ESRISS clearly mentions the need for proper knowledge management and monitoring of systems. Organizations such as AKVO are well-equipped for this and can contribute to the success of the new approach (see: www.akvo.org)
- **Training.** At the moment there are several Dutch twinning and training projects in Egypt that can contribute in in developing the knowledge on the FIETS aspects:
  - NICHE project, headed by Mr. Ahmed k.Moawad and executed by MottMacDonald;
  - Twinning project Waterschap Aa en Maas (See: www.aaenmaas.nl);
  - Twinning project Wereldwaternet, which will restart (see: www.wereldwaternet.nl)
- Co-production of **pre-fabricated equipment**: Egypt has a well-recognized production facilities and a joint venture between a Dutch producer of prefabricated wastewater equipment and Egyptian company could boost the wastewater sector. An example is the product of SimGas for biogas production at household scale (Figure 16). This can easily be turned into an Anaerobic Baffle reactor. Other examples are the co-production of the ABR, Figure 17 and Figure 18.
- Introduction of innovative **faecal sludge treatment** such as Jagran (see: www.jagran.nl);
- Introduction and training on the construction of **constructed wetland** such as Ecofyt (See: www.ecofyt.nl) or BrinkVos (http://www.brinkvoswater.nl/uk/water_purification/Constructed_wetland_filters.html ,
- Improvement of the performance of **fish ponds** by renown institutes as the University of Wageningen (See: http://www.wageningenur.nl/en/project/Investigating-the-suitability-of-constructed-wetlands-for-the-treatment-of-water-for-fish-farms-1.htm). See Appendix 8;
- Delivery of desludging equipment, for instance by ROM (See: www.rombv.com/)
- De delivery of innovative sludge transfer stations by geotubes, Figure 19;
- Sludge drying by means of (movable) belt filters, for instance by Multivis (See: http://www.multivis.nl/frame-home-uk.htm).

Figure 16: SimGas prefabricated Biogas installation

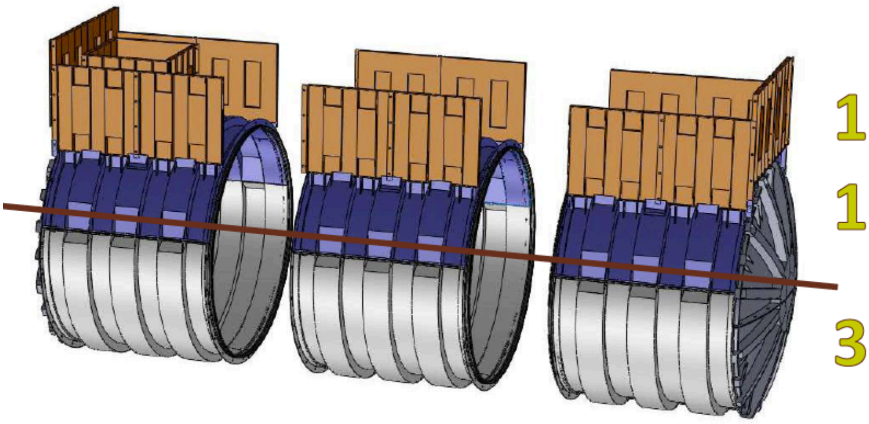


Figure 17: Prefabricated ABR (Borda, reproduced from ESRISS, 2012)

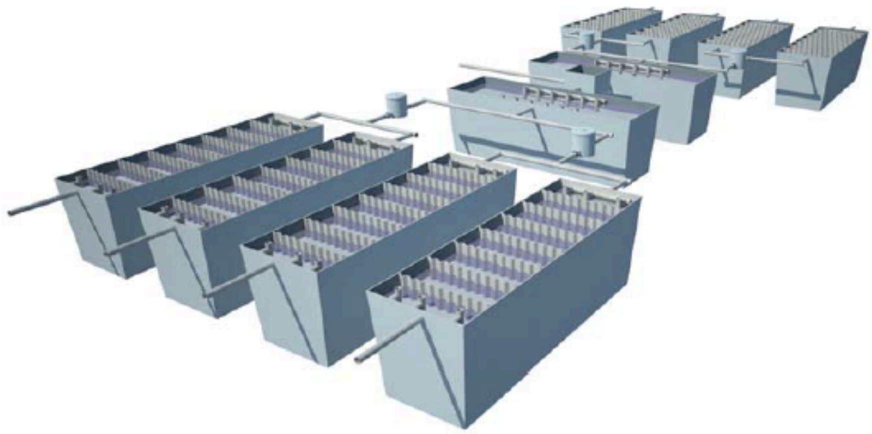


Figure 5*: Example of modular prefabricated treatment units, consisting of 2 prefabricated settlers and 8 prefabricated anaerobic baffled reactors (ABR), treating about 80 m^3/day (drawing: courtesy of BORDA[3])*

Figure 18: Prefab AUF (Spit, 2012)

Figure 19: Sludge transfer station by geotubes

6. Suggestions financing mechanisms

Required activity of the mission: "*Assess potential funding sources for setting up a business case*".

Apart from the funds from EU, WorldBank and Arabic countries; the following funding could be used for setting up business cases:

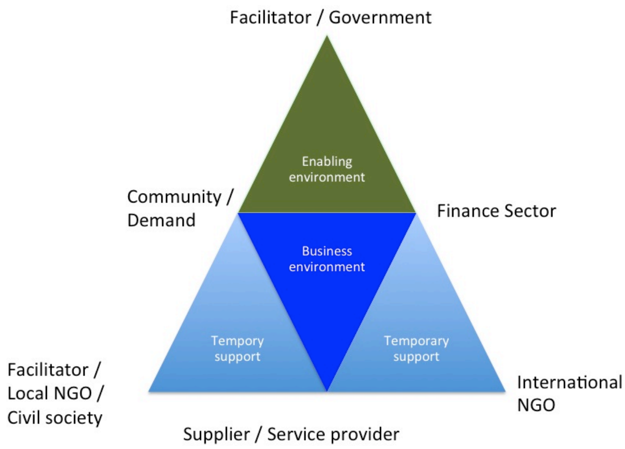
- Sustainable Water Fund (FDW), around € 50 mln. that will open early 2014. This fund finances 50% of Public Private Partnerships in the water sector. See: http://www.agentschapnl.nl/en/programmas-regelingen/sustainable-water-fund-fdw ;
- Private Sector Investment Programme (PSI), which funds 50% of any Private sector investing in Egypt. See http://www.agentschapnl.nl/sites/default/files/PSI%20Brochure%20Arab.pdf ;
- Partners for Water (PfW). See http://www.partnersvoorwater.nl/?page_id=74 ;
- DHK Subsidy Netherlands Government: 50% on a demonstration project, feasibility study or knowledge development. See: http://www.agentschapnl.nl/programmas-regelingen/dhk;
- Meso financing from local sources;
- youngStartup Ventures who invest time, experience, knowledge, connections and team-oriented approach creating working partnerships with entrepreneurs and management teams who have the character and the drive to succeed. See: http://youngstartup.com/;
- Veolia. See: http://fondation.veolia.com/en/applying-for-grant.htm (Open: 1st to the 30th June 2013 and from the 1st to the 30th September 2013).

7. Outline feasibility study

Required activity of the mission: "*Prepare an outline for the feasibility study*"

As explained in § 2 we cannot wait until the 'enabling environment' for rural sanitation in Egypt is in place; also because nobody knows exactly how it should look like. Instead we propose to start with the Sustainable Sanitation Pyramid model as shown in Figure 20.

Figure 20: Sustainable Sanitation Pyramid



In this model we have 6 parties working together:

- A facilitator being the AC/HCWW and/or Local governorate could have role in collection fees for O&M;
- The community represented by CDAs, the demanders of the services and responsible for payment of O&M fees, provision of the funds for the construction of the wastewater collection system and the provision of the land for the wastewater treatment system;
- The finance sector, if loans are needed. For the time being we assume that the Egyptian Government finances the treatment. The Local governorate could have role in collecting fees for O&M;
- A service provider: an entity which designs, constructs, operates and maintains the wastewater collection and treatment system;
- Temporary support by a facilitator, a local NGO like Together, which organizes the involvement of the community;
- An international NGO (or company, water board, water utility, etc.) who supports especially the service provider in adequate technical set-up of the system and supports the finance sector in developing innovative funding.

The feasibility study has the following phasing:

- Refine and elaborate the proposed rural sanitation pyramid (2 months):
  - Study the findings of the ESRISS project in detail;
  - Study examples of the utilization of service providers elsewhere;
  - Elaborate together with AC/HCWW and other relevant organizations a working model;
  - Assure political support for the sanitation pyramid;
- Select a region where the programme will be implemented so that efforts can be concentrated and the project can be implemented efficiently. Select a number of villages, say 30 (say 60,000 capita, assuming an average village has 2000 inhabitants) based on the methodology proposed in § 3;
- Assure financing of the treatment works for the first 10 villages. Assuming treatment costs US$250 per household of 5, AC/HCWW or another party needs to be prepared to invest US1 million;
- Develop a methodology in 10 villages:
  - Raise interest of the population;
  - Assess field conditions;
  - Find service provider;
  - Plan, design and prepare cost estimate of collection, treatment and reuse system;
  - Sign contract between village and service provider for at least 5 years of services;
  - Detailed design and tendering;
  - Construction.
  - Monitor, Evaluate and refine the methodology;
- Develop an outline for treated wastewater reuse scheme:
  - Crop pattern;
  - Irrigation system;
  - Impact assessment on soil, water table, health, crop quality and production, etc.;
  - Monitoring and Evaluation scheme;
- Develop an outline for faecal sludge management and reuse of faecal sludge:
  - Desludging services;
  - Intermediate storage;
  - Faecal sludge treatment;
  - Reuse.

Appendix 1: Terms of Reference

Terms of Reference for a consultant for the reconnaissance study on innovated sanitation facilities and treated effluent reuse for rural areas in Egypt

Background. In the context of the Water Mondiaal programme, Egyptian and Dutch experts jointly prepared a number of project papers on sanitation and wastewater management during fall 2012. The members of the Egyptian/Dutch High Level Water Panel selected the most relevant and promising project idea. The project idea, "Feasibility of Promoting the Application of Innovated Sanitation Facilities and Treated Effluent Reuse for Rural Area in Egypt", was selected by the Panel to be further developed in 2013. Consequently the Egyptian Holding Company for Water and Wastewater (HCWW) prepared an outline (enclosed) for a rural sanitation/wastewater reuse programme with the following objectives:

Improve the quality of life through treating the wastewater effluents at large scale for rural areas of Egypt so that the health risk will be reduced and the potential for wastewater reuse increased. The proposed project will promote the application of innovated sanitation facilities for rural areas in Egypt by conducting a pilot project as a demonstrated example. The experiences gained through this project will lead to:

- Improved sanitation coverage,
- Improved pollution abatement in the irrigation and drainage canals and
- Improved beneficiary services.

Promote treated wastewater effluents reuse, manure management and treated sludge application through development of the selected pilot scheme and involvement of private sector.

Based on the attached programme-outline of the HCWW and following the request of the Egyptian Government, the Dutch Water Mondiaal Deltateam has agreed to send a consultant to Egypt. His/her task would be to prepare for phase 1 and phase 2 of the attached programme-outline and to carry out a reconnaissance study as to determine the added value of the Dutch water sector in such potential rural sanitation/wastewater reuse management programme in Egypt.

Activities. More specific, the consultant will be asked to conduct the following activities:

- Clarify, adjust and confirm with the relevant stakeholders the attached programme-outline which was prepared by the HCWW;
- Conduct a field visit to Upper Egypt (El Minia and Bani Suef) for a quick scan of the potential project areas and prepare criteria for the final selection of the project areas;
- Identify/propose innovative and sustainable rural sanitation/wastewater reuse approaches that could be applied under the local circumstances in Upper Egypt;
- Assess the potential added value of the Dutch Water Sector in implementing such a rural sanitation/wastewater reuse programme in Egypt;
- Assess potential funding sources for the implementation of the programme and the possibility of setting up a business case;

- Prepare the outline for the feasibility study.

Outputs. The consultant is expected to deliver the following outputs:

- Reviewed, agreed and confirmed programme outline;
- Assessment of the potential project areas and a number of criteria for final project area selection;
- Suitable rural sanitation/wastewater reuse approaches proposed;
- Assessment of the Dutch added value in this programme;
- Overview potential funding sources and/or suggestions for financing mechanisms (business case);
- Outline for the set up of the feasibility study;
- A complete report of the mission; and
- Presentation of the results at the Egyptian-Dutch Panel meeting in June 12/13/14 in the Netherlands.

Required competencies of the expert:

- Extensive experience with rural sanitation and wastewater management;
- Good understanding of the drinking and wastewater sector in Egypt;
- Being able to think cross sectoral and link the various stakeholders involved;
- Relevant network in Egypt as well as in the Netherlands with links to private sector partners.

Conditions. Within the month May 2013, the consultant is required to go on mission to Egypt for a period of 6 days (leaving Saturday and returning Thursday). This includes 1 travel day and two days in-country travel to El Minia governorate and Bani Suef. For preparation and reporting the consultant may charge 3 days in the Netherlands. During the field visit to Egypt, the consultant is expected to work with a local expert on sanitation and wastewater. The consultant should present the results of the mission at the Eg/NL Water Panel meeting, which takes place mid June 2013.

Appendix 2: Terms of Reference Request for Proposal

Feasibility of Promoting the Application of Innovative Sanitation Facilities and Treated Effluent Reuse for Rural Area in Egypt

Version, 4 March 2012

1. Background

1.1 Dutch Water Mondiaal program

The Egyptian – Dutch Water Mondiaal program aims for a long term relationship between Egypt and Netherlands whereby government, private sector and knowledge sector (Golden Triangle) work together towards sustainable, financially viable solutions. The program has requested ideas for cooperation between Egypt and the Netherlands on the subject of Wastewater Management and Reuse.

APP organized several working group & scoping meetings and workshops to have more insight into views on the opportunities. The Egyptian and Dutch expert members prepared a number of project papers and the Panel members selected most promising projects. The project entitled "Feasibility of Promoting the Application of Innovated Sanitation Facilities and Treated Effluent Reuse for Rural Area in Egypt" has been selected for preparation and implementation in 2013.

1.2 Rural Sanitation Facilities in Egypt

For the majority of villages in rural Egypt, wastewater collection and treatment has lagged behind development of the water supply system. Most households in these villages have access to latrines or flush toilets connected to infiltration trenches or septic tanks, but the lack of adequate sanitation systems to remove the large quantities of wastewater, remains a serious problem. The situation is particularly dire in the Nile Delta and Nile Valley area where high population densities and an elevated groundwater table create unsanitary conditions. Most of rural areas have access to improved latrines connected to a septic system; others have simple unlined pits, and few households do not have any latrines at all. In addition, much of the septage evacuated from latrines and septic pits is discharged directly into nearby canals and drains, via pumps, evacuated trucks or direct gravity connections.

1.3 Potential for Treated Effluents Reuse in Rural Area

In Egypt, potential and acceptance of treated wastewater reuse is more pronounced as a result of:

- The increasing scarcity of alternative waters for irrigation exacerbated by increasing urban demand for potable water supplies and the growing recognition by water resources planners of the importance and value of wastewater reuse;
- The high cost of chemical fertilizers and recognition of the value of nutrients in wastewater.
- The demonstration that health risks and soil damage are minimal if necessary precautions are taken;
- The sociocultural acceptance of the reuse practice.

The amount of treated wastewater is about 8 to 9 MCM per day where only 1 MCM is primary treated. There is a plan to reuse treated wastewater in forest (150,000 feddans) located in Delta fringes and along the Nile valley in Upper Egypt. However, there is lack in communication among the involved ministries, which could be main reason not to have successful wastewater reuse schemes at large. So, there is a need to combine and tendering the wastewater treatment plant and wastewater reuse scheme together when possible.

1.4 Needs for the Proposed Project

Around 11 BCM of wastewater will be available by year 2030 representing 20% of our water share. Only 300 MCM of treated wastewater is directly reused each year. Another unknown quantity is reused mixed with drainage water. Potentially, most of the generated treated wastewater could be reused. There are many constraints facing wastewater reuse in practice. Lack of sanitation and treatments facilities in rural area is at top of these constrains. Economics of scale make conventional wastewater treatment and collection system cost prohibitive expensive in smaller more dispersed rural settlements. For full coverage of rural sanitation, it is estimated to allocate Egyptian Fund of 70 to 80 Billion LE by 2020. However, with latest development, economic crises and other interventions, it's not foreseen to achieve the target rural sanitation coverage.
It is obvious that there is a need to promote application of innovated sanitation facilities for rural areas including low cost treatment technologies, collection systems and treated effluent reuse. This idea will facilitate the thinking and the partnering needed to co-create innovations that will lead to sustainable business in wastewater sector adapted to rural area of Egypt.

2. Project Objectives

The main goals of the proposed project are to:

- Improve quality of life through treating the wastewater effluents at large scale for rural area of Egypt so that the health risk will be reduced and potential for wastewater reuse increased. The proposed project will promote application innovated sanitation facilities for rural area in Egypt by conducting pilot project as a demonstrated example. The experiences gained through this project will lead to:
    a. Improved sanitation coverage,
    b. Improved pollution abatement in the irrigation and drainage canals and
    c. Improved beneficiary services.

- Promote treated wastewater effluents reuse, manure management and treated sludge application through development of the selected pilot scheme and involvement of private sector.

3. The Project Area

The project will cover complete village administrative boundary in rural area of Upper Egypt. Selection criteria will be developed and initial selection for 4 to 5 villages will proposed in coordination with Holding Company for Water and Wastewater (HCWW). Final selection will be processed in the feasibility study phase. The project area could be located in area where reuse of treated effluents would be possible in new agriculture area (Potentially Bani Suef and Minia governorates).

4. Project Cycle and Phases

The project will be subjected to five phases as a typical turnkey project starting with preparing TOR and ending by Monitoring and evaluation as briefed below.

Preparation Stage

1. **Phase I**: Prepare Terms of Reference for the technical proposal phase

The objective of the present Terms of Reference (TOR) is to present the outline in how the technical proposal should be prepared considering all the mentioned tasks and aspects.

2. **Phase 2:** Prepare the technical proposal for the feasibility study

The proposal should show the methodology in handling the technical, institutional, economical and social aspects and evaluating any proposed intervention including sanitation facilities and reuse options for treated wastewater and sludge.

3. **Phase 3**: Prepare feasibility study and conceptual design

The feasibility study will cover in details all the proposed improvement interventions in terms of technical, institutional, economical and social dimensions. The final products would be proposal for sanitation facilities and treated effluent reuse scheme that would be fit with rural area of Egypt as well as conceptual design, implementation schedule, estimated cost and potential sources of finance for the proposed activities.

4. **Phase 4**: Detailed design

The Detail design study will cover in details all the integrated system of rural sanitation and reuse of treated effluent. The final products would be detail design, implementation schedule, estimated cost, tender documents and sources of finance for the proposed activities.

Implementation and Evaluation Stage

5. **Phase 4**: Implement the proposed activities recommended in the feasibility study

The implementation stage will cover the activities proposed in the feasibility study and detailed design for both sanitation facilities and reuse of treated effluent.

6. **Phase 5**: Conduct monitoring and evaluation for the implemented activities

To evaluate the project after construction for scale up purpose, there is a need to monitor and evaluate and project after implementation for couple of years.

5. Scope of Consultancy Service

The ***consultant*** should only ***present a proposal including detailed methodology***, ***and activities required to handle the feasibility phase*** covering the following tasks:

Tasks 1: Selection of the project area
The Consultant will present the approach and selection criteria of project area applied to initial selection for 4 to 5 villages proposed in coordination with Holding Company for Water and Wastewater (HCWW). Final selection will be processed in the feasibility study phase.

Tasks 2: Assessment of the current conditions in project area
The Consultant will present the methodology to assess the overall collection and sanitation facilities, wastewater effluents and reuse practice, manure and solid waste management conditions in the project areas, including the social and institutional aspects related to these services. The Consultant will present the methods to assess the existing sanitation and solid waste management situation in the project area; this would consist in the identification and the collection of all data and existing information related to the project area; the information to be collected would cover, but not limited to: physical, social, economical, institutional, legal and environmental aspects. An initial institutional stakeholder's review and the consideration of existing engineering studies should also be included in this initial task of the project. For this purpose a comprehensive documentation and data assembly effort will be required. It is expected that the various involved agencies will be contacted, for delivering full inventories of available material.

Task 2: Strategic Sanitation Plan of Project Area
The Consultant will present ***his concept*** in developing a general sanitation infrastructure plan for the project area, as the result of an integrated multi-criteria evaluation process (vicinity, existing WWTP, PS, wastewater effluent.. ect) . Existing successful experience or similar projects already developed in Egypt should be considered in the selection of solutions that will be considered in the Strategic Sanitation Plan. The development of the Strategic Sanitation Plan should be based on an integrated approach that considers the interaction that these activities have with the water resources, the environment and with the social and economical characteristics of the communities in the area. The best alternative selection, to be proposed in the Strategic Sanitation Plan, should be the result of the application of a **multi criterion decision** process, that considers not only the economical technical, institutional, environmental and social aspects of each alternative, but also the perception and opinions of all related stakeholders, especially the ones from the involved communities. Outline of treated wastewater reuse scheme is part o the developed strategy including potential area to be irrigated with the treated effluent, proposed irrigated crops, irrigation methods ..ect.

Through out the consultant concept, technology alternatives should consist of simple and low cost solutions that have proven themselves through successful experiences around the world. Keeping proposed solutions simple and with low cost, according to the local conditions so that people can afford and maintain them is one of the major objectives of the project. The Strategic Sanitation Plan should be accompanied by the social and institutional development/capacity building programs which are considered necessary to allow the local related institutions to be able to design, construct, operate and maintain the infrastructure proposed by the Strategic Sanitation Plan. The consolidated Strategic Sanitation and treated effluent reuse Plan should indicate the type, main physical characteristics, location, level and type of waste water treatment when applied for each system proposed, presenting an estimate of the investment, operation and maintenance costs for each proposed system.

Task 3: Feasibility Analysis

The ***Consultant*** will present his ***methodology to carry*** out studies of the technical, financial and institutional feasibility of the proposed alternatives of innovated sanitation facilities scheme including:

- Collection system
- Treatment technologies
- Manure treatment and management
- Sludge treatment and management
- Treated effluent reuse scheme including :
  - Potential allocated land for reuse scheme
  - Proposed cropping pattern (potentially cash crops)
  - Recommended Irrigation methods
  - Outline of the monitoring and evaluation scheme

The feasibility analysis should include but not necessarily limited to:

- Land acquisition
- Technical feasibility
- Operating procedures and maintenance requirements
- Role of the beneficiary communities in service provision
- Details of supporting activities such as community mobilization, training needed to plan, construct, operate and maintain proposed facilities
- Proposed coordination mechanism among key ministries at the local level for planning and management of interventions
- Proposed agriculture activities (cropping pattern).
- Institutional and organization (Roles of the involvement key players)
- Monitoring and evaluation program
- Establishment of the financial viability of proposals
- Costs estimates, and implementation schedules
- Ideas for cost recovery mechanisms
- Contracting capabilities

- Business case and model for micro finance

The main features of the selected option are:

- Simple to operate and maintain
- Limited skill is needed for operators
- Low energy consumption
- Low capital investments
- Low operation and maintenance cost
- Possibility for scale up

Task 4: Detail Design

The results of the feasibility analysis should be concluded by selection of the most viable alternative for all project elements and approved from concerned parties. The consultant will present his ***approach in handling*** design elements including:

- Collection system
- Treatment technologies
- Manure treatment and management
- Sludge treatment and management
- Treated effluent reuse scheme and management including:
    - Allocated land for reuse scheme
    - Proposed cropping pattern (potentially cash crops)
    - Irrigation scheme
    - Monitoring and evaluation scheme
- Tender package

Pilot project will be implemented in coordination between Egyptian and Dutch sides. Technology development will be implemented through co-operation between Ministry of Water and Wastewater Utilities, private sector and research institutes & consulting firms.

6. Organization

- The target group to handle the proposal is a Dutch expertise that has a wide experience in sanitation facilities in Egypt or similar countries.
- The workplace will be Cairo with possibility of few field trips to some rural area.
- The selected consultant will work closely with AAP office and representative(s) from Holding Company for Water and Wastewater (HCWW).

Appendix 3: Itinerary

Date	Activity	Venue	Persons
18/5/13	Preparation Travel to Egypt (evening flight)	Amsterdam - Cairo	
19/5/13	Kick off • Advisory Panel Project on Water Management (APP); • Holding Company Water & Wastewater (HCWW) • Discussion ToR Mission; • Briefing situation rural sanitation Egypt; • Contacts rural sanitation initiatives; • Planning program mission	Cairo	• Dr. Samia M. El-Guindy, Director APP (+20122318556, app@link.net); • Dr. Magdy Salah El-deen, Assistant Director APP (+20124557926, app@link.net); • Ashraf El-Sayed Ismail, counterpart, (+201227835558, ashsayed@hotmail.com); • Dr. Ahmed k.Moawad, Head Technical Support and Planning Section HCWW (+ 20122159841, ahmed.moawad@hcww.com.eg); • Gamal El- Masry, wastewater manager HCWW (+201200060607); • Eng. Nasser Taha Nasser, O&M wastewater manager (+201200005232, nassertah64@yahoo.com) • Mohamed Abd El-Moniem HCWW; • Ashraf Shaheen.
20/5/13	Field visit Rural Wastewater Treatment Scheme NGO Together	Bani Suef	• Eng. Anwar M. Manaf, Sanitation Head Wastewater Sector • Bani Suef CWW, formerly Chemonics International (+201224850795, anwarmanag@yahoo.com) • Sameh Seif Ghali, Executive Director Together (www.together-eg.org, +2010019190, sameh.seif@together-eg.com)
21/5/13	Field visit • UASB Fayoum CWW • Rural Wastewater Scheme Ministry of Irrigation	• Sanhour, Fayoum • Zawyat El-Karatsah, Fayoum	• En. Hosni Mohamed El- Sayed (Consultant ECG) • Villagers
22/5/13	Discussion preliminary findings with HCWW and Egyptian-Swiss Research on Innovations in Sustainable Sanitation (ESRISS);	Cairo	• Prof.Dr.Rifaat Abedel Wahaab, General Manager ESRISS (+20125187971, rifaat.abdelwahaab@hcww.com.eg); • Philippe Reymond, Project Coordinator Sandec (+201064834314, philippe.reymond@eawag.ch)

Date	Activity	Venue	Persons
	Discussions preliminary findings with APP		• Dr. Samia, Dr. Magdy, Ashraf.
23/5/13	Debriefing HCWW and courtesy call Royal Netherlands Embassy in Cairo	Cairo	• Tarek A. Morad, PhD., Deputy Head Economic & Development Cooperation Department (+20 (0)2 2739 5500 ext. 561, tarek.morad@minbuza.nl) • Mr. Joost Geijer, Agricultural Counsellor Ministry Economic Affairs at the Embassy (+201068826162, KAI-LNV@minbuza.nl).
24/5/13	Return to the Netherlands Early morning flight	Cairo - Amsterdam	
29/5/13	Discussion draft with NWP and Delta Team	The Hague	• Koen Overkamp, NWP, k.overkamp@nwp.nl; • Monique van der Straaten, Partners for Water, (monique.zwiers@agentschapnl.nl); • Nicolette Koopman, Water Mondiaal, Ministry of Foreign Affairs, (n.d.l.koopman@minez.nl); • "Bas Boterman, NWP (b.boterman@nwp.nl)
6/6/13	Handing in final report	The Hague	
14/6/13, 14.00 hrs	Presentation findings to Panel	Rotterdam	

Appendix 4: Findings mission

4a. Briefing situation rural sanitation Egypt

(Interview Dr. Ahmed k.Moawad, Head Technical Support and Planning Section HCWW)

- Overview existing situation:
  - Egypt has 4000 villages and 29,000 hamlets (< 500 inhabitants);
  - There is no Open Defecation in Egypt: because of religious reasons, everybody has a toilet. However only 50% of the toilets (42 mln people) are provided with an environmentally sound treatment system;
  - Costs:
    - Wastewater O&M costs HCWW around LE 0.75 per m3 whereas 8 piaster per m3 is collected from the community;
    - For drinking water costs are LE 1.2/m3 and 50 piaster/m3 is the maximum price and 23 piaster/m3 the average price;
  - Problems encountered:
    - People dump manure in the sewerage which overloads the treatment system;
    - Ascaris ova are still found in the faecal sludge;
    - Biogas produced in systems is not used, just flared.
- New developments:
  - The Swiss funded ESRISS project advises the World Bank on the implementation of rural sanitation in Egypt;
  - The Egyptian government started to reassess the current procedures for treated wastewater reuse in agriculture;
- Biggest challenge for HCWW is to cover the small villages with adequate sanitation.

4.b. Field visit Rural Wastewater Treatment Scheme NGO Together

(Bani Suef, Interview Anwar M. Manaf and Sameh Seif Ghali)

- Mr. Anwar M. Manaf has recently joined HCWW. He took 10 years leave without pay to work for Chemonics. He worked 5 years in the Fayoum project with Royal Haskoning;
- Eng. Anwar M.Manaf designed the system in Bani Suef. Bani Suef is a small village with piped water supply (consumption: 80-100 litres per capita per day). All houses have a flush toilet. The wastewater is collected in a sewerage system and then pumped to a treatment plant. The treatment plant is located on government land along the drainage channel. The treatment plant receives water from two villages (3000 persons, 200 households) and consists of the following steps:
  - Sedimentation in 3 concrete tanks;
  - Aeration over a weir and by injecting compressed air;
  - Reed bed;
  - Disinfection by sunlight in shallow concrete basin;
  - No reuse: sludge is disposed into the drainage channel;
  - Sludge drying;
  - On a trial basis sludge is digested in a sludge digester. Gas is collected in a steel gasholder.
- The system has been initiated by the NGO 'Together' with CSR (Corporate Social Responsibility) funds from Hermes investment group, who also funded the houses and other infrastructure in the village;
- The system was constructed in 2008 at LE 500,000 (US$ 100,000);
- Households pay LE 5 per month for O&M of the system. This is collected through the Community Development Organization (CDA).

Our observations on this system are the following:

- The concept of having an NGO operating a WWTP is very interesting and could be investigated further;
- The idea to construct this along the bank of a drainage channel is very interesting and can serve as an example;
- The design and operation is very complex for these rural conditions and the state of repair and water quality leaves a lot to desire: sedimentation was poor, reed bed does not function at all;
- There effluent is used in an indirect way through its discharge into the drainage channel that is also used for irrigation;
- Investment costs at US$ 500 per household are reasonable compared to other countries but may be elevated for the Egyptian context;
- The idea of biogas productions seems to be donor driven and not picked up by the operators.

Overall conclusion:

- Institutionally an interesting concept if it would be backed up technically by a competent entity;

- The system could be simplified;
- Biogas production received little interest.

Figure 21: Impression Bani Suef

Figure 22: Typical village toilet

Figure 23: Water meter

Figure 24: Pumping station

Figure 25: Sedimentation tank (right) and sludge drying bed (left)

Figure 26: Lay out Bani Suef (Courtesy Eng. Anwar M. Manaf)

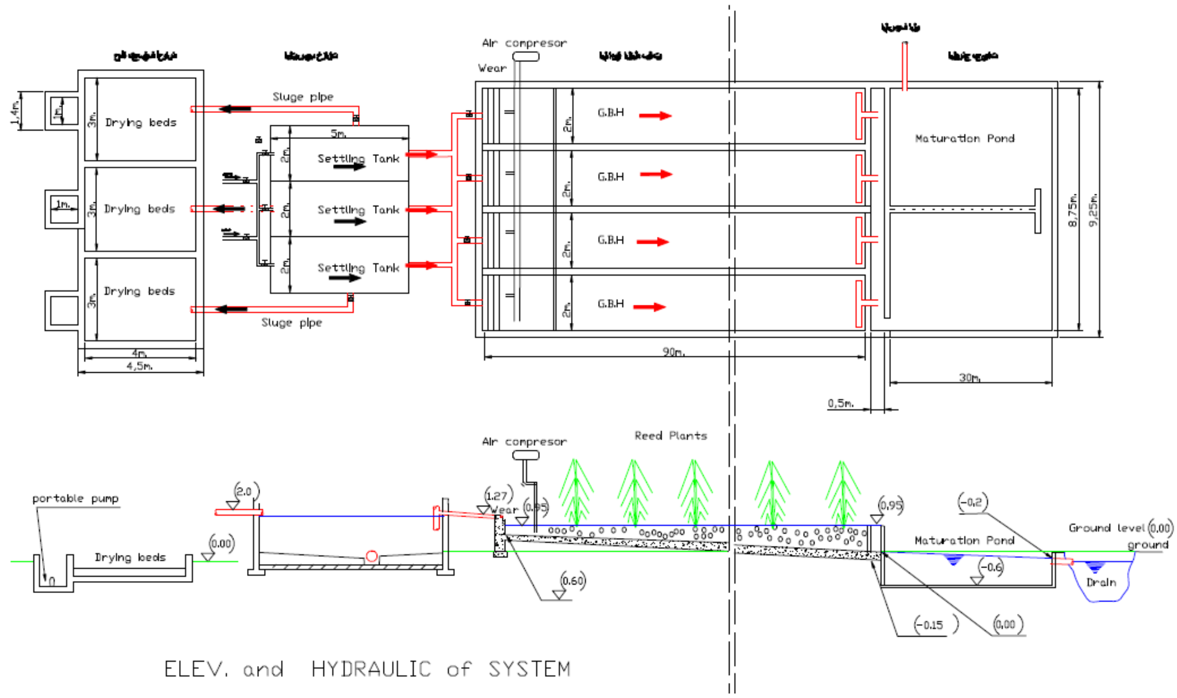


Figure 27: Cross section reed bed

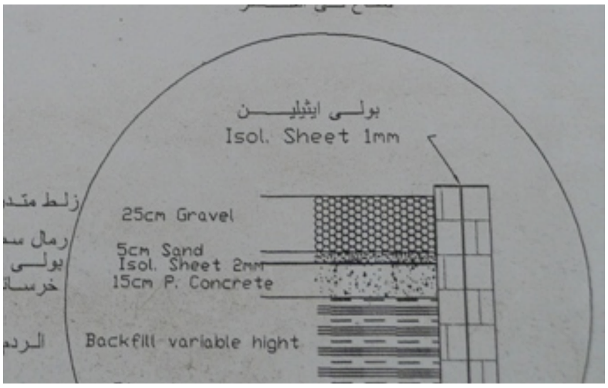


Figure 28: Aeration: cascade and compressed air

Figure 29: Reed bed

Figure 30: Disinfection

Figure 31: Discharge into drain

Observations from ESRIFF (Source: Philippe Reymond, e-mail dated 27 May 2013)

The sanitation system of Together Association in Sheikh Yacoub is one of the more complete so far; it encompasses an integrated approach, with a compact and well-maintained maintained infrastructure, awareness raising and capacity building components as well as financial sustainability for O&M. The association is backing up and monitoring the initiative, with the support of Beni Suef Affiliated Company. This initiative is quite recent and its evolution should be monitored, especially the performance of the plant, the discipline of the population as well the success of fee collection by the CDA; the NGO is just starting with collection of fees, which should be followed-up, as it can be a source of problems. Until now, everything seems to run smoothly and it leaves a good impression. It must also be acknowledged that this is a quite unique situation, as the whole village has been rebuilt by the project, easing also the planning of the new sanitation system.

Technical pros and cons are summarized in the table below.

SHEIKH YACOUB - Together Association	
Pros	**Cons**
• the WWTP is above ground, thus easy to operate and maintain; the wastewater is pumped once, and then flows down by gravity; sludge can very easily be removed from the settling tanks by gravity • strong implementing NGO • strong community building process • integrate approach to rural village development	• sludge is not stabilised in the primary settling tanks • clogging of the gravel beds • horizontal filter may be partly anaerobic, thus reducing its performance • infiltration into the ground from gravel filters ? Swiss mission observed reduced outflow • Doubtful usefulness of “oxidation channel”

• link with Beni Suef Affiliated Company for effluent quality monitoring	

Clogging of the gravel beds is, according to us, the main threat on the system. During our visit, the gravel of the beds was in the process to be cleaned/replaced. We could see that, at least on another bed, there was some surface flow, showing that it was also experiencing some clogging. Cleaning/replacing gravel is not an easy task, and it is far from guaranteed that every community would do it when needed. What it is more, it has to be considered that at each cleaning/replacement, the plants have to be replanted and time is needed until they reach their full development, guaranteeing an optimal performance of the bed.

It would also be good to measure the efficiency of the aeration of the system.

4.c. Field visit UASB Reactor Sanhour (Fayoum)

- AC/HCWW is presently upgrading and extending the UASB Reactor at Sanhour: the trickling filters have been removed and are being replaced by aeration tanks. In addition the UASB is being extended;
- It was explained that the operation of the trickling filters was cumbersome; especially after installation of the UASB. The Dissolved Oxygen in the effluent of the UASB was nil and the flow was intermittent. The distribution of wastewater on the tricking filters was problematic;
- Because of the construction works, the UASB Reactor performed not as it should. EKN[3] explained to us at the end of the mission "*that what we visited was effectively a construction site where the current WWT plant is being expanded (phase II) and where the polisher was being replaced (to enable the plant to comply with the 'current' environmental laws/discharge standards). The plant is not functioning at the moment; however, it does receive wastewater from the three villages connected to it, however, this is effectively only being collected and not being treated in view of the fact that the plant major parts of the plant are disconnected (a construction site). The situation now is obviously very different from when the WWTP was functioning under normal operational circumstances under supervision from management as well as the health authorities/inspectors. The WWT plant has been functional for a number of years (the problem was the trickling filters/polishers)".*

Overall conclusion:

- In principle UASB Reactors could be appropriate for larger rural sanitation systems. Its merits could include ease of operation and lower costs of operation, small physical footprint, ease of maintenance, etc;
- The suitability of the UASB technology for small village systems still needs to be proved. Hence, we agree with ESRISS that "*Based on experience and research results, UASB is not recommended for ezbas; it is premature in the current situation (Dr. Rifaat Abdel Wahaab, personal communication). It has to be mentioned however, that UASB is a very effective technology, which works well in many countries. Solid-liquid-gas separation is however very sensitive and necessitates great care"* (ESRISS report, page 23).

[3] Email Mr. Tarek A. Morad, PhD. Deputy Head Economic & Development Cooperation Department on 30 May 2013.

4.d. Field visit WWTP AT Zawyat El-Karatsah, Fayoum

- The system in Zawyat El-Karatsah is designed by Tarek Sabry, Ahmed El Gendy;
- It serves a village of 180 households, 1000 persons. The construction (2009) costed LE300,000 (US$ 60,000), so US$ 333/household. The local community paid the collection system and every household pays monthly LE 10;
- It consists of a sedimentation tank followed by 3 Anaerobic Upflow Filters consisting of gravel and plastic media. Length = 16 m', width = 7m', height = 4m';
- The system is constructed by the Ministry of Irrigation (MWRI) and operated by the Ministry of Local Governments;
- The tank is being desludged every 6 months. At that moment the sludge layer is 40 cm thick and 20 cm is removed to keep an active biomass in the system;
- Once every 18 months, the system is being cleaned by high pressure water;
- It is unclear where the sludge is being transported;
- The effluent is not reused, just discharged into the adjoining drain.

Figure 32: Settling tank and anaerobic upflow filter (in the field only 1 settling tank)

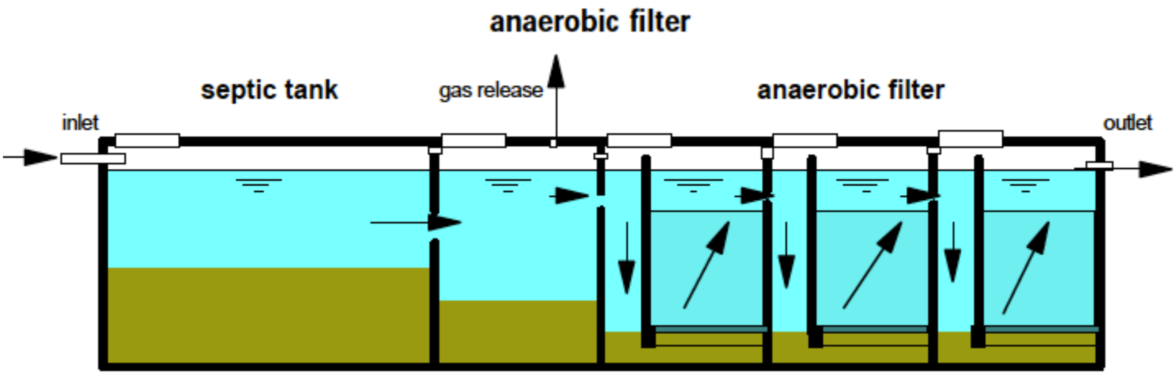


Figure 33: Settling tank and Anaerobic Upflow Filter

Figure 34: Effluent

In general the advantages of this system are:

- Simple and fairly durable if well constructed and wastewater has been properly pre-treated;
- High treatment efficiency;
- Little permanent space required because of being underground.

In general the disadvantages are:

- Costly in construction because of special filter material;
- Blockage of filter possible;
- Effluent smells slightly despite high treatment efficiency.

Overall conclusion:

- This system appears to be a very suitable solution for rural Egypt provided the Government is relaxing standards for disposal into drains.

4.e. Discussion with ESRISS

During the mission we received the report of ESRISS of December 2012. This was discussed along with the preliminary findings of the mission as shown in Appendix 5:

- On reuse: we noted in the report of ESRISS that reuse hardly gets any attention. ESRISS has concluded that reuse of effluent is fairly complicated:
    - Farmers need water at other times than that effluent is being generated. Hence an expensive storage reservoir would be required;
    - In any way, farmers take the water from drainage channels so in principle reuse is being practiced whatever is the official policy;
    - Nevertheless, 'official' reuse will be more important in upper Egypt than in lower Egypt;
    - Reuse of biogas needs more study in the Egyptian context before it can be promoted on a large scale;

- According to ESRISS, selection of wastewater technology should depend on the sensitivity of the receiving surface water;
- Separation of black and grey water and reuse of grey water following simple treatment is only feasible in new housing estates;
- ESRISS is not aware of any adverse effects on treatment systems in Egypt as a result of 'hard' soap or 'grease', as witnessed by the mission in ABRs in South Africa;
- JICA is also very much interested in contributing towards sanitation and is preparing an 'in stream' pilot using solar power;
- ESRISS thinks sludge drying is (becoming) a problem and interested in the application of mobile sludge dryers;
- ESRISS is very interested in prefabricated units;
- Other comments have been taken into account in the screening of technical alternatives.

4.f. Discussion with Royal Netherlands Embassy

- On the institutional set-up Mr. Tarek mentions the fact that Netherlands assisted projects have tried to get the Egyptian water user association (water boards) interested to assume responsibility of the sanitation systems. However, this was a complicated matter and not very successful because of other interests;
- As far as lack of environmental awareness is concerned, the reporting of villagers on (illegal) discharge of wastewater by villagers has assisted in triggering actions;
- The embassy is very much interested in reuse and is certainly in favour of including actions on chicken feed production, bio-gas generation, etc. in the reuse options;
- The same accounts for 'on-site' household systems: there might be instances where this is of interest in the Egyptian context;
- On financing, there is an interesting experience with meso-financing were the Governor of Fayoum was able to generate LE 5 million in an afternoon. Unfortunately this was a one time experience;
- Regarding capacity building it is worth mentioning the opportunities for the Dutch Water Sector (Waterschap Aa en Maas/ Marit Borst, Waternet/ Paul Bonné) and the NICHE project headed by Mr. Ahmed k.Moawad and facilitated by MottMacDonald (Caroline Bakker). These initiatives could and should certainly play a role in creating the enabling environment for rural sanitation;
- The embassy strongly advises the mission to come forward with very concrete steps to make rural sanitation a success.

Appendix 5: Summary ESRISS report: Small scale sanitation in Egypt: challenges and ways forward

Objectives. Extensive sector analysis based on meetings with most sector stakeholders in Cairo (Ministries, utilities, research institutions and consultants) has led to the conclusion that there is a great need for the development of cost-effective, context-appropriate and replicable small-scale sanitation systems for settlements not covered by present or future large-scale centralized schemes. By “small-scale” we refer to “settlements or groups of settlements of up to 5,000 inhabitants”. This need is reflected in the ISSIP project, where solutions are currently needed for villages with a population up to 1,500 inhabitants.

The development of a wide-scale replicable model for the Nile Delta is the ultimate goal of the ESRISS Project. In order to achieve that, the first step is to analyse the past experience of small-scale sanitation in Egypt and understand the reasons behind the success and failures. This report is the result of this analysis and provides a comprehensive review of all factors influencing small-scale sanitation systems, with recommendations for future projects.

Methodology. Different methods were used to build our assessment: (i) Interviews with key-stakeholders of the sector to identify the existing initiatives, gather the sparse data, available knowledge and experience; (ii) a thorough literature review; (iii) Selection of the most prominent initiatives, field visits, assessment with evaluation questionnaire and analysis of samples at the National Research Centre (NRC).

The main matrix of analysis is the enabling environment framework. It structures the factors that impact projects’ success and failures into six components: government support, legal framework, institutional arrangements, skills and capacities, financial arrangements and sociocultural acceptance. Thus, all the components of sanitation systems are assessed comprehensively. Technical factors are analysed separately. In the first part of the report (Chapter 3), the identified challenges are discussed, component by component. The main challenges observed are described, and suggestions for improvement are formulated. These challenges are synthesised in a table at the end of the chapter. Then, the second part (Chapter 4) provides practical recommendations for small-scale sanitation project design. This directly relates to the tasks that consultants have to carry out in sector projects such as ISSIP.

Background. The Nile Delta is a very challenging area, with very dense housing, growing pressure on the agricultural land, high water demands and high population growth. Villages of the Nile Delta are now served with water supply, but few of them already benefit from proper wastewater collection and treatment. There is a clear demand to properly dispose of wastewater in small communities, with some of them building “informal” or “groundwater lowering” sewer systems. Otherwise, people rely on on-site sanitation. In both cases, wastewater and sludge are dumped in the nearest water body (drain or, often and illegally, canal) or directly on agricultural fields. At the same time, the situation is worsening due to rising water tables caused by perennial irrigation and increased provision of drinking water, often leading to the malfunctioning of existing on-site treatment facilities. So far, there is no viable small-scale system (including viable financial and management schemes) available for replication in Egypt. Most small-scale initiatives in Egypt did not stand the test of time or remained at a pilot stage.

Results and recommendations. This assessment reveals that isolation of existing initiatives and lack of commitment by the government agencies are significant factors preventing wide-scale replication. Indeed, none of the approaches tested so far has been institutionalised. Furthermore, fully community-based approaches do not appear to work in the Egyptian context. It is clear that HCWW and its Affiliates must play a pivotal role in the development and management of small-scale sanitation; collaboration and coordination with the other stakeholders of the sector (Ministries, communities, NGOs, researchers) should be fostered. So far, the sector is in a vicious circle as isolated initiatives remain prototypes and, as such, are not cost-effective, do not receive the attention required, are considered too expensive and/or prone to failure, and therefore are not replicated.

A clear governmental strategy is required to develop a standardised model for wide-scale replication. Standardisation of small-scale sanitation systems is needed to allow economies of scale, reduction of costs and an increase in quality. These systems should be modular and flexible. The use of prefabricated units, which could easily be manufactured in Egypt, for part of or for the entire treatment scheme, would be an added advantage. Standardisation also means that the systems could be managed by specialised units in the Affiliated Companies, or by a professional private company subcontracted by HCWW. Laws, regulations and Codes of Practice need to be adapted to this specific context, and innovative mechanisms should be put in place to allow full-cost recovery. An incremental approach should replace the current “all or nothing” philosophy, which has not served Egypt well. The legal and institutional framework should enable consultants to move beyond “business as usual”. Small-scale sanitation needs pragmatic answers. The assessment also reveals a lack of baseline data characterising sanitation in rural villages, leading to under- or over-dimensioned infrastructure. Animal manure and effluent of dairy factories need to be considered as parts of the sanitation system. Small-scale sanitation needs an integrated approach with tailor-made designs, coupled with a comprehensive preliminary assessment in each settlement. “Soft components” (e.g. preliminary interview of stakeholders and management schemes) must become an integral part of each design. Donors have a major role to play to foster integrate approaches. Specificities of small-scale sanitation should be reflected in the terms of reference, as well as in the tendering and bidding procedures. The non-technical components should be considered as a must and more flexibility is necessary to foster innovation and cost-efficient designs.

Finally, rural sanitation needs lessons learnt. Several projects have been implemented by different organisations and Ministries in the past, but lessons learnt are few and far between. Solutions need to be built incrementally. Failures should be documented and analysed, in order to avoid them in future. It is strongly recommended that HCWW create an online library and repository on its website, to collect reports and experiences done in Egypt. It would help any motivated agency, NGO or interested individuals to take up rural sanitation challenges.

3.8 Synthesis table of challenges and opportunities

	CHALLENGES	*OPPORTUNITIES*
Tech. factors	**Design parameters:** - lack of baseline data (characterisation and quantification of rural wastewater, water consumption, description of villages and existing practices) for dimensioning systems adapted to rural villages; design parameters not adapted to the specificities of the Egyptian rural context - underdimensioning leading to poor performance or overdimensioning leading to high costs and sometimes also reduced performance - lack of baseline for forward planning, i.e. how settlements, water consumption and small-scale industries develop - high population growth, leading to quick overload if underestimated - high water consumption, increasing as the water supply improves; future water supply improvements must be taken into account - lack of flow measurement (even in big treatment plants); inflows highly variable, not buffered as in urban contexts - higher concentrations in rural contexts - manure dumped in the sewer system, often not taken into account in the design - dairy factories and other small- and medium-scale "industrial" activities may imply extra peak loads; future economic development must be anticipated. - high concentration of inert material, like sand, mainly due to non-asphalted roads - no storm water drainage system: stormwater is derived into the sewer network, carrying sand and mud. A stormwater overflow is needed in front of the treatment units - high groundwater table and/or clayey soils leading to higher construction prices **General design features:** - lack of hydraulic design - lack of proper sludge management (desludging, treatment and disposal) **Environmental factors influencing the cost of infrastructure:** - high groundwater table	*- Sequence the system in different component, whose design and implementation can be delegated to experts that really master their respective component* *- Work closely with several local contractors rather than one big governorate-level contractor* *- Prefabricated units are a promising alternative, saving time and money and increasing quality control.*

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Tech. factors	- type of soil (sometimes clayey in the delta) **Availability of land:** - land is both expensive and precious - difficulty to extend WWTPs with large footprint; limited flexibility **Cost comparison:** - focus on construction cost only, and not on entire *life-cycle* costs. - cost of land often not taken into account when comparing technologies **Quality of the work:** - some consultants and contractors seem to confound "low-cost" with "low-quality" - some contractors are not reliable and don't deliver work with the quality required - lack of quality control by concerned stakeholders **Hindrances for innovation:** - lack of learning culture and constructive criticism; focus on "business as usual" - contractors shy away from innovative systems; they tend to be very conservative; this may be encouraged by the legal and regulatory framework and agencies like NOPWASD. - culture based on seniority; young people have difficulties to impose their ideas - consultants who tend to make patents and sell their system as a whole (or as a turn-key system) - systems judged without thorough analyses (e.g. UASB and small-bore sewers)	

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Government support	**Rural sanitation strategy:** - wide-spread view that everything shall be connected to big centralised WWTPs - wide-spread view that the government shall provide everything and that it is not the role of the communities to take over rural sanitation - lack of strong rural sanitation strategy - economic and political crisis, accentuated by the Revolution - lack of finance and skilled labour **Policy for full-cost recovery:** - lack of GoE political will to raise water and wastewater fees to achieve full-cost recovery - lack of political will to use the police to enforce environmental laws and collect water bills - little means for leak detections and water flow measurements, leading to lump sum payments that are below the actual consumption and high non-revenue water **Policy for decentralisation:** - reluctance for decentralisation and delegation of power	*- Rural Sanitation is now taking centre stage in Egypt* *- Revision of the National Rural Sanitation Strategy* *- On-going work on Rural Master Planning by HCWW and GIZ*

Legal and Reg. frame-work	**Standards and Codes of Practice:** - standards are not adapted to the rural context and are difficult to meet with cost-effective systems - Codes of Practice are not updated and may lead to design mistakes. - some low-cost options are not in the Codes of Practice (e.g. small-bore sewer systems) - the regulatory framework encourages consultants and contractors to apply strictly the Codes of Practice in order to cover themselves. **Tariff regulation:** - very low water tariff, which does not allow full-cost recovery - difficulty to raise taxes in the current context - dilemma for communities between "bear the existing conditions for some years or decades and pay less" or "pay more and improve their standards of living in a short time". **Legal basis to decentralise responsibilities to communities:** - legal framework does not encourage delegation of responsibilities to the communities and decentralisation in general (overly centralised state) - associations (e.g. CDA) cannot penalise bad payers or violating acts, as they do not have any judicial authority **Contract management:** - low-cost often associated with low-quality - need to sell small-scale projects in packages, to make them financially more attractive - need for adapted contracts which increase the responsibility and accountability of consultants and contractors **Enforcement of laws and regulations:** - difficulty, in the current context, to enforce environmental laws and collect taxes - managers of government-owned WWTPs are protected, but not private ones.	*- New Water and Wastewater Sector policies developed by EWRA and GIZ, focusing on water tariffs*
Instit. arrang	**Institutional setup of the sector:** - number of different Ministries involved in the WW sector makes initiatives complicated; lack of clarity in the definition of the roles & responsibilities of the principal sector organisations - lack of coordination among Ministries, especially between HCWW and NOPWASD (and MWRI) - general lack of communication and exchange of information	*- New Ministry of Water and Wastewater Utilities taking under an independent umbrella HCWW, NOPWASD and EWRA.* *- Dual management model currently investigated by RODECO-GIZ and HCWW's*

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Instit. arrang	between and within institutions - lack of transparency and dynamism of NOPWASD - lack of institutional framework specific to small scale sanitation - politics of "everything or nothing" that hinders the development of intermediate solutions **Linkages between private service providers/NGOs and line agencies:** - HCWW is not responsible for collection and treatment from on-site sanitation systems; unsewered systems are not considered as proper sanitation systems - Missing link between on-site sanitation service providers and line agencies, as well as between NGOs and line agencies **Management capacity of communities:** - communities lack capacities to operate a full sanitation system themselves; supervision and support is necessary - wide variability of CDAs, making a careful selection crucial - potential conflict of interest between CDA and misusers from the community - lack of power of CDAs **Management interface between communities and institutions:** - no management interface between communities and Affiliated Companies - no or very little interaction between Affiliated Companies and the leaders of small-scale sanitation initiatives. **Linkages between research sector and line agencies:** - gap between governmental agencies and the research sector (e.g. academics and policy-makers) - need for the line agencies to encourage research and pilot full-scale implementation, and bridging the gap between academics and engineering consultants; academics often lack the technical skills to implement a system at full-scale and the financial power to do so - research institutes themselves tend to work in isolation - most professors are mainly consultants **Managing consultants and contractors:** - lack of control and regulation of the sector - loose definition of roles and responsibilities, implying a lack of accountability and that, in the end, everybody can blame somebody else - tendency to choose different consultants for the feasibility studies and for implementation, which reduces accountability	*legal advisers* *- HCWW will progressively uptake former NOPWASD responsibilities (timeframe not yet determined)*

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Instit. arrang	and strengthen the "blamogramme" - project cycle (design, construction, O&M) divided between different institutions. - so-called "Habibee society" and "Habibee economy", where everything works through "friends" network and where people protect each other; possibility of conflict of interests. - small sector, where everybody knows everybody and where key-players play a dominant role. - lack of transparency in the sector: no dissemination of information; difficulty in seeing mistakes as valuable experience; special "arrangements" within institutions and consulting companies - collusion between consultants leading to drastic price hikes - nobody to push consultants to improve from one project to the other **Role of donors:** - many projects focus on infrastructure and lack an integrate approach of sanitation - ToRs written by donors often fail to include important aspects such as capacity-building, O&M and system monitoring or those components end up neglected when implementing the project. Donors are often satisfied with the appearance of the WWTP on the inauguration day - initiators (donors, governmental institutions) and consultants tend to privilege their image and hide problems; reasons for failures are often not (seriously) investigated and rarely published - bidding and tendering procedures that are too complicated for small-scale sanitation and increase the costs, hindering replication potential. - if the whole project is delegated to one single contractor, he will tend to give a package price, which is usually much higher than the sum of the components; this threatens cost-effectiveness and makes control of expenses and quality more difficult - lack of cooperation between development agencies (though a donor platform exists) **Institutional memory:** - lack of institutional memory; lack of detailed reports on lessons learnt - no centralised library at HCWW - lack of follow-up of projects	

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Skills and capacities	- availability of skilled human resources is limited - lack of capacity-building; capacity-building is needed, even with simple systems - lack of skills specific to small-scale sanitation systems among the consultants and contractors- wastewater sector largely dominated by technical engineers, lacking the integrate approach of sanitation systems (i.e. including financial & management schemes and socio-cultural acceptance) - limited capacities available within the Affiliated Companies, especially for monitoring of plants (data are collected, but rarely analysed; treatment processes are often not understood); awareness raising about the benefits of small-scale sanitation are needed. - awareness of the population - brain drain	*- Training centres implemented by Dutch cooperation and USAID (e.g. in Beheira)*
Financial arrangements	**Capital costs:** - difficult to get the *real price* of the system, without overheads; the system should be divided in smaller components in order to facilitate the monitoring of expenses - contractors that raise prices to unrealistic heights (link to risk covering and sometimes collusion/corruption) - economy of scale is lacking so far **O&M costs:** - no full cost-recovery because of very low water tariff, difficulty to collect water bills, high non-revenue water - equity principle that prevents HCWW to collect extra money in communities to cover O&M of decentralised WWTPs - without an extra financial input from the communities for the regular O&M of their infrastructure, proper maintenance is not possible	*- Possibility to finance water meters for the project area* *- Connected households pay less than unconnected ones: a driver for improvement*

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Socio-cultural acceptance	**Dealing with the environment:** - lack of education in rural areas, lack of awareness about hygiene and environment quality **Commitment of CDA / villagers:** - villagers are very interested in wastewater collection, but not so much in treatment; their priority is the construction of a good sewer network - lack of awareness on the actual price of water and wastewater service and lack of willingness to pay (even if the capacity to pay is there, as shown by the money spent for mobile phones) - communities from the Delta have been "spoilt" by international aid - people from the Delta are very individualistic - lack of initiatives in community development **Lack of O&M culture:** - lack of O&M culture ("rent capitalism") **Lack of lessons learnt:** - dissemination of lessons learnt is a major gap - "failure" and "mistake" tend to be taboo words - culture of secret regarding information; "information is power" - lack of follow-up from donors and implementing agencies; donors or implementers are sometimes afraid for their own image and, in order to hide project failures, may avoid publishing anything negative.	*- GIZ and ESDF community mobilisation experience*

Table 1: Challenges and opportunities of rural sanitation in Egypt

Appendix 6: Background prioritization

To assist in a systematic assessment of potential project areas, we propose to use a model for behaviour change, based on Poiesz[4]. This model distinguishes between 'Motivation', 'Capacity' and 'Opportunity'. The model is explained using an example:

Mr X currently has no household sanitation facilities. The decision whether or not to construct a household toilet depends on his **motivation**. He can be motivated because he would like a clean toilet in his house for his family, especially so the female members of his household do not have to walk outside in the dark. However, even if he is motivated but does not have the funds to purchase a new toilet and/or if he does not know how to construct one (**no capacity**), the facility will not be constructed. But, if he is motivated and has the capacity, but other factors prevent him from doing so (i.e. if he has no room at the premises and/or if the groundwater table is high and/or the soil is impermeable and/or if his house is far from the city sewerage = no opportunity), he will still not be able to construct his toilet. It is therefore important to assess each situation in order to invest most effectively in achieving the goal.

Unlike most models, the Triad model uses a **multiplication** to assess the 'T' score.

If during an assessment it is found that the motivation is 50%, the capacity is 10% and the context is 100%, the T-score = 0.5 * 0.1 * 1 = 0.05 (5%). If the energy is put in raising the 'Motivation' with 10% (as is the case with most Sanitation programmes) the T-score becomes: (0.5+0.1) * 0.1 * 1 = 0.06 (6%), an increase of only 20%. However, if the energy is put in raising the 'Capacity' with 10%, the T-score becomes: 0.5 * (0.1+0.1) * 1 = 0.1 (10%), an increase of 100%!

Motivation deals with the **willingness** of a household to implement and use sanitation. On the one hand motivation can be intrinsic, and specific to the individual:

- **Interests,** for example: *"Mr X is interested in new technologies, so he wants to have a modern wastewater treatment technology"*;
- **Desires,** for example: "*Mr X likes to have guests and wants them to have clean facilities to use at his house"*;
- **Purposes and aims,** for example: "Mr X *knows that a good sanitation facility does not pollute the groundwater which his family uses as drinking water source*";

On the other hand, motivation can be extrinsic, steered by:

- **Social validation**, for example: "*Mr X wants to have a toilet because everybody else has one and he does not want to be left out";*
- **The fear from penalties**, for example: "Mr X h*as a toilet because that is demanded by the building code of his town. If he does not have one, he will get a penalty or: If he has one he pays a lower property tax".*

Cialdini, see below, has described six methods to increase motivation.

[4] Gedragsmanagement, Waarom mensen zich (niet) gedragen, Prof. dr. Theo B. C. Poiesz, 1999

Capacity deals with the **ability** of a household to implement and use sanitation. Intrinsic capacity has three aspects:

- **Financia**l aspects (ability to pay). For example: *"Mr X is farmer and has the capacity to pay for improved sanitation but only immediately after the harvest"*;
- P**hysical** aspects (ability to construct, operate and maintain). For example: *"Mr X is old and does not have a son to dig a pit for the improved sanitation facility"*;
- **Knowledge** aspects (ability to understand how a sanitation system is working). For example: if Mr X does not understand that bacteria and viruses can pollute his drinking water, he will not understand the importance of constructing a leaching pit above the groundwater level.

Opportunity deals with the aspects that stimulate or impede sanitation:

- Intrinsic aspects that people can influence such as 'time available'. For example: How much time does Mr X have available to work on the implementation of his sanitation facility?;
- Extrinsic aspects that individual households cannot influence. For example: planning and permitting system, high groundwater table, impermeable soils and high population densities that impede on-site sanitation systems.

Cialdini[5]defines six 'weapons of influence':

- **Reciprocation**. People tend to return a favour. Thus, the pervasiveness of free samples in marketing;
- **Commitment and Consistency**. If Mr X commits, orally or in writing, to an idea or goal, he is more likely to honour that commitment. Even if the original incentive or motivation is removed after he has already agreed, he will continue to honour the agreement.
- **Social Proof**. People will do things they see other people doing. Hence, if Mr X sees people in the community purchase a toilet, he will follow;
- **Authority**. Mr X will tend to obey authoritative or influential figures;
- **Liking**. Persuasiveness. People were more likely to buy if they liked the person selling it to them;
- **Scarcity**. Perceived scarcity will generate demand. For example, offers that are available for a 'limited time only' encourage sales.

[5] **Dr Robert Cialdini** is best known for his popular book on persuasion and marketing, Influence: The Psychology of Persuasion (ISBN 0-688-12816-5). His book has also been published as a textbook under the title Influence: Science and Practice (ISBN 0-321-01147-3). In writing the book, he spent three years going "undercover" applying for jobs and training at used car dealerships, fund-raising organizations, telemarketing firms and the like, observing real-life situations of persuasion. The book also reviews many of the most important theories and experiments in social psychology. Harvard Business Review lists Dr. Cialdini's research in "Breakthrough Ideas for Today's Business Agenda".

In the Egyptian context of rural sanitation:

Motivation

'Motivation' deals with the way in which the stakeholders involved (HCWW, Community, Ministries, Regional Authorities, NGOs, contractors, operators, countries or people **want** rural sanitation facilities and **want** to reuse the effluent.

'Weapons of influence' that might be used in a rural sanitation project to influence the motivation:

- **Reciprocation**. People tend to return a favour. Thus, if a service provider provides the wastewater treatment, the community could finance the wastewater collection system;
- **Commitment and Consistency**. If a community commits, orally or in writing, to the idea of improved sanitation, it is more likely to honour that commitment;
- **Social Proof**. People will do things they see other people doing. Hence, if village 'A' sees village 'B' to improve sanitation, they will follow;
- **Authority**. A village will tend to obey authoritative or influential figures. Germany uses this idea in 'WASH United' and The Netherlands in 'Football for WASH' where soccer players are used to influence a community;
- **Liking**. Persuasiveness. People are more likely to participate if they like the service provider;
- **Scarcity**. Perceived scarcity will generate demand. For example, offers of a service provider that are available for a 'limited time only' encourage participation.

Capacity

Capacity has three aspects:

- **Financial** aspects (ability to pay):
  - The ability of HCWW to pay for implementation of rural sanitation;
  - The ability of the community to pay for operation and maintenance fees;
- **Managerial aspects:**
  - The ability of a CDA to collect fees and to manage funds and to deal with defaulters;
- **Knowledge** aspects:
  - The ability of HCWW to plan, design, construct, supervise construction of appropriate rural sanitation systems;
  - The ability of a service provider to operate and maintain a rural sanitation system.

Opportunity

Opportunity deals with the aspects that stimulate or impede sanitation and reuse:

- Intrinsic aspects that HCWW can influence such as '**distance to future sewer**'. If a village is close to a (future) sewerage cluster, HCWW will be less inclined to improves wastewater treatment;
- Extrinsic aspects that a village cannot influence. For example the distance to an irrigation channel: if a village is close to an irrigation channel, there will be less interest in reuse of treated wastewater.

Scoring/ Prioritization

> The scoring/prioritization has been discussed years and years ago and the table didn't provide us with any new criteria.

We propose to select / prioritize potential project areas by using the following model that 'predicts' the success of an intervention as a multiplication of, 'Motivation' (M) and 'Capacity' (C) and 'Opportunity': T score = M * C * O.

For instance if a village is 100% motivated to have improved sanitation with reuse and has a very strong CDA, it is useless to implement an project if it is close to a (future) cluster sewer project or if it is close to an irrigation channel.

Or, if a village is far away from a future cluster, far away from an irrigation channel, has found a good service provider, it will be useless to implement a project if the CDA is mismanaging village funds.

So even if the O= 100% and M = 100%, in case C = 0%, T = 0% (100% * 100% * 0%). It also illustrates that it is much more effective to pay attention to a factor that is relatively low than trying to increase a factor that is relatively high. Say if O =100%, M = 60% and C = 20%, it is much more effective to increase C from 20% to 40% than trying to increase M from 60% to 80%. T increases from 100% * 60% * 20% = 12% to 100% * 60% * 40% = 24% instead of 100% * 80% * 20% = 16%.

Appendix 7: Draft Presentation Mission on 22 May 2013

See separate file.

Appendix 8: On the implementation of fish ponds

Information from the project: *Investigating the suitability of constructed wetlands for the treatment of water for fish farms, Description of the project and present status.* By: Peter G.M. van der Heijden (E-mail: peter.vanderheijden@wur.nl, Phone (+)-31-317-481394, Centre for Development Innovation, Wageningen, January 2012 – December 2013).

1. Motivation and project aim. Fish is the cheapest source of animal protein in Egypt and hence important for the country's food security. In the past two to three decades the aquaculture sector has grown rapidly and at present Egypt is Africa's largest producer of farmed fish (> 900,000 tons in 2010). The Egyptian population consumes on average approx. 16 kg/person/year and over 60% of this originates from fish farms. Concerned with the limits to the amount of fresh water available to the nation, Egyptian laws originating from 1983 prohibit the use of irrigation water (Nile water) for grow-out fish farms. Fish farms are allowed to use saline water or water from the drainage canals. The majority of the fish farms are located in the northern parts of the delta (near Lake Borullus and Lake Manzala), in Fayoum and in the newly reclaimed desert regions west and southeast of the Nile Delta. The majority of these farms rely on drainage canals as the source of water to fill ponds and refresh pond water. The reliance on the drainage canals includes the risk of letting in water that is contaminated with agro-chemicals and/or heavy metals. If the contamination is below lethal levels the fish are not immediately affected, but part of the chemicals may be absorbed and accumulates in the fish. This may pose a health risk for the consumers. This risk is also known by authorities outside Egypt who are concerned with food safety. Farmed freshwater fish from Egypt is at present not allowed to be imported in the EU.
Egyptian fish farmers would like to grow a product that is free from contaminants, safe for all consumers and that can be exported. As long as the Egyptian laws prohibit the use of irrigation water for the on-growing of freshwater fish most farmers will continue to rely on water from the drainage canal in the years to come. An organisation of Egyptian fish farmers has raised the idea to investigate and test if engineered (constructed) wetlands are effective as filters that remove hazardous chemicals from the drainage canal water before being used in the fish ponds. This is the Main Objective of this project: to test the suitability of Constructed Wetlands (CW) to treat drainage water for fish farms. We also hope to explore if CW's can be used to treat and re-use the fish farm's waste water in a constructed wetland and make it suitable for re-use on the fish farm. If effective in this way, the CW's will contribute to reduction of the amount of water that is used by fish farms (contributing to "more crop (fish) per drop') and will result in a product that is safer for the consumer. The project will test the suitability of CW on a private fish farm in Kafr ElSheikh. The project renders support to the design and construction of the pilot CW. The fish quality (especially the level of heavy metals and agrochemicals) in the fish raised in ponds with treated water will be compared with the levels in fish raised in ponds filled with untreated water. Also the effect of the CW on general water quality parameters relevant for fish farms and water treatment will be monitored. So far there are as far as we heard no cases of fish farms in Egypt treating the incoming or outgoing water with CWs.

2. Target group. The major target group are owners and managers of fish farms, of which there are thousands in Egypt. The request for support for the testing of the suitability of CWs for fish farms came from board members of the Egyptian Fish Producers and Exporters Association (FPEA), and organisation with 30+ members.

3. Implementation. Approach. There are various types of CWs that each have their own characteristics. First step in the project has been to identify the most suitable type for the needs and conditions of Egyptian fish farms. In collaboration with 'Ecofyt' (a small Dutch company that has designed and constructed CWs in the Netherlands and abroad for over twenty years) and a CW expert of Van Hall Larenstein the options and most appropriate type of CW in relation to the needs of Egyptian fish farms were explored. When filling ponds or partially replacing pond water, fish farms require large volumes of water in a relatively short time. A visit to the Constructed Wetland of the Lake Manzale Water Research Station near Post Said that is operated by the Drainage Research Institute (DRI) and learning about this station's experiences with treating water from the Bahr El Baqar Drainage canal and using it in the Centre's own fish farms helped us to define the surface flow wetland as the most suitable type because of its ability to treat relatively large volumes of water on a limited land surface and having an acceptable removal efficiency of contaminants. To obtain ownership and commitment, the construction of the pilot CW would for at least 50% be financed by the fish farmer. The project's contribution to the pilot CW consists of expert assistance with CW design, advise with the construction, a contribution to the purchase of some necessary equipment and the cost of laboratory analysis of the fish, feed and water. The Fish Producers and Exporters Association has two board members that are ready to invest in a pilot CW on their farm. One is located in Fayoum, using water from Lake Rayan 1, the other is situated in Kafr El Sheikh, using water from the drainage canal connected to Pump Seven. A mission by staff members of Ecofyt and CDI in December 2012 led to the choice of the farm in Kafr El Sheikh as site for the pilot CW. The quality of the water available to the fish farms in Kafr El Sheikh is poorer than the quality of the water available to the fish farms in Fayoum, making the need for treatment in Kafr ElSheikh region more urgent.

4. The pilot CW – what has been achieved so far. The farm which hosts the pilot CW is situated in Kafr El Sheikh, the governorate with the highest number of fish farms in Egypt. Being situated in the heart of Egypt's aquaculture industry we expect it to have good potential as a demonstration site. The owner has agreed to convert one fishpond of 1100 m2 to a constructed wetland of approx. 900m^2.


Photo 1 and 2: pond A1 before and after conversion to pilot constructed wetland. (Photos: Peter G.M. van der Heijden)

The pilot CW is divided in two compartments. In each compartment a different plant species (reed and water hyacinth) is placed to compare their contribution to the water treatment. Both plant species are abundantly available in Egypt and near the pilot site. With a retention time of 4 days the CW is expected to treat 72 m^3/day. When satisfactory treatment levels are reached a shorter retention will be tried (3 days, which would raise the capacity to 96 m^3/day). By monitoring the quality of the water leaving each compartment we hope to be able to make recommendations regarding the most effective plant species for this type of filter. The owner of the farm will fill the neighbouring fishpond with treated water and fish raised in this pond and fish raised in ponds filled with untreated drainage canal water will be analysed for heavy metal and agrochemical content. In January 2013 the design, technical drawings, building instructions and equipment & materials list for the pilot Constructed Wetland were finalised and sent to the fish farmer. CDI and the owner of the fish farm signed a contract in which the contribution of the Project (managed by CDI) and the fish farmer to the pilot CW construction and operation were specified. In April 2013 two electric pumps, two water meters and an electric switch board for the pumps were purchased in the Netherland and sent to Egypt. To obtain reliable data about amounts of water passing this pilot CW electric pumps and water meters with known characteristics and good reliability were preferred over locally available but less known equipment.
Following the construction guidelines sent by the expert of Ecofyt, the owner of the fish farm 'Baledna' where the pilot site is located has removed sediment from the pond, covered the bottom with 10 cm of clean sand, purchased reed shoots and collected water hyacinths. In the first week of May a staff member of Ecofyt stayed three days on the farm and assisted with the construction, especially the installation of the electric equipment and switchboard. Reed shoots have been planted and water hyacinths have been placed.

Photo 3 & 4: construction of pilot CW. A layer of 10 cm white sand was placed in the pond bottom. (Photos: Frank van Dien)

Photo 5, 6 & &: Pilot CW water inlet structure; water outlet structure and overview of the CW. (Photos: Peter G.M. van der Heijden)

Minor adjustments regarding the levelling of the pond bottom and water depth and addition of rice straw (to kick-start heavy metal adsorption) still have to take place before the CW can start operation. With the Drainage Research Institute (part of the Ministry of Water Resources and Irrigation - MWRI) discussions are taking place to test the effectiveness of a similar CW at the Lake Manzala Water Research Station near Port Said, using the small CW's that DRI is constructing for research purposes. If this can take place in 2013, we will have at the end of 2013 data regarding the effectiveness of CW's for treating Drainage Canal water and producing safer fish from two different locations.

5. What is planned for the rest of 2013?

5A: Pilot CW on private farm: construction will be completed; water will be used to fill up one neighbouring production pond in which consumption fish (tilapia) will be raised. After filling this pond the treated water will be used in the tilapia hatchery; tilapia breeding and the cultivation of fry and fingerlings is expected to benefit from the use of cleaner, treated water. Water quality of inlet water and treated water will be monitored every 1 – 2 months. Harvest is expected in November/ December 2013. Fish will be sampled and sent for analysis, together with sample of the feed and of fish raised in ponds with untreated water, to QCAP for determining heavy metal and agrochemical residues levels.

5B. Pilot CW at DRI research station near Port Said. If agreement on the details of the study set-up and division of costs and labour can be reached with DRI, a test similar to the one taking place in Kafr ElSheikh will be conducted in July-December 2013. The quality of the water coming in and leaving the small constructed wetlands (now under construction) will be monitored, and tilapia will be raised in a small pond with treated water. After harvest some fish will be sampled and levels of heavy metals and agrochemicals in the fish will be analysed and compared with levels of fish raised in ponds filled with untreated water.

5C. Sharing the results. The results of operation of the private CW during the 2013 fish production cycle and the results of the laboratory analysis will be shared with a wider audience of fish farmers during a workshop planned for December 2013 / January 2014. If the collaborative study with DRI can take place, the results of this study will also be shared. Visits to at least one of the two sites (private farmer of DRI Research station) will be part of the seminar. In addition, articles will be written and offered for publication in magazines about fish farming.

6. 2014 and beyond: expansion. CWs is relatively simple and robust concept to treat drainage water and fish farm effluent. When this project reaches its objective and CW's have been shown to be effective as a method to remove hazardous compounds from drainage water (and thus contribute to the production of a healthy and clean product), the next step is to bring this message to the attention of the aquaculture sector. In Egypt the sector consist of 6000 to 8000 fish farmers. Based on satellite images ALTERRA (Wageningen UR) estimated in 2010 the total pond area in Egypt at 104,000 hectares, but higher estimates are also available. A large part of these farms rely on drainage canal water. There are approx. 10 regional and national associations of fish farmers and of persons interested in aquaculture in Egypt and the majority is qualified as 'sleeping' (not active). To inform the sector about the usefulness of CW's as a possibility to treat water on the farm will need packaging of the message in pamphlets and brochures, and bringing it in various ways to the target group. Fish farmers can be made aware of the existence and usefulness of the technique by means of presentations in TV and radio programs, articles in magazines and news papers, in public meetings, etc. Other extension methods that allow a more detailed communication with smaller numbers of participants are presentation and discussion with groups of farmers and with individual farmers, visits to the demonstration site, workshops and small training courses explaining in detail the design and construction principles, etc. Although its mission is research and not extension, DRI is interested to play a role in setting up and implementing a program designed to reach and train fish farmers on the construction of CW's. A further investigation may result in other partners that could also play a role in the next step: spreading the technology among the Egyptian fish farmers. Besides from informing also some convincing and showing of clear (economic) benefits will probably be needed. Including a CW in his farm (or as a common treatment for a group of neighbouring farms) will mean additional cost to the fish farm owner as well as changing his normal pond water management routine. In case no free area is available to place a CW, installation of a CW will mean transformation of productive pond area to a water treatment facility (CW) as has been the case for the pilot project in Kafr ElSheikh. This is a cost that will most likely raise discussions and a clear benefit will have to be shown to convince the farmer. DRI thinks about giving a licence to farms that use drainage water on the condition that they include a CW in their farm. Another argument in favour of including a CW in his farm may be better water and fish quality and better export possibilities for the product. Providing information on the long-term health hazards of compounds commonly found in drainage canal water and an appeal to the sector's responsibility as producers of SAFE food for the Egyptian consumers may also be needed. The design and start a program that brings the CW technology in various ways and with various partners to the Egyptian fish-farming sector would be a logical and useful succession to the project described in this brief report. Support to such a program does fit well in the objectives of one of the components of Water Mondiaal and is given here for your consideration.