East Meets West Foundation (EMWF)

Final Evaluation Report

of the

Clean Water Program in Vietnam

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(August 15, 2006)

Table of Contents

Acknowledgements

This report was written by Rick McGowan, a rural water supply and sanitation specialist based in Vietnam. People contributing information on program design, management, costs, performance, procurement, surveys, engineering, and monitoring and evaluation include: Mrs. Hoang Thi Hang Tam (Clean Water Program Coordinator), Mr. Nguyen Quy (IT engineer and survey enumerator), Mr. Cao Dung (IT specialist and survey enumerator), Mr. Hong (water supply engineer), Mr. Duong Cong Tuan (site supervisor), Mrs. Hong Thi Kin An (survey enumerator), and Mrs. Tran Thuy Hai (survey enumerator).

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Note: As of August 2006, US$1 is equivalent to about VND 16,000.

APPENDICES (*Note: These appendices are contained in the hard copy Evaluation Report*)

Appendix 1 – Consultant's Terms of Reference (TOR)

Appendix 2 – Conclusions and Recommendations from the EMW and WFP (Water for People) Hygiene Improvement Workshop

Appendix 3 – List of Water Supply Manuals Available from American Water Works Association

Appendix 4 – Administrative and Monitoring and Evaluation Documents of EMW Clean Water Program (in order of their use in the project)

- Water Project Investigation Form (relevant local authorities, socioeconomic, demographic and technical data of proposed site/hamlet).
- Questionnaire (pre-selection summary of water family-specific site conditions, including socioeconomic descriptors, current and potential water source(s) and utilization patterns).
- Criteria for Ranking Water (for site ranking and selection).
- Request for Clean Water System Construction Funding (summary of required components, site location, estimated beneficiaries, project activities, cost breakdown, water needs assessment, and required community inputs).
- Water Quality Test Results (separate forms for chemical / biological tests).
- List of Equipment Required for System Design (e.g., water quality testing equipment for specified parameters, and equipment to measure electricity quality, well production, distance and elevation measurements, etc.)
- Letter of Commitment (household committing to participate in project).
- Registration Form for Installing Water Meters and Fittings (individual families confirming their intent to pay for house connections with meters).
- Weekly Status Report (activities accomplished in previous week, activities scheduled for next week, and status of completion of planned objectives – e.g., total meters of piped to be installed, pipeline trenching, amount completed this week, and amount to be completed for next week, and notes on difficulties/problems encountered). This is written by the site supervisor.
- Evaluation Form (post-construction quantitative description).
- Project Summary (post-construction narrative).

List of Acronyms

ADB	-	Asian Development Bank
AWWA	-	American Water Works Association
ATP	-	Ability to Pay (for water tariffs and construction co-financing)
AusAID	-	Australian Agency for International Development
CERWASS	-	Center for Rural Water Supply and Sanitation
CHE	-	Provincial-level Centre for Health Education
CPC	-	Commune People's Committee
CSS	-	Customer Satisfaction Survey
CWP	-	Clean Water Program (EMW)
CWS	-	Church World Services, which chairs the NGO RWSS Forum in Hanoi
DANIDA	-	Danish International Development Agency
DPC	-	District Peoples' Committee
EMWF	-	East Meets West Foundation (also EMW)
GOV	-	Government of Vietnam
HHs	-	Households
Hp	-	Horsepower (equivalent to 746 w, or 0.75 kW)
HRD	-	Human Resources Development
HSBC	-	Hygiene and Sanitation Behavioral Change
IDE	-	International Development Enterprises (sanitation NGO)
IEC	-	Information, Education and Communication
INGO	-	International NGO
LCC	-	Life Cycle Cost (including initial capital investment and O&M costs)
LPCD	-	Liters (of water consumed) per capita per day
m^3	-	Cubic meter (of water)
m^3/day	-	Cubic meter per day (water production or use)
M&E	-	Monitoring and Evaluation, or Materials & Equipment (in procurement)
MABUTIP	-	Management Board of Urban Technical Infrastructure Development Projects

MARD	-	Ministry of Agriculture and Rural Development
MDG	-	Millennium Development Goals
NGO	-	Non-Governmental Organization
NRWSS-2020	-	National Rural Water Supply and Sanitation Sector Strategy to Year 2020
NTP	-	National Target Program for RWSS and Environmental Hygiene
NTP-II	-	2nd Phase of National Target Program on Rural Water Supply & Sanitation
O&M	-	Operation and Maintenance
P-CERWASS	-	Provincial CERWASS (Center for Rural Water Supply and Sanitation)
PPC	-	Provincial Peoples' Committee
PPP	-	Public Private Partnership
PWSC	-	Provincial Water Supply Company (GOV)
PWSDC	-	Provincial Water Supply and Drainage Company
QARQ		Quantity, Accessibility, Reliability and Quality (of water)
RRD RWSSP	-	Red River Delta Rural Water Supply and Sanitation Project (GOV/WB)
RWC	-	Rainwater Catchment
RWS	-	Rural Water Supply
RWSS	-	Rural Water Supply and Sanitation
TOR	-	Terms of Reference
UNICEF	-	United Nations Children's Fund
VND	-	Vietnam Dong (about VND 16,000 per US$ 1 as of June 2006)
VWU	-	Vietnam Women's Union
WaterSPS	-	Water Sector Program Support (DANIDA-financed)
WB	-	World Bank
WFP	-	Water for People
WHO	-	World Health Organization
WQ	-	Water Quality
WSS	-	Water Supply and Sanitation
WTP	-	Willingness to Pay

Executive Summary

The East Meets West Foundation (EMW) hired a water and sanitation specialist with working experience in Vietnam to evaluate EMW's Clean Water Program (CWP) that is focused in Quang Nam Province, and to a lesser extent in Quang Tri Province. The consultant carried out a series of field visits to about 25 CWP sites, most of which were already built, and others which were either under construction, or still in the planning stage, to assess the EMW project planning and development process.

This report is based on a review of numerous documents (Site Investigation forms, Community Questionnaires, Request for Funding Proposals, Memoranda of Understanding between beneficiary communities, local authorities and EMW, Letters of Commitment, Water System Evaluation Forms) that are included in the administrative, planning, management, and monitoring and evaluation process carried by the EMW Water Team. This report includes findings of the Customer Satisfaction Surveys (for which a stand-alone report was produced), site visits and discussions with project beneficiaries at about 25 water system sites in Quang Nam and Quang Tri Provinces, and numerous discussions with EMW Water Team and other staff in Danang and Hanoi. Another separate report (the results of which are summarized in this report) focused on various water system management models, including options for private sector water management.

The consultant assessed EMW's approach to the provision of improved (piped and treated) piped water supply, including site selection, coordination with prospective beneficiary communities and local government authorities, project planning, organizational development, water source selection, water quality, engineering design and construction, supervision and quality control, operation and maintenance, monitoring and evaluation of program activities.

The EMW program takes a generally accepted, community-based approach similar to that taken by other NGOs in other countries in the region (as well as the World Bank in Vietnam, which is soon to start up a $45 million Rural Water Supply and Sanitation Project in the Red River Delta). Briefly, the approach begins by discussing selection of potential beneficiary communities with the local authorities using clear and agreed upon selection criteria, and then making initial visits to prospective communities to discuss the goal, objectives, and procedures for planning, constructing and maintaining simple piped water systems in selected communities. Once agreements are made between the responsible parties (participating communities, local authorities, and EMW), water source selection and testing, engineering design, procurement of goods, materials and equipment, and construction proceeds, with very strong community involvement in virtually all aspects of planning and system development.

EMW has successfully coordinated its activities to ensure the necessary cooperation and active support from the local authorities. This is in part due to the limited geographic focus of the program, so that there has been ample time to develop good working relationships with the local authorities especially in Quang Nam Province. This is critical to ensure the success of development programs in Vietnam.

Thus far the EMW program has been successful applying a very participatory planning and development process for improved water supply through the construction of 67 piped water systems (plus a small number of dugwells, hand pumps and latrines) since its origin in 1996. Another 17 piped water systems are expected to be completed by the end of 2006.

The evaluation field visits, meetings with beneficiary communities and local authorities, long but interesting discussions with Clean Water Program staff, and the results of the Customer Satisfaction Survey (see section 11.3 below), all show that there was a generally high level of beneficiary satisfaction with the water schemes developed under the EMW Clean Water Program. Using a very participatory and community based approach, in regular consultation with the local authorities, EMW water program staff have been largely successful in providing reasonably good quality piped water service to project beneficiaries at a relatively low cost.

Partly because of lack of access to good quality alternative water sources (dug wells, drilled wells, surface water, or springs), customer willingness to pay (WTP) for good quality, reliable piped water was usually high. Beneficiary communities were actively involved in planning and construction (digging and back-filling pipe trenches), and paying for house connections and monthly water bills. Water managers and storekeepers (for construction materials) were trained by EMW, and are doing a reasonably good job. Construction supervisors, while capable, appear to be somewhat stretched as the program accelerates. Additional technically qualified supervisors and design engineers will certainly be needed to support the proposed program expansion discussed later in this report.

Problems identified during the survey were already well known to EMW program staff. In most cases, significant efforts had already been made to rectify problems related to:

- Water quality - which is a major constraint in much of Quang Nam Province);
- System design modifications - (related to tank design, and sedimentation / filtration), and design and construction standards) have been improved over time;
- Contractor performance - some contractors initially involved in the program have been dropped due to inadequate performance, but the current set of contractors (who are responsible to build the water towers, and install pumps, electrical controls, valves, mechanical filtration equipment) are doing a reasonably good job, especially as their experience and technical capability and experience grows over time.
- Quality of materials and equipment - some initial problems with low quality PVC pipe have already been rectified, and equipment (e.g., pumps, controls, filtration systems) selection and quality have been steadily improved.
- Engineering design resources - appear to be barely sufficient, so that additional engineering design and supervision support and training is required, especially if the program scope will be significantly expanded as proposed later in this report.

The Customer Satisfaction Surveys (CSS) carried out in 75 selected households showed that the EMW water program has been fairly successful in the planning and development of improved water supply for thousands of project beneficiaries, largely in Quang Nam, and to a limited extent in Quang Tri Provinces. Close working relationships have been developed with the local authorities, who in turn have actively supported the program implementation, and have carried out their agreed upon responsibilities to help ensure the success of the program. On the basis of these CS surveys, visits to other existing EMW water system locations, review of some sites for prospective new water schemes (e.g., around Hue), and extensive discussions with program staff, recommendations for improving and expanding the CWP here in Central Vietnam are given in this overall evaluation report.

Some donors (e.g., DANIDA and AusAID), NGOs (e.g., International Development Enterprises - IDE) and GOV agencies (e.g., The Vietnam Women's Union) have achieved some success in improving community health by promoting the adoption of improved sanitary latrines, and improved personal hygiene behavior, especially through more frequent hand washing with soap. It is strongly suggested that EMW adopt that local and regional experience of hygiene and sanitation behavioral change (HSBC) programs to increase the CWP's positive impact (i.e., improved community and family health) in beneficiary communities. How this might be (and already has been) done, particularly in Quang Nam, is described herein.

EMW has made initial inroads to coordinate its water activities with those of some GOV agencies (e.g., PCERWASS in Hue). As a follow up to this evaluation, the possibility of developing a public private partnership (PPP) to provide water service in larger rural areas (possibly even Class V small towns) was discussed. One opportunity to expand working relationships with other GOV agencies (e.g., Central Vietnam Division of Hydrogeology and Engineering Geology – CEVIHEGEO) and private companies (e.g., FrOG Tech, an Australian geohydrology firm) is now under discussion, and could help pave the way for EMW to provide water services to larger rural communities and small towns. Discussions are underway to identify potential financing partners active in the water sector in Vietnam (e.g., ADB, World Bank, Danida, AusAID, etc.) to assess the possibility of EMW and its partners developing deep groundwater sources for improved water (and sanitation) services to larger communities.

Finally, a proposed set of activities and associated budget estimate for the proposed expanded CWP (assuming availability of funding of about $10 million over the next ten years) are discussed in this evaluation report.

1. Evaluation Objectives and Major Tasks Carried Out

The objectives of this East Meets West (EMW) Clean Water Program evaluation were to:

- Conduct a full evaluation EMW's Clean Water Program on all levels – design, testing, site selection, technology, implementation, economics, staffing, and training, monitoring and reporting.
- Produce recommendations (not a full program plan) on how to improve the program, including identifying successful areas that should be enhanced, what activities (if any) should be discarded, and what additional activities might be added to maximize the positive impacts (health, social, financial, etc.) of the program on its beneficiaries.
- Recommend how best to monitor and evaluate program outputs and impacts, including suggestions for assessment of public health impact.
- Recommend how best to take a new and improved program to scale.

To achieve the above objectives, the Consultant carried out the following major tasks:

- <u>Review of Program Documentation</u> - Reviewed most available EMW program documentation, including, brochures, registration forms, commitment letters, investigation forms, questionnaires assessing demand for improved water, funding request forms, project ranking forms, water quality test results, engineering drawings, system evaluation forms, and Project Summaries for about 30 water systems.

- Field Visits to Participating Communities - Made field visits to about 25 water systems built by EMW over the last ten years in Quang Nam and Quang Tri Provinces[3] to assess technical, institutional, financial and social issues.

- Discussions with Local Authorities, Beneficiaries and Staff - Held numerous discussions (mostly through a translator, as my Vietnamese language ability remains limited) with local authorities (e.g., Commune People's Committees - CPC, District People's Committees - DPC, beneficiary community members, construction contractors and workers, Water Managers, storekeepers, and most EMW water program staff.

- Comparison with Similar Projects - To assess lessons learned, reviewed documentation of (and personal familiarity with) other similar rural water supply and sanitation (RWSS) projects in Vietnam and elsewhere in the region, such as Indonesia, the Philippines and Nepal, for purposes of comparison of the overall approaches to system planning and implementation, relative costs of water service provision, institutional arrangements, monitoring and evaluation, hygiene and sanitation behavioral change promotion, and overall success of different projects.

- Customer Satisfaction Survey – carried out a detailed survey of 75 EMW water system beneficiary households, covering water quantity, accessibility, reliability and quality, cost (construction cost-sharing and water tariffs), community and GOV roles in system planning and development, construction and operation and maintenance (O&M), and sanitation and hygiene practices. Survey results are given in section 11.3 below.

- Assessment of Water System Management Models – to identify advantages and disadvantages of different management models that are (or could be) used to improve efficiency and cost-effectiveness of EMW water system management.

2. Overview of EMW Clean Water Program

The suggested goal and objectives[4] of the water supply program are given below:

- Goal – improve quality of life for families in targeted provinces and districts, primarily through the provision of improved water (and potentially for environmental sanitation[5]) services to directly improve community and family health.

- Objectives – Provide improved clean drinking water (and improved environmental sanitation – sanitary latrines and targeted propaganda to expand the use of hand-washing using soap) to the largest number of beneficiaries in the target areas.[6]

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3 The great majority of EMW water systems have been constructed in Quang Nam Province. I only visited one in Quang Tri Province, which was not yet completed.

4 "Suggested" because I have not seen any specific goal or objectives stated in reports I reviewed.

5 The addition of an environmental sanitation program, covering improved latrines as well and promotion of improved hand washing with soap as a disease prevention measure.

6 These are often the same families, as the poorest families typically have the most limited access to all utility services, including water supply and environmental sanitation.

This objective seeks to maximize the number of program beneficiaries, rather than focus solely on providing services to the poorest families, or families with the worst water conditions in the target areas. The objective is to provide maximum coverage of improved water supply to those willing to pay (co-finance) for such service. This implies that families with the most difficultly in accessing clean water may not necessarily receive priority in program assistance. However, following this objective will result in the largest number of people benefiting from program investments. The program goal and objectives should be discussed and agreed upon by EMW senior management, as this has important implications for site selection. See the discussion on site selection criteria in section 4.1.1 below,

It is important to describe the project scope, meaning coverage not only within the provinces, but also within participating districts and communes within the province. While not yet available, it would be useful to review disaggregated data on coverage and service areas (i.e., areas within communes that have access to EMW-financed piped water) to more accurately assess the Program's impact on provinces, districts, communes and ultimately hamlets within the program area, which is now focused on selected districts within Quang Nam Province. In brief, the EMW Clean Water Program can be described as follows:

- It is focused on very few provinces – namely Quang Nam and Quang Tri. This makes it logistically and organizationally easier to manage and implement. Logistics support costs are typically less than would be the case with a more widespread group of beneficiary communities, and better working relationships can be developed and sustained with fewer local government agencies. On the downside, it may be more difficult to find enough "good sites" that are technically and financially feasible.

- Site selection focuses on communities with the greatest water need – This can lead to developing water systems in communities with the most difficultly obtaining clean water. This has implications on customer satisfaction and willingness to pay for improved water services (especially water quality). It makes it more difficult for EMW to provide good water quantity and quality at a reasonable cost. For example, high sedimentation levels at many of sites require more costly de-sedimentation and filtration. Salinity in groundwater deeper than 7-8 meters in areas within 20-30 km of the ocean is a problem, because salinity is not financially viable to treat. Some water systems in Quang Nam near the ocean have difficulty providing adequate fresh water, as systems pump from a "fresh water lens" that can be quickly depleted if higher volume pumping is required to meet demand[5].

- Community co-financing of systems is required – Requiring community co-financing of EMW-financed infrastructure helps ensure long term financial sustainability. If people are willing to co-finance (both cash and in-kind contributions) their water systems, they are more likely to feel responsible for maintaining the facilities. Cash contributions pay for house connections (pipe, water meter and valves). In-kind contributions are community provision of labor for digging and back-filling pipe trenches, and for installing house connections. Families willing to do this are much more likely to be willing to pay water tariffs to keep systems operating over the long run.

- No Hygiene and Sanitation Behavioral Change Component – Unlike other RWS projects in Vietnam and elsewhere, this program has no environmental sanitation

[5] This can be a problem when a system is designed to cover a limited service area, and demand (number of people served) grows to a point where the pump may start drawing up more saline water.

component. Sanitary latrines and hygiene and sanitation behavioral change (HSBC) promotion are not included in EMW activities so far, though consideration has been given to adding this component[6]. Environmental sanitation is widely recognized as an important component of water projects implemented by NGOs, bilateral donors (e.g., Danida and AusAID), and large multi-lateral donor organizations (e.g., World Bank and ADB, both of which have extensive experience in the water sector here in Vietnam). Since one program goal is to maximize project benefits from improved community health, careful consideration should be given to whether an HSBC component should be added. This issue is discussed in more detail in section 12 below.

EMW has worked in Vietnam since 1987. Since initiating the Clean Water Program in 1996, EMW has developed about 70 rural water supply systems (67 of which are piped water systems, and the remaining three are for hand pumps, dug wells, and some bathrooms) serving rural communes and hamlets. The program is based in Quang Nam province in Central Vietnam, and to a very limited extent in Quang Tri Province. EMW's experience in design, construction and working with beneficiary communities and local authorities to plan, finance and manage these water systems has expanded considerably in those ten years.

With the minor exceptions mentioned above, EMW water systems are all piped systems, which pump shallow groundwater through a sedimentation tank and sometimes a mechanical filter, then into an overhead storage tank. See the typical water tank in the photo at right. From the storage tank, the water flows into a distribution network to the beneficiary community households. System designs have been improved over time. For example, reinforced concrete tanks are now used instead of the early brick and mortar tanks that tend to leak after a while, better quality pipe is now being used, improved water treatment (both de-sedimentation and filtration) is used on more recently built systems, and some early quality control problems seem to have been largely resolved.

Beneficiary families pay for house connections to the distribution line, and must install a water meter to measure water consumption to pay their monthly water bill. According to the CSS results (which describe the frequency and length of periodic water outages - see section 11.3 below), while piped water is normally available, families often keep about 2-3 m^3 of water in large ceramic jars within or next to their houses, in case water outages occur. For managing each piped system, a Water Manager is selected, trained, and his (all the water managers whom I met were men) salary is paid for from monthly water tariffs that he is responsible to collect. Table 1 on the following page summarizes basic performance indicators for the EMW Clean Water Program.

[6] The Hygiene Improvement Workshop held in December 2005 with the NGOs Water for People (WFP) and IDE.

Table 1: EMW Water System Statistical Summary

Largest # of Customers/system	Smallest # of Customers/system	Average # of Customers/system	Est. Total # of Beneficiaries		Populations are based on time of construction, so they underestimate actual population.	
3,400	**172**	**1,275**	**85,398**			
Avg. Cost of Piped Water System	**Max. Cost of Piped Water System**	**Min. Cost of Piped Water System**	**Minimum PCC***	**Maximum PCC**	**Average PCC**	
$13,660	**$43,514**	**$400**	**$2.68**	**$34.88**	**$9.85**	

***PCC = Per Capita Cost, or total investment cost (including construction, equipment, materials, etc.). The costs above do not include community contributions of labor for digging all the pipeline trenches, and materials (pipe, water meters, and valves) for house connections, which is probably about an additional 20%.**

To put this in perspective, data in the NGO VUFO - NGO Resource Centre & Water Supply and Sanitation Working Group Water & Sanitation Sector Reference Document (*Overview of Organizations in Vietnam Assisting Water Supply, Sanitation and Hygiene Promotion*, 2nd Edition, Hanoi, VUFO - NGO Resource Centre & WSS Working Group, December 2005) states that the total estimated number of households benefiting from improved water supply in 2004-2005 reported by all institutional sources (GOV, World Bank, and other sectoral NGOs) is 51,687. EMW's contribution of 6,969 beneficiary households represents about 13% of the total number of rural households in all of Vietnam who gained access to potable (piped) water countrywide (not including private installations) during that two-year period. This is quite significant. The largest RWSS sectoral contributor, DANIDA, provided improved water supply to 13,511 HHs in 2005, CARE helped about 2,000 HHs, and World Vision helped about 2,500 HHs. Numerous other smaller NGOs made more modest contributions toward RWS sectoral development.

3. Other Donor and NGO Approaches for RWSS in Vietnam

3.1. Major Investors in RWSS in Vietnam

Up until the last ten years, there were no major donors except UNICEF and few international NGOs providing support for rural water supply (RWS). The Government of Vietnam (GOV) through the local authorities and UNICEF were the two most important agencies supporting RWS sectoral development. More recently, other major donors (both multilateral and bilateral) have become actively involved in providing RWS (and to a limited extent sanitation - RWSS) services in Vietnam. The current list of sectoral supporters includes:

- <u>GOV</u> – Following guidelines in the National Rural Water Supply and Sanitation Sector Strategy through 2020 (NRWSS2020) and the National RWSS Target Program (NTP), the Ministry of Agriculture and Rural Development (MARD) supports RWSS development in many provinces. Thousands of small piped water systems were constructed under NRWSS-2020, but many have since fallen into disrepair due to lack of adequate financing and subsequently inadequate maintenance and repair. Traditionally, water supply has been the responsibility of the local authorities, who sometimes provide funding for small piped systems when funds are available, but this has only modest impact on increasing overall coverage. The percentage of rural population that has access to clean water is currently estimated to be around 55% - 66%. However, it is important to note that the term "clean water" does not necessarily mean water that meets national water quality standards.

- UNICEF - Over the past 20 years, UNICEF has helped many rural families install about 100,000 hand pumps and lined dug wells. Perhaps two to thee times as many hand pumps have been privately installed as a result of this program. While many of those hand pumps are still in use, many have failed or fallen into disuse because of poor maintenance or poor water quality. This forces many people to either use low quality surface water, or buy piped water from pushcart vendors at very high prices (up to 50,000- 75,000 VND /m^3 in 2005, or about $3-5 /$m^3$). Compare this to average tariffs of piped water systems in Vietnam of about VND 1,500 – 4,000 / m^3 (about US$0.10 – $0.25 per m^3). Compare that to a one-liter bottle of locally produced La Vie drinking water that normally sells for VND 10,000 (US$0.63, or US$ 628 per m^3).

- World Bank (WB) – While previous and current WB WSS projects focus on large towns, WB and GOV recently approved a US$45 million Phase One of the Red River Delta Rural Water Supply and Sanitation Project[9]. This project focuses on four Red River Delta provinces[8], and will use a very consultative approach to RWSS planning and development. It also supports private sector involvement in system construction and management, through the use of Joint Stock Companies (JSC) where appropriate.

- Asian Development Bank (ADB) – ADB has financed four water (and to some extent sanitation) projects focused on small, medium and large towns in the Mekong River Delta in Southern Vietnam, and the Central Region mainly along the coast. The fifth ADB water and sanitation project[9] has just been prepared and will likely start up in 2007. Note that on 20 March 2006 ADB announced that it expects to double the investments it will finance in the water sector over the next five years.[10] Presumably this will include rural water supply and sanitation as well. This will be of great benefit to narrowing the large existing gap between water "haves and have nots" in rural Vietnam.

- Danish International Development Agency (DANIDA) – DANIDA's Water Sector Program Support (Water/SPS), focuses on IEC (Information, Education and Communication) for RWSS programs in the highlands areas, including medium and small towns such as Dalat. DANIDA is one of the largest donors in the RWS sector, and takes a very community consultative approach in its water supply projects, based on its experience that projects are more successful projects when prospective beneficiaries are fully informed of, and willing to accept and participate in, project procedures and requirements (e.g., co-financing the cost of infrastructure) when these are discussed with them prior to project implementation.

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7 Pre-Feasibility Study for the GOV / World Bank Red River Delta RWSS Project. Rick McGowan et al, March 2005)

8 The Red River Delta provinces of Nam Dinh, Ninh Binh, Hai Duong and Thai Binh.

9 The Central Region Small and Medium Towns Development (CSMT) Project, Asia Development Bank and the GOV Ministry of Construction's Management Board for Urban Technical Infrastructure Development (MABUTIP).

10 According to plans announced at the 4th World Water Forum on March 20, 2006. The new ADB program will focus on the delivery of substantial investment, reform, and capacity development in three key areas - rural water services, urban water services, and river basin water management.

- Australian Agency for International Development (AusAID) – AusAID has supported RWSS development through projects such as the Cuu Long Delta RWSS for many years. This 5-year project aims to reduce poverty and improve the overall living standards and health of around 500,000 rural poor in five provinces in the Cuu Long (Mekong) Delta through improved water and sanitation services. AusAID and DANIDA recently decided to jointly support the next phase of the National Target Program (NTP-II) on Rural Water Supply and Sanitation. The decision to support jointly and to support Vietnam's own programme rather than create a specific donor project or programme is a bold step towards securing Vietnamese ownership of the development process.

- International and Local NGOs – In addition to EMW, other international NGOs supporting RWSS development in Vietnam include CARE, World Vision, Save the Children, Plan in Vietnam, Church World Services, International Development Enterprises (IDE), BORDA, etc.[11]). Compared to the scale of EMW's water program, their programs appear (the actual extent of their support is not always clear) to provide important, but relatively modest, support for improved RWS infrastructure.

3.2. Sectoral Coverage and Policy Targets

In spite of substantial donor support, coverage of clean water (e.g., meeting GOV water quality regulations) in Vietnam is highly variable, not only across regions but also across provinces, districts and communes. Development in the RWS sector in Vietnam has traditionally been the responsibility of the local authorities, but because of local resource constraints, coverage (% of population served) of improved water supply remains very limited in many areas, such as Quang Nam and Quang Tri.

According to a recent statement by the Ministry of Agriculture and Rural Development (MARD, June 2006), access to improved water supplies grew from 26% of the population to 49% between 1993 and 2002 (the most recently available estimate). During the same time, access to hygienic latrines grew from 10% to 25% of the population. Although no one really knows what the coverage is at this time (June 2006), the common estimate for coverage of rural water supply nation-wide is about 60%. Based on an estimated rural population of about 62.5 million people[12], about 40% (25 million people) do not have access to improved water supply. The National Rural Clean Water Supply and Sanitation Sector Strategy for 2020 (RWSS-2020) states that the national sectoral goals to be achieved by 2020 include:

- By 2010, 85% of rural people have access to 60 liters per capita per day (LPCD) of clean water, and 70% have access to hygienic latrines, with good personal hygiene;

- By 2020, all rural people have access to 60 liters per capita per day of clean water, and there will be universal access to hygienic latrines and suitably improved personal hygiene (e.g., regular hand washing with soap).

This implies that with a population growth rate of about 1%, in four years (by 2010) somehow enough funding must be mobilized to provide water for about 26 million people. At an

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11 See the Water and Sanitation Sector Reference Document, VUFO-NGO Resource Center and WSS Working Group (December 2005) for the list of NGOs involved in RWSS in Vietnam, and details of their sectoral support programs.

12 According to the MSN Encarta entry on Vietnam Facts and Figures, the estimated population of Vietnam in 2006 is about 84.4 million, 74% of which is rural, so the rural population is about 62.5 million people.

estimated per capita cost for GOV RWS systems co-financed by bilateral donors (e.g., DANIDA or AusAID) or multilateral donors (ADB or World Bank), that would require more than US$ 1 Billion, using a per capita cost of about $40. Even if beneficiary households were willing to co-finance about 25% of that cost, external financing of about $750 million would still be required. For this reason, some RWSS sectoral development specialists feel that these goals may be somewhat optimistic, given the currently rather limited level of sectoral funding.

The terminology used in Vietnam to describe piped water systems is a bit confusing, and does not necessarily accurately describe the actual quality of service provided (in terms of water quantity, quality, accessibility and reliability - QARQ). Terminology such as "Improved water" and "clean water" does not necessarily mean water that one might actually consider drinking, if you had a choice to do otherwise. Water quality in many piped water systems in Vietnam often does not meet the national water quality standards (see the Vietnam WQ standards given in the table in section 5.3 below).

More than 25 years ago, UNICEF made a commitment to greatly expand the coverage of improved RWS throughout Vietnam. Hundreds of thousands of hand pumps were installed on small-bore drilled wells and cement-lined dug wells. Even today, many rural households still use dug wells (lined and unlined) with ropes and buckets, or buckets and pulleys, even in relatively large towns such as Cam Ranh. Many UNICEF pumps can still be seen in rural areas of Vietnam. However, where families have the financial means to do so, many hand pumps have been replaced (or supplemented) either by small bore wells using either electric surface or submersible pumps, or preferably by piped water connections, where they exist.

Nearly all ongoing RWSS development is financed through donor agencies, including multilaterals (e.g., World Bank, ADB), bilaterals (AusAID and Danida, which is the largest sectoral bilateral donor here in Vietnam), and NGO[13] programs now include a hygiene and sanitation program. EMW has discussed the possibility of including such a program, and held a Hygiene Improvement Workshop in December 2005 to investigate this further[14]. Besides improved sanitary latrines for families, these programs sometimes provide funding for limited institutional latrines (e.g., for schools, local government Health Centers, or local markets).

Most RWSS programs also include hygiene and sanitation behavioral change (sometimes referred to as HSBC) promotion programs that try to enhance community awareness (for families, and children through health education programs in primary and secondary schools) of health / hygiene / sanitation linkages. Some HSBC programs carry out hand washing promotion programs in conjunction with the private sector (e.g., Lever Brothers, a major manufacturer of soap world-wide). More frequent hand washing, coupled with access to good quality piped water and improved latrines, has been shown to significantly reduce diarrheal disease in rural communities, by as much as 35% in some typical rural communities[15]. This provides a justification for EMW to incorporate and SHBC program of some sort in its Village Clean Water Program. How best to do this is discussed in section 12 below.

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13 CARE, SAVE, IDE, CWS, etc. – Specific details are available on the Vietnam NGO RWSS forum website.

14 *Draft Trip Report on the EMW and Water for People (WFP) Hygiene Improvement Workshop*, (Craig Hafner and Khanh Le) in December 2005.

15 Refer to Carol Hetler's sanitation impact study in Indonesia under the Government of Indonesia and World Bank Water Supply and Sanitation for Low Income Communities (WSSLIC-1) Project (1993-97).

4. Water System Planning and Development Process

Steps taken to select, plan and develop EMW rural water systems are described in the text box on the following page, from the recent Trip Report on the EMW and Water for People (WFP) Hygiene Improvement Workshop[16], sponsored by the American Water Works Association (AWWA). The planning and coordination process that EMW carries out seems to be fairly effective, as verified by results of the Customer Satisfaction Survey[17] done during this evaluation. The planning process is very participatory, involving all relevant stakeholders (beneficiary communities, local authorities, and the EWM water team) in decision making. Both EMW and the local authorities have made considerable efforts to ensure that prospective beneficiary communities and households were aware of potential project benefits, and their own roles and responsibilities in ensuring that those benefits would materialize.

EMW developed a series of useful forms to drive and document the process by which its water systems and sites are selected, planned, coordinated, constructed, monitored and evaluated. The current process is somewhat different than that described in text box from the Hygiene Improvement Workshop, as shown in Table 2 below.

Table 2 - Overall Planning and Implementation Process Steps

1. People's Committee makes a request to EMW for assistance.
2. EMW does an initial investigation/survey to prepare preliminary information about the project.
3. EMW and community complete investigation of proposed water source, check water quality and initial design. EMW hires local well driller to drill for potential water sources.
4. EMW sends water samples from potential sources for WQ testing to an approved WQ testing lab to determine the appropriate source or sources.
5. EMW completes the detailed engineering design.
6. Program approach and responsibilities summary sent to local authorities, copied to community HHs to review and consider.
7. EMW holds a meeting with the whole community to explain the project. At that time a Board of Managers is formed and a Water Manager is identified by the people's committee.
8. EMW and Commune Committee agree on a Memo of Understanding (MOU).
9. EMW obtains commune and appropriate authority's approval of the design.
10. EMW plans the detailed project construction schedule.
11. Implementation – during this step the commune identifies the potential management model for O&M.
12. Turning over Ceremony or official signing off and transfer of papers and ownership.
13. On-going reporting by water manager of operation and maintenance issues every three months.

16 Danang, Vietnam and Field Visits, Dec. 1 – 17, 2005, Craig Hafner and Khanh Le.

17 See a summary of the Customer Satisfaction Survey results in section 11.3 below.

Site Selection by Local Authorities, Communities and EMW

The EMW Water Team developed a series of 11 forms to facilitate the water system planning and development process. The function of each form is described below. Each year, the Provincial People's Committee (PPC) selects certain districts where it requests support from EMW for the development of rural water systems. EMW sends the long-listed District People's Committees (DPC) a copy of the Water Project Investigation Form. I refer to this as Form #1 (see Appendix 2 for copies of these forms). After receiving forms, the respective DPCs then develop long lists of communes and hamlets that might be appropriate sites EMW assistance. Form #1 is filled out for each prospective site, and a date is set for a site visit by all of the Water Team members. Form #1 summarizes basic socioeconomic and health data for the proposed beneficiary community, and other important indicators such as current and possible future water sources, water quality, availability of reliable electricity, and willingness in principle to participate and co-finance the water system. After subsequent site visits and discussions between the community, local authorities, and the EMW water team, sites are either accepted or rejected. To put this is perspective, of 43 prospective sites proposed last year by the local authorities, only 10 sites were eventually selected for program support.

After a site is tentatively selected for support (pending the system feasibility study), a Family Questionnaire (Form #2) is filled out by 15-20 families at each short-listed sites. The form collects basic family-level socioeconomic, health and water use data. This corresponds more or less to the Socioeconomic Surveys (SES) routinely used in development projects funded by World Bank or ADB, but more simplified (a WB or ADB SES is about ten pages long with 100 questions, and the typical sample is 100 families per village). The SES Family Questionnaire is more than adequate for this task. The questionnaire data is used to fill out Form #3.

Form #3 (Criteria for Ranking Proposed Water Systems) assigns a weighted value to the various data from Form #2 to develop a numeric ranking of all the prospective sites, so that a relatively objective order of priority is assigned to each short listed site. The number of systems actually funded in a given year depends upon the availability of program funding for that fiscal year, as well as on the technical and financial feasibility of the proposed system.

4.2. Technical Feasibility Study of Proposed Site

Form #4 (Request for Clean Water System Construction Funding) describes the proposed water system location, main components (water tower, filter system, drilled wells, pumps, electrical system, pipe distribution system, etc.), cost of each major component, number of anticipated beneficiaries, list of project activities (essentially what EMW inputs will consist of), estimated schedule of completion, a summary of the current water situation and a water needs assessment at the proposed site, tasks assigned to the project partners (e.g., the local authorities, and members of the beneficiary community), and some photos of the current situation. This document is sent to EMWF in the US for review and comment, and serves as the basic document for seeking donor financing.

After sending the project procedures given in Form #4, EMW schedules a meeting with the local people to discuss the proposed project, including test drilling of the proposed water source. Form #5 gives the Summary Results of the Water Quality (WQ) Testing of water samples from the test well. It uses the more or less standard WQ criteria for 11 physical, and chemical and biological. There are two separate forms that provide the biological test results (faecal coliforms per 100 ml). If there are no major problems with the proposed water source, the planning process proceeds apace. If there is any major problem with the proposed source, the feasibility of other potential sources will be assessed.

4.3. Agreements on Partner Responsibilities and Financial Commitments

Besides the brief mention of roles and responsibilities of all development partners given here, they are described in more detail in section 7 (Institutional Arrangements) below. Continuing on with Form #6 (Memorandum of Understanding – MOU for Construction of Clean Water Systems) it is initially sent to the local people to review, and then discussed directly in a follow-up meeting with EMW. Representatives of the District People's Committee (DPC), the Commune Peoples' Committee (CPC), and EMW senior management and Water Program staff meet to discuss project activities and agreements thus far, and then agree on detailed responsibilities and the contributions required of all partners in the upcoming water system planning and development tasks. The final MOU is then signed by EMW, the DPC and CPC.

Form #7 (Commitment Letter for Involvement in the EMW Clean Water System Project) is signed by each individual family confirming their commitments to co-finance the water system through their contribution of labor (digging and back-filling pipeline trenches – see early construction photos) and cash (the cost of the house connection).

Form #8 (Registration Form of Installing Water Meters and Fittings) is the financial commitment for each family who agreed to pay the cost of installation of a house connection, which is a small diameter pipe with a good quality water meter installed between the distribution pipeline and individual households. It also obligates the family to make an initial deposit for the cost of the house connection materials and equipment, which are bought in bulk by EMW from a proven supplier to ensure quality control of both the pipe and the meter. These two forms #7 and #8 have now been combined to simplify the process.

4.4. Construction and Performance Monitoring

Form #9 is the Evaluation of the Clean Drinking Water System. It includes a list of people (and their contact information) responsible for the water system management, a brief technical system description, number of beneficiaries, expected water production, initial water tariff, breakdown of O&M expenditure categories, and the type of management model to be used. It also leaves space to discuss any potential difficulties and troubleshooting suggestions. Finally there are photos of the overall system, its components, and pleased customers.

Form #10 is the Weekly Construction Progress Report, listing what activities have been completed in the current week, and what are planned to be carried out the following week, and is an integral part of construction monitoring and inspection. These reports document the construction process, as shown in the photos.

It would be helpful to develop a Form #11 that would presumably be a Quarterly (or Semi-Annual) Water System Status Report on the condition of the system, the collection and utilization of water tariffs, reporting of maintenance and repairs required and carried out, etc. This should be included in the post-construction monitoring and evaluation process. These periodic status reports would feed into an overall MIS that would track water system quantitative indicators (water production, number of customers, frequency of breakdowns, water quality, accessibility, reliability and quality. A more detailed assessment of the construction, supervision and inspection process is given in Section 9 below.

4.5. Handover of Water System Ownership to Community

After completion of all construction, pipe installation, and house connections, ownership of the water systems are formally turned over to the relevant local authorities for subsequent management, operation and maintenance, repair, and where appropriate, later expansion to unserved households. In the spirit of openness and cooperation, EMW provides all participating communities with detailed documentation of their water systems at the time of formally turning over ownership. This recently updated version of the handover documentation includes the following:

- All relevant administrative documents (e.g., Memorandum of Understanding (MOU)s, Management Board, minutes of discussions on project implementation, etc.);
- Water System Completion Report;
- Water Quality testing results;

- Well Drilling data and costs;
- Water Tower - location, design drawings, construction contract, and inspection results;
- Water distribution map, proposals for additional distribution (if any), plumbing (pipe-laying) schedule, contract, pipe and fittings inventory, and disbursement vouchers;
- Electrical system description;
- De-sedimentation and filtration system, including design drawings, contract and cost estimate, minutes of final inspection and had-over, and disbursement vouchers; and
- Copies of forms #7, 8 and 11 (see section 4.4 above) developed during the planning and implementation phases.

These documents would be quite useful to the beneficiary communities in the event of any problems they might have later on, especially if any components need replacement, or if questions arise about water quality issues.

5. Engineering Design and Construction

5.1. Performance Indicators

Rural water supply systems are often described and assessed in terms of the following important indicators based on the acronym QARQ, which stands for:

- Quantity (Q) - the amount of water available from the system on the basis of liters per capita per day (or LPCD). Typical LPCD levels vary from as low as 30 (for public taps where water is only available periodically (e.g., several hours per day) to as much as 120-150 LPCD for house connections when water is available on a continuous basis.

- Accessibility (A) - an indicator of how far (meters or kilometers) or how much time (minutes or hours) it takes for the average user (see photo) to collect the water needed each day.
- Reliability (R) - an indicator of the regularity with which water is available, which can vary over a given day and seasonally. Water reliability varies seasonally since the yield of many existing surface and ground water sources drops as the dry season progresses, and is only restored upon the arrival of the annual rains. In some areas, the groundwater table was also reported to drop as the dry season progressed.
- Quality (Q) - varies considerably from site to site, and is a significant problem at nearly all of the sites visited. This is discussed in some detail in the following section

- Continuity - Besides the QARQ criteria described above, some people feel that a fifth criterion of Continuity in also important, meaning the number of hours per day water is typically available at the system's water points (here, house connections).

This section focuses on engineering and other technical aspects of the EMW Clean Water Program, particularly in terms of how successful it is in terms of meeting these QARQ criteria.

5.2. Description and Typical Cost of EMW Water System Components

Although there are four or five gravity piped water systems that have been built by EMW, the vast majority of their water schemes use shallow well pumping systems (see several different systems in the photo below) that consist of the following components:

- Water Tower – have a capacity of either 21 or 50 m^3, and have three separate tanks. Well water is pumped to a de-sedimentation tank, then flows down into a temporary storage tank. It is then pumped up to the highest storage tank, from which it flows into the distribution pipeline. Because of often high turbidity in shallow wells, newer systems also have mechanical filtration devices, which cost $2,300. Typical cost of water towers is about US$ 5,000 (for a 21 m^3 tank - the 50 m^3 tank costs $8,000).

- Pumps (and associated electrical controls) – Depending upon the site and water production of the wells (each site has at least two wells, sometimes three or even more), one or more pumps are used to pump from one or more wells to the mid-level sedimentation tank. A second pump lifts water from the temporary discharge tank from the sedimentation tank up to the storage tank at the top of the water tower. The well pumps are either surface mounted centrifugal pumps or submersible pumps installed in the well. While the centrifugal pumps are generally cheaper and easier to repair, the submersibles can also be used where flooding is common, as they are unaffected by this. Costs of pumps commonly used on EMW systems range from about $175 – $320 (more detail about pumps is given in section 5.3 below).

- Shallow Boreholes (Drilled wells) – All pumped systems have at least two shallow (5-10 m deep), small diameter (40-60 mm) drilled or water-jetted wells (see photo), most commonly with surface mounted centrifugal pumps. Typical dimensions and costs are as follows:

- For shallow wells in frequently flooded areas where submersible pumps need to be used[18], well diameters are about 140 mm, the borehole itself is about 300 mm, and the pump diameter is about 250-280 mm. Small diameter shallow wells (60 mm diameter borehole) with no casing cost about VND 30,000 to drill, and use centrifugal surface mounted pumps.
- Drilled wells less than 10 m deep in alluvial soils only cost about VND 200-300,000 ($19) with casing.
- An 8-15 m deep shallow well 60 mm in diameter costs about VND 200-300,000. Larger diameter (100 mm+) boreholes for submersible pumps are usually at least 8 meters deep, and cost about VND 16 million ($1,000).
- A drilled and cased shallow borehole (10-15 m depth) costs about $30 – $40 (VND 480,000 – 640,000). Drillers receive no payment unless they hit water.
- A standard shallow (8-10 m) submersible pump (see the next section) and large diameter borehole costs $1,000 for the borehole, casing and pump.
- The standard EMW system has two drilled wells, with a capacity of about 45-50 m^3/day, and serves about 500 households (HH), about 1,500 – 2,000 people.

• <u>Deeper Boreholes</u> - While local well drillers can drill up to 15 m, beyond that a professional driller is required. Some typical costs and dimensions are:

  - Deep wells cost about VND 1 million per meter, and hard rock drilling is even more costly (several times more), and requires specialized equipment. A typical 60 m deep well in alluvial soils runs about VND 60 million, and a 40 m deep borehole runs about VND 40 million. In rocky areas, drilling costs can easily run several times as much.
  - Drilling a borehole with a 140 mm casing (requiring a 300 mm borehole) for a submersible pump costs about VND 1 million ($62) per meter.
  - Drilling a 50 m deep borehole with a 60 mm casing costs about VND 500-600,000 ($31-38) in alluvial soil, as in commonly encountered in the lowlands of Quang Nam. However, in a rocky area with underground boulders, drilled wells 30-60 meters deep could cost VND 30-60 million ($1,875 - $3,750, including the submersible pump).

• <u>Transmission / Distribution Pipelines</u> - Cost varies depending upon pipeline length and diameter, as well as the pipe material. Pipe costs typically average about VND 24,000 (US$1.5) per meter using a mix of 60-100 mm diameter pipe, mostly high quality PVC[19]. The average sized system (covering about 1,275 people) requires about 10,000 m of pipe, which costs about $1.50 per meter. Average pipe cost (which of

[18] This is because surface mounted centrifugal pumps would likely be flooded, short-circuiting the pump unless it was purposely installed and protected against likely flood damage. Centrifugal pumps cannot be used in situations where the water level is more than 5 meters.

[19] A comparison of PVC and High Density Polyethylene Pipe (HDPE) is given in section 5.3.5 below. In short, HDPE is considerable stronger and longer lasting than standard PVC, but costs more.

course varies tremendously from place to place) per system is then about $10-15,000, which typically represents about 60% of total capital cost for each scheme.

- House Connections - Each participating household is connected to the distribution pipeline through a small diameter pipe with a valve and water meter for billing purposes. The cost of the water meter is VND 50,000 for the older Chinese variety. Meters in the newer systems are manufactured by a Chinese/German joint venture cost about VND 65,000. To ensure their accuracy, the meters are calibrated before installation at an additional cost of VND 15,000 ($1).

The vast majority of EMW piped water systems (67 systems completed so far) fit the description above, but EMW has also installed 6 dugwells, and 7 hand pumps on drilled wells. For co-financing a gravity water system in the hills outside of Hue City, EMW has agreed to contribute a substantial section of the pipeline from the slow sand filter (see photo) to connect into the distribution system. This may be the first in a series of gravity systems co-financed by EMW in collaboration with the local Provincial Center for Rural Water Supply and Sanitation (PCERWASS). If that this collaboration is successful, EMW should continue to pursue such joint projects, while maintaining its participatory planning and implementation approach with beneficiary communities.

To leverage investments in joint projects, EMW should continue to insist on certain conditions such as household co-financing (cash for house connections and in-kind labor for digging and backfilling pipeline trenches – CERWASS has already agreed to this) and mandating full cost recovery tariffs. The tariff is VND 1,000/m^3 (US$0.06). Since properly constructed gravity systems typically have low O&M costs for the first five years, this is not a problem. However, when major repairs are eventually required, the O&M fund may be insufficient to finance those repairs and the system may well be abandoned. To help ensure financial sustainability, which is often not commonly achieved with GOV-financed water systems, reasonable (and affordable) tariffs must be regularly paid.

Monthly tariffs are collected based on metered water consumption. Typical consumption for one family (with an average of about five people consuming 30 or 40 liters per capita per day - LPCD) is about 4.5 - 6 cubic meters (m^3) per month. Note that this amount is mainly for drinking and cooking, but depending on the family choice, also could be for bathing and washing clothes. Other typical water demands (e.g., water animals and gardens) are usually met with water from other sources such as a dug wells, hand pumps, or surface water sources (e.g., rivers, ponds, or irrigation canals).

5.3. Engineering Design Issues

5.3.1. Water Demand and Coverage

Calculating water demand is based on population of the intended service area. Domestic water consumption includes water for cooking, drinking, washing, bathing and other hygiene and sanitation purposes. According to the design consumption standard for rural areas stated in the GOV Document No. 20 TCN-33-85, the standard consumption is 25–50 liters per capita per day (LPCD). According to the NRWSS-2020, by the end of 2010 per capita consumption in rural areas will be about 60 LPCD.

However, this should be considered a target, and not necessarily achievable in all situations. In fact, many HHs are unlikely to use this much piped water just because of the cost of piped water. Demand will also increase over time as the population of the service area increases, and when HH income increases, making more money potentially available to buy more water. EMW takes this into consideration by using a 1.2 multiplier on current demand to account for future growth. Coverage is the percentage of people living within the Service Area (the area serviced by the water distribution system). Where some households are located too far away from the planned distribution network to be easily hooked into the system, those HHs are given the option of paying about VND 1 million per 100 meters of additional pipe required.

5.3.2. Water Sources

In Quang Nam, finding and developing suitable water sources that are: a) relatively easily accessible, b) good quality, and c) sufficient quantity to meet the water demand at the site is not so easy. Groundwater below about 7-8 m depth is often saline (especially near the ocean). At shallower depths, sedimentation levels are often high in alluvial soils (see photo), and contamination from agricultural activities or unhygienic disposal of human and animal waste can be problematic. When seeking an appropriate water source, test wells are drilled to assess: a) static water level (depth from the surface to the water when no pumping occurs); b) drawdown (in meters) when the well is being pumped); c) water yield (i.e., m^3/hr), and d) water quality (samples are collected for later analysis).

Because fresh water is less dense than salt water, it “floats" on top of salt water. This is important when drilling groundwater wells on islands or areas near the sea, such as much of Quang Nam. The weight of rain water percolating into the ground depresses the salt water beneath it, forming the shape of a lens. The boundary separating fresh water from salt water is a transition zone of brackish water, caused by seasonal fluctuations in rainfall, tidal action in nearby rivers, and water being withdrawn either by pumping or natural discharge.

Because of the relatively thin freshwater lens at many sites, Water Managers have adopted the practice of drilling multiple wells to develop a small bore field. They then shift from one well to the next in the bore field so as not to over-pump any of the wells. Several systems we visited had adopted this practice. The wells drilled for this project are generally fairly small diameter (70 – 150 mm). Well yields range from 4-8 m^3/hr, but each site has 2 wells delivering a total of up to 8-10 m^3/hr. While a well operating 24 hours a day (if the well could be continuously without excessive drawdown) could deliver up to 192 – 240 m^3/day, enough to meet the needs of about 6,400-8,000 people (at 30 LPCD). In fact, the pumps are operated alternately (taking turns) so as to minimize drawdown and wear and tear on the pumps.

So far, the focus of EMW activity has been in relatively flat, low-lying areas. If EMW chooses to expand its water program to more hilly areas, then it will likely focus more on gravity-fed piped systems than it has so far. About 4-5 gravity systems have already built using water from rivers, streams, or mountain springs. This will require dealing with different system design issues (e.g., small dams, slow sand filtration, etc.), and EMW is now starting to gain experience in this area, by working with the Hue-based Center for Rural Water Supply and Sanitation to construct a gravity piped system in the hills near Hue. Quang Nam PCERWASS (the GOV provincial RWSS agency) focuses only on gravity systems, so this may be a disincentive for EMW to work on gravity systems. Many GOV gravity systems have been abandoned after just a few years, because of bad management. Nonetheless, PCERWASS is preparing to construct 4-5 new gravity systems this summer in mountainous areas largely populated by minority groups (GOV sets aside special funding for this purpose. In addition, World Vision also has constructed many gravity systems in the hills, which can save considerable labor carrying water from a source to one's home.

5.3.3. Pump Selection

Pump sizing and selection depends upon: a) the elevation head (the distance from water level when the well is being pumped up to the discharge point in the water tower), and b) the desired flow rate (m^3/hr or liters/second). For example, the average number of water consumers in the EMW piped water systems is 1,275 people. If they each use 30 liters of water per capita per day (LPCD), the daily demand is about 38 m^3. Note that if people actually use 60 LPCD (which is unlikely in the generally poorer communities where EMW provides assistance), all these numbers would double.

If a pump runs continuously, its flow rate must be at least 1.6 m^3/hr. A pump with higher output could run fewer hours, which is more desirable because it is easier on the pump over the long run. It is important not to use too large a pump, because it would constantly cycle (turn on and off), shortening motor life. Pumping at too high a flow rate (more than the well's sustainable yield), especially from a limited yield water source (common in Quang Nam) may cause excessive drawdown (when the underground water level drops way off), thereby increasing pumping head and using more power. It could also cause the pump to draw up sediment (a common problem in Quang Nam). The design flow rate should not be more than the well's sustainable yield, which is determined during the initial well testing.

The Water Team engineer selects from a range of pumps available in Danang, or uses pumps recommended by a knowledgeable well driller with working experience with EMW. To choose the right size and kind of pump for a situation requires assessing the pump curve for each pump. Pump curves show output (liters/sec or m^3/hour) at the "total system head" (elevation plus friction loss). Choosing pumps to give enough water at the system head, and to do so efficiently, results in electricity savings over time, so reduces O&M costs. How to select an appropriate pump for any given situation is described in "*Pump Selection – A Field Guide for*

Energy Efficient and Cost Effective Water Pumping Systems in Developing Countries"[20], hard and soft copies of which were given to the EMW Water Team. It would be helpful if relevant sections of that document were translated into Vietnamese and used as a training tool. Table 2 on the following page describes the advantages and disadvantages of different kinds of pumps. Locally available pumps used on EMW water systems include:

- Pentax submersible pump (Italy), 5 m3/hr output for VND 5.1 million ($319);
- Wilo centrifugal pump (German), 2 HP (1.5 kW) for VND 5 million ($313);
- LG centrifugal pump (Korea), 2 HP (1.5 kW) for VND 7.2 million ($450);
- Mastra submersible pump (Italian),1 HP (0.75 kW) for VND 5.1 million ($319); and
- DK20 centrifugal pump (China), 1 HP (0.75 kW), for VND 450,000 ($28).

5.3.4. Storage Tank Sizing

There are different approaches to sizing storage tanks, and guidelines range from 25-100% of total daily demand. The bigger the tank, the higher the cost, but also the more security of service, meaning the safety margin should the pump fail. For example, using the 38 m^3/day demand above, the tank should hold between 9.5 (say 10) – 15 m^3 of water. Standard tank used in EMW systems are 21 m^3 (for small systems) and 50 m^3 (for large systems). Those tanks would hold 55% - 130% of daily demand for the average sized system.

This suggests that at some tanks are somewhat oversized for the number of consumers. But practically speaking, it provides an additional margin of safety mentioned above, and takes into consideration steadily increasing demand as the population grows. In addition, it is not practical to try to build exactly the right size tank for each site (although that could be done, if necessary). Using a wider range of standard sized tanks is more practical. To reduce storage tank costs somewhat, I suggest that in the future, EMW use three tank sizes (say, 20, 35 and 50 m^3), and that no tank should be designed to hold more than 100% of daily demand.

5.3.5. Pipe Type and Sizing

There are at least three important issues when it comes to selecting pipe: what type of pipe to use (steel, PVC, HDPE), how much it costs, and what are the optimal pipe diameters (and thicknesses) for each section of the transmission line and distribution network. Optimizing pipe diameters along the distribution pipeline can yield significant costs savings[21]. Up until recently, most pipes used for the EMW water systems has been standard PVC (polyvinyl chloride), and limited steel piped for exposed sections such on water towers, and standpipes in people's yards. Steel pipe is appropriate for high pressure systems, and is both relatively heavy and expensive. Since EMW systems typical are not high pressure systems (although that may change for gravity systems that might be built in more mountainous areas), it is unnecessary for most EMW pipe applications, for which plastic pipe (when suitably buried and protected) is more than sufficient.

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[20] *Pump Selection – A Field Guide for Efficient and Effective Water Pumping Systems in Developing Countries*, R. McGowan and J. Hodgkin, USAID Water and Sanitation for Health Project, July 1992.

21 See section 5.6 below on technical references and computer programs to optimize piping systems.

While PVC is cheaper than other pipe and is relatively easy to install, it does have certain disadvantages, such as deterioration and eventual cracking when exposed to sunlight over the long term. It also tends to develop leaky joints resulting in water losses (up to 20%, according to some sources) when not properly installed, and potential breakage can occur when it is not buried deep enough (at least 70 cm) when heavy vehicles drive over too shallow pipe trenches.

Because of this, EMW has shown considerable interest in switching over to using High Density Polyethylene (HDPE) Pipe. High Density Polyethylene (HDPE) solid wall pipe has been used in potable water applications since the '60's, and has been gaining approval and growth in municipalities ever since. Some distinctive advantages of HDPE pipe that provide important benefits for water applications are listed below[22]:

Table 3: Applications of Common Types of Water Pumps

Pump	Use	Advantages	Disadvantages
Self-Priming Centrifugal	Surface-mounted motor and pump for high-volume, low-head applications; commonly used for irrigating from a river	Ease of installation and access; low starting torque; wide range of capabilities	Limited 5-meter suction head; relatively inefficient compared to centrifugals that have flooded inlets (such as submersible and shaft-driven units); output greatly affected by variations in head
Submersible Centrifugal	Down-hole, medium-volume, high-head, integrated motor/pump unit	Motor is directly coupled to impellers; easily cooled because submersed; multi-stage to accommodate a wide range of heads; straightness of well not critical; no noise; no pumphouse necessary	Potential problems with submerged spliced electrical cables; sandy or highly saline water causes rapid degradation (water quality affects replacement interval for pump and motor since these are submersed); high capital cost; expensive to repair (pump set requires removing unit from well); requires electricity (cannot use other drivers); needs voltage fluctuation protection
Shaft-Driven Centrifugal Vertical (or Deep Well) Turbine	Down-hole, medium-volume, medium-head pump driven by rotary shaft	Surface-mounted motor offers ease of maintenance; self-priming; wide range of capacities available; good sand/silt tolerance	Shaft losses reduce efficiency compared to submersibles; shaft and borehole alignment are critical to proper operation; installation is difficult; output affected by variations in head; difficult to maintain (pump must be pulled for service)
Jet	Medium-head, medium-flow, down-hole pump and surface-mounted motor	Low equipment and maintenance costs; can be used beyond suction limit; very reliable; easy access to motor and pump for maintenance; low starting torque; least expensive intermediate-head pump; adaptable to very small wells (50 mm)	Relatively inefficient compared to other types of pumps
Positive-Displacement Reciprocating-Piston (Jack)	High-head, low-flow, down-hole piston and cylinder, driven by sucker rod from surface; most commonly used with windmills	Can pump low flows against very high heads; output is fairly independent of head; simple design; easy to repair; efficiency little affected by changes in head	Maintenance requires periodic replacement of leathers and cylinder; requires correct alignment; more expensive than centrifugals of same size; relatively inefficient as leathers degrade; pulsing flow; in PV systems (see Chapter 6) requires batteries or power-conditioning units (PCUs) for high starting current
Positive-Displacement Rotary	Medium- to high-head, medium-flow, Mono or Moyno pumps	Generally very robust; output fairly independent of head; simple construction; self-priming; good efficiency over wide range of heads except for under 20 meters; no back-flow valve required; speed of operation can be adjusted to fit conditions without significant loss of efficiency	Sand or very hard water can cause premature degradation of rubber stators; requires gearing; can overload motors if downstream valves are inadvertently closed; installation is difficult. Although newly-developed nitrile stators have lower starting torque, in PV or wind systems standard units require battery or PCU to supply high starting torque
Diaphragm	Flow produced by flexing diaphragm that is generally used for low-head, low-flow applications	Few moving parts; low internal friction; tolerant of sand or other particulates	Low capacity; not appropriate for deep wells; constant flexing causes diaphragm wear; fairly uncommon type of pump

22 Adapted from the Plastic Pipe Institute and the American Water Works Association websites.

- HDPE pipe can be heat fused together to form a joint that is as strong or stronger than the pipe itself, and is essentially leak free. This eliminates the potential leak points every 10-20 feet as found with PVC, eliminating infiltration (potentially contaminated water getting into the pipe) and exfiltration (water losses due to leakage from cracked pipes or bad joints) problems experienced with alternate pipe joints such as PVC.

- The Life Cycle Cost (LCC) of HDPE pipe differs from other pipe materials because the "allowable water leakage" is zero rather than typical leakage rates of 10 to 20% for PVC and Ductile Iron.

- Because it is bendable, this can eliminate many fittings required for directional changes in a piping system where fittings and thrust blocks or restraints are required with alternate materials.

- HDPE pressure pipe can accept repetitive pressure surges (e.g. from pumps cycling on and off) that significantly exceed the static pressure rating of the pipe.

- Longer pipe lengths mean fewer connections, thereby reducing labor time and costs.

- The polyethylene pipe industry estimates a service life for HDPE pipe to conservatively be 50-100 years, effectively eliminating any replacement costs.

- Polyethylene pipe is more able to structurally withstand impact than PVC pipe, for example, when a truck drives over an insufficiently deeply buried HDPE water line.

The downside of using HDPE is its cost. There are two varieties of HDPE available in Danang, a cheaper version made in Saigon, and a more expensive version made in Danang itself. For the same equivalent length and diameter of pipe, HDPE is about twice as expensive as the same quality of PVC pipe. However, for more critical design situations (e.g., rocky areas that might puncture PVC, steep runs that require higher pressure pipe, or any situations (such as road crossings, even where pipe sleeves or concrete pipes might be too expensive as protection for the PVC pipeline), it might be better to use HDPE.

Pipe sizing is a straightforward procedure that can be done by using a calculator and standard pipe loss charts. Because there is pressure drop from friction loss as water flows through a pipe, pipe size decreases the farther away you are from the water tower. How to do this is described in the *Pump Selection – A Field Guide for Energy Efficient and Cost-Effective Water Pumping Systems in Developing Countries*, described in Section 5.6 below.

5.3.6. Evolution of EMW Water System and Component Designs

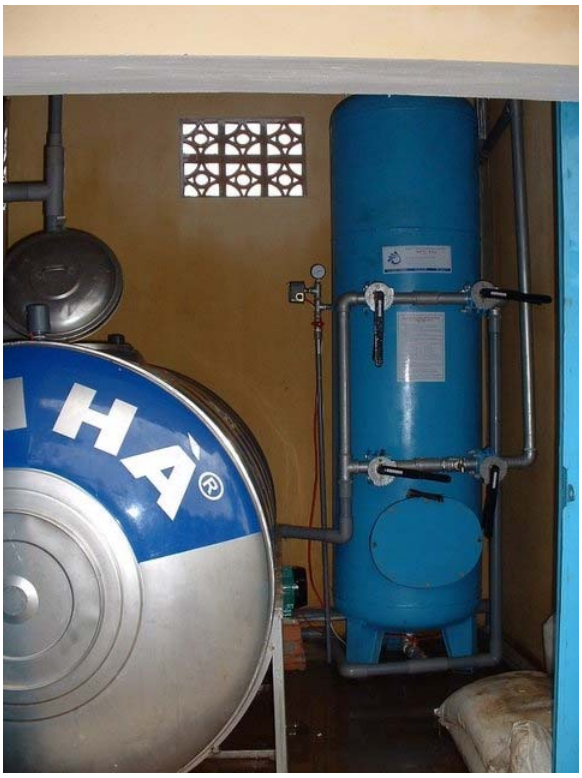
Engineering design of various water system components has evolved in several ways since the beginning of the Clean Water Program. Important design modifications include:

- The use of steel reinforced concrete tanks instead of the older brick and mortar tanks, which typically have a shorter lifetime and are much more prone to leakage.

- Sedimentation tanks were built into the water towers, but were sometimes unable to deal with heavy sedimentation loading. So, EMW decided to install mechanical filtration tanks with a capacity of 10 m^3/hr and costing about VND 36 million ($2,300 is the US$ denominated cost) in situations where a standard sedimentation tank is inadequate to ensure adequate water quality. All new systems now use both de-sedimentation and mechanical filtration (see photo on the following page).

- While there are no known harmful health impacts from iron in drinking water, discoloration (reddish color) and an undesirable taste mean that steps need to be taken to reduce high iron concentrations. High iron concentrations can also result in growing iron bacteria, which causes red coloration, bad tastes and odors, clogged pipes and pump failures. See section 5.4 below how to deal with iron problems.

As the water program staff has accumulated experience about what works and what doesn't, designs have been periodically modified to better meet the conditions in the field. This is an on-going process that has been applied to all system components, but particularly those having to do with sedimentation and improving water quality. One technology that EMW may want to consider is the development of rainwater catchment (RWC, see photo below), where it is appropriate (e.g., where there is sufficient rainfall to make it worthwhile). The use of RWC in rural communes is very common in certain areas of Vietnam (e.g., the Red River Delta) that receive adequate rainfall to make the investment worthwhile. The advantage of utilizing rainwater is that it provides generally high quality of water at a low cost. The downside is the high variability of rainfall both by location and time of year. The generally arid areas in Quang Nam Province are not particularly promising areas for investing in RWC.



While EMW already retains the services of an experience retired GOV water engineer to supervise design revisions, it would be useful to consider whether another qualified engineer might need to be hired in the event that the water program received significant additional funding for a substantial increase in the number of water systems that could be built each year. Another useful position to fill would be an experienced hydrogeologist who primary responsibility would be to help more precisely identify the best available local source of water for new proposed systems.

5.4. Water Quality

Table 4: Water Quality Criteria

No.	Water Quality Criteria	Units	Allowable Limit
1	pH	n.a.	6.5 – 8.5
2	Color	TCU	15
3	Turbidity	NTU	2
4	Hardness	mg/l $CaCO_3$	300
5	NaCl (salinity)	mg/l	250
6	Iron (Fe)	mg/l	0.5
7	Manganese (Mn)	mg/l	0.5
7	Phosphate	mg/l	2.5
8	Sulfate (SO_4)	mg/l	250
9	Chlorine	mg/l	250
10	Oxidization	mg/l	2.0
11	Ammonia	mg/l	1.5
12	Nitrite (NO_2)	mg/l	3.0
13	Nitrate (NO_3)	mg/l	50
14	E.Coli	units	10
15	Total Fecal Coliform	units	50

The 2005 EMW Annual Report says that "EMW constructed and installed 15 water systems that brought clean water to over 16,000 people. Clean water is free of water-borne diseases, sewage, chemicals and other pollutants. Access to clean water can improve the health of an entire family. "However, "clean water" can mean different things to different people. In some cases, not all water parameters can be met for either physical or financial reasons. Nonetheless, if water quality can be considerably improved over the "non-system" condition, it is still worth while to develop a system that provides higher quality water as shown in table on the right to beneficiary communities, even if it does not strictly meet all GOV water quality criteria.

Water quality is a common constraint at many EMW water system sites, particularly for pH (which can corrode pipes), turbidity (sedimentation), salinity, iron, hydrogen sulfide - "rotten egg" smell, color, phosphates from fertilizer, pesticides and herbicides from agricultural activities, etc. As described in Section 4.2, water quality tests are done several times during the system planning and implementation stages. Before a prospective water source is confirmed, its water quality is tested to ensure that it meets (more or less) basic water quality parameters. If not, consideration is given to what kind of treatment is required to bring the existing water quality up to the required standard. If that can be done in a reasonably cost-effective way (e.g., through de-sedimentation and mechanical filtration to reduce turbidity, through aeration to reduce iron, or through chlorination to remove faecal coliforms, etc.), the required treatment will be incorporated in the system design and budget.

Use of the word "clean" water can have different meanings for different people. Finding water that strictly meets all GOV and international (World Health Organization – WHO) standards (which are almost the same) for drinking water can be difficult at some sites. The most difficult problem is high salinity below a depth of about 8 meters in many areas of Quang Nam Province. Salinity (which makes water essentially undrinkable above a relatively low concentration) is not easily technically and economically resolved. Water with significant salinity can be treated using the reverse osmosis process or evaporative desalination, but at the village level these are expensive and complex to maintain technologies, and so are not recommended. In addition to excessive salinity, high levels of sedimentation, iron (one recent sample was measured at 10 times the allowable level), hydrogen sulfide ("rotten egg smell"), occur at some EMW sites.

The box below briefly describes common treatment for iron and hydrogen sulfide. In addition, because of the frequent proximity of rice fields to water sources, the presence of pesticides, herbicides and fertilizer is a potential problem as well. Unfortunately, these organic pollutants are very expensive to test for, as a separate test is often required for each specific type of pesticide or herbicide, thus considerably driving up the cost of water quality analysis. To my knowledge, EMW does not routinely test for pesticides, herbicides and fertilizer as part of their water quality testing regimen. It is very expensive to do so, as for example, not all pesticides or herbicides are chemically similar, so that multiple tests would have to be carried out to identify commonly used chemicals. This is both expensive and impractical.

Water Quality Problems in Quang Nam

Iron and hydrogen sulfide (H2S) are common well problems that frequently occur together and often lend themselves to similar treatment. The standard methods used to treat both are variations on the same three-step principle of oxidation, precipitation, and filtration. An oxidizer is added to the water, which induces precipitation of the iron and hydrogen sulfide, and the precipitated contaminant is then filtered out of the water.

The methods vary according to the oxidizer and the filtration methods used. Common oxidizers include chlorine and potassium permanganate. Ozone and hydrogen peroxide are increasingly used. Precipitated iron is most commonly filtered out with specially prepared media. Carbon is most frequently used to filter hydrogen sulfide, although carbon can also be very effective for filtering iron. Catalytic carbon is designed to be more effective than standard carbon with both iron and hydrogen sulfide. Air is a powerful treatment for both iron and hydrogen sulfide, and air systems have the great advantages of low cost, safety, reliability, effectiveness, and ease of installation. Aeration systems add no chemicals to well water and avoid on–going chemical expense. Aeration systems are relatively trouble-free and completely safe. (*Adapted from: Pure Water Products, LLC website)*

Where excessive iron is a problem (0.3 parts per million (ppm) of iron and 0.05 parts per million (ppm) of manganese is objectionable to most people), iron removal can be done using either aeration and filtration (iron and manganese precipitate out of water when exposed to air, and can then be filtered out), greensand filtration, chemical treatment (polyphosphates), or chemical/mechanical (ion exchange). Refer to the EMW Water Team reference library in the AWWA's Technical Series on Water Treatment for details (see Section 5.6 below).

An ultraviolet water treatment device was installed in a school at the site of the Cam Phu water system. The ultraviolet light kills coliforms that can cause diarrhea, especially in children. This is a relatively new and promising technology, but still relatively expensive. While it does significantly reduce coliform contamination, it does not do anything for high iron, salinity, pesticide, herbicide or other water quality problems commonly encountered in much of Quang Nam Province.

It is important to regularly monitor not only the quality of water in the selected source, but also the quality of water delivered to homes, and how people store water in the homes. Even if good quality water is available from the source (which can often be problematic here in Quang Nam and the surrounding provinces in the Central Region), it is important to monitor the quality of water provided to homes. Unnoticed cracks in the distribution pipeline may allow pollution to enter the pipelines when the pipeline is not pressurized. Water must be properly stored in the home in order to maintain the quality of water provided by the system. Even with piped water delivered to the house, people often store water in uncovered containers in the kitchen or elsewhere as a security measure should there be a system outage for some hours or even days[23]. If not properly done, water stored in the house can become contaminated. Enhancing community awareness of the importance of sanitary in-house water storage is important. This is another reason for a sanitation and hygiene awareness program.

There are several other alternatives to help ensure the quality of water once it reaches the household. It is common in rural areas in Vietnam to see people drink water from boreholes after applying primary treatment such as simple sedimentation tanks, or clay / fiber water filters. Besides a variety of household level water filtration systems, there are other point-of-use water treatment products such as "SafeWat" which is being promoted by PSI /Vietnam based on the urgent need for safe drinking water in the provinces of the Mekong River Delta. It is essentially chlorine (dilute sodium hypochlorite). It was developed by the U.S. Centers for Disease Control (CDC), and is being promoted in over 15 countries now, including in Vietnam. In the 4 months since the inception of this program in Vietnam, PSI has provided 70,000 units of "SafeWat" to families, enough to provide clean water to 42,000 people for one year, or 70,000 families with 6 weeks of clean water.

The program initially appears to be cost-effective, efficient, and shows promise of being more widely adopted. A social marketing and promotional program (including TV ads) is now being developed. The pilot program combines social marketing of SafeWat, a 150 ml bottle of 1.50% sodium hypochlorite solution with a hygiene improvement campaign. Each bottle will treat enough water to protect a family of four for 5-6 weeks and can be purchased through our partners for just VND 4,000 (US$ 0.25). SafeWat, including the solution and bottles, is 100% locally produced in Vietnam, leading to in-country revenue and job opportunities. It is something that EMW may want to consider as more experience is gained in its use and acceptance in rural villages.

5.5. Water Losses

Water losses are usually counted two ways. One is "Unaccounted for Water" (UFW), the other is "Non-Revenue Water" (NRW). UFW in Vietnam in urban systems is typically 30-40% of the total water production. UFW is mainly due to water losses in the distribution system, faulty water meters (in the house connections), and illegal water tapping which is very common, even in large urban water systems. Another common source of UFW is the practice of "trickling", which happens when people turn down their water tap so that the water flow trickles through the meter at such a slow rate that the meter wheel does not turn, even though water is running through it. This water is then not registered by the meter, and so is not paid for in the monthly water tariff. In at least some of the EMW systems (e.g., Tam Hoa Commune), households who steal water in this manner were cut off from the system, if the Water Managers find out about it.

One way to monitor water loss is to install a water production meter at the head of the distribution line out of the water tower, and additional meters at the heads of distribution subsystems (e.g., major branches of the distribution system, such as where the pipeline goes to each hamlet) to help identify where water losses might be of particular concern. EMW has done this already. Comparing water production with total metered consumption will show the extent of water losses. If it is more than 30%, a water loss study should be done to identify

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23 For example, if a pump fails and needs to be replaced, or if a pipe breaks and has to be replaced.

the major source(s) of the losses, and then to rectify the problems. Generally, well-built new systems generally have low losses initially, will older systems typically have greater losses.

5.6. Technical References and Tools for Water System Design

A variety of very useful manuals and guidelines are (or could easily be made) available to the EMW Water Team. Unfortunately, few if any have been translated into Vietnamese. Although there are very likely excellent technical guidelines from agencies such as the Water Resource Universities, the Ministry of Construction, and other engineering universities, such manuals are often difficult to use unless the reader has taken a university course using that as a text book. However, there are other practical and sometimes (but not always) easy to use guidelines in English that could be used by the EMW Water Team, including the following:

- *Pump Selection – A Field Guide for Energy Efficient and Cost-Effective Water Pumping Systems in Developing Countries*, Rick McGowan and Jonathan Hodgkin, USAID Water and Sanitation for Health Project, July 1992. This manual is both practical and easy to use (if I do say so myself). Although it also covers a variety of power sources (wind, solar, diesel) that are not used in the EMW program, this manual would be quite helpful in future training programs for the EMW Water Team[24].

- *The Principles and Practices of Water Supply Operations Series* from the American Water Works Association, a full set of which was provided to EMW courtesy of Water for People (WFP), includes:

    - *Water Sources*
    - *Water Treatment*
    - *Water Transmission and Distribution*
    - *Water Quality*, and
    - *Basic Science Concepts and Applications*

- *Manual of Individual Water Supply Systems* (U.S. Environmental Protection Agency).

- <u>*WaterCAD water system design computer program*</u> - This program (which has been used to design ADB-financed water systems in Nepal and other countries) can model any kind of water system that EMW might want to build, and do all the tasks listed under the EPA-Net program below. From its website[25], WaterCAD is a hydraulic and water quality modeling solution for water distribution systems. It features advanced model building, optimization, and asset management tools. WaterCAD helps engineers analyze, design, and optimize water distribution systems. WaterCAD is a reliable, resource-saving, decision-support tool for water infrastructure. The only trouble is that the WaterCAD program costs about $500 for the basic version.

- <u>*EPA-Net water system design program*</u>[26] – This <u>***free***</u> program developed by the US Environmental Protection Agency (EPA) performs extended period simulation of hydraulic and water-quality behavior within pressurized pipe networks. A network can

24 Hard and soft copies of this manual have been given to the EMW Water Team by the consultant.

25 For reference refer to the website: ftp://ftp2.bentley.com/dist/collateral/spec/watercad_specsheet_eng_lores_106.pdf

26 Downloadable for the EPA website at: http://www.epa.gov/nrmrl/wswrd/epanet.html#Downloads.

consist of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks water flow in each pipe, pressure at each node, height of water in each tank, and concentration of chemical (e.g., chlorine) throughout the network over time. EPANET was developed by the Water Supply and Water Resources Division of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory. It is public domain software that may be freely downloaded, copied and distributed. EPANET provides a fully-equipped, extended period hydraulic analysis package which can (among many other things):

- Handle water systems of any size;
- Compute friction head loss, and minor head losses for bends, fittings, etc. ;
- Model constant / variable speed pumps, and compute pumping energy / cost;
- Model various types of valves including shutoff, check, pressure regulating, and flow control valves;
- Allow storage tanks to have any shape (i.e., diameter can vary with height);
- Base system operation on simple tank level or timer controls.

6. Financial, Economic and Cost Issues

6.1. Water Demand and Willingness and Ability to Pay

A common problem in Vietnam is that where households have easy access to relatively clean (this term is used loosely) water, they try to minimize their expenses by using as much non-piped water as possible. This reduces the water revenue collected by the Water Manager, potentially reducing the financial sustainability of the system. For example, if a water scheme is designed so that it can provide water at say 30 LPCD (the standard amount in rural water schemes), this means that each family is expected to consume about 30 liters x 5 people per family x 30 days per month, or about 4.5 m^3 per household per month. Therefore, rural water schemes are often designed to provide about 5-6 m^3 per family per month.

However, if people have a usable alternative source (for example, a dug well or small drilled well with a hand pump, it is likely they will use this water for non-critical uses such as bathing and washing clothes. This common practice has the effect of reducing the amount of water used, and hence the amount of water tariffs collected.

Water demand is also seasonally dependent in Quang Nam Province, as the salinity of the groundwater table varies over the wet and dry seasons. Right now, the river water is quite salty, so that it is not a viable alternate water source. This increases the demand for piped water, even though it is much more expensive, and so increases overall scheme revenues. The opposite happens in the raining season.

Since the quality of piped water in existing EMW systems is sometimes problematic due to the often poor quality of the groundwater sources, if a better source can be developed, water demand will very likely increase accordingly. People mentioned this as an important issue to consider when EMW replies to the community response for an improved water source to be integrated

into the system. The women in the photo above expressed their serious concern about the poor quality of available existing alternative sources, and their willingness and ability to pay for improved water through a proposed expanded system in Tam Giang.

It is also important to assess customer ability to pay, sometimes referred to as "affordability". While people in Binh Dao Commune are clearly willing to pay for improved water services (largely because of the very poor quality of easily accessible ground water and surface water in rivers and creeks), one other issue to consider is affordability. Large multilateral donors such as World Bank and ADB typically use 4-5% of monthly household income as a limit for what people should be expected to pay for water.

In the Water Consumer Satisfaction Survey conducted as part of this evaluation, we surveyed at least one poor, one average and one relatively well-off household in each village surveyed. The average monthly income for the 75 HHs surveyed was VND 1,002,000. Their water bills were typically about VND 8,000 – 20,000 per month, with an average of VND 15,600. Some of the poorer families only used minimal levels of 1 – 2 m^3/month to minimize household expenditure on water. The ratio of water cost divided by average HH income was only about 2%. Thus, well below the guideline of 4-5% of monthly income to be spent on water according to ADB and World Bank. Note that it is very common for HHs to understate their monthly income in surveys such as this. Thus, their water expenditures would be considered within the reasonable range according to the common measure of affordability.

6.2. Construction Cost and Financing Sources

Construction of EMW piped water systems is co-financed by three groups – beneficiary communities, local authorities (Commune People's Committee), and EMW. Each family accessing piped water pays the full cost of their house connection (pipe, water meter, and installation thereof). In addition, they share in the overall community responsibility for digging and back-filling all of the pipe trenches. For example, in the Que Son 2 system, the average cost of a house connection (water meter, valve and pipe from the distribution line to the individual house) was VND 154,000. The cost of construction, equipment and materials for the Hue Son 2 system was $21,000 from EMW, plus about VND 180,000 each from the 358 participating HHs for their house connections, for a sub-subtotal of $4,027. Therefore, the total HH cash contributions represented about 16% of the total system cost (not including the in-kind labor contribution from the villagers for digging and backfilling the pipe trenches). The labor contribution was worth about $10-15 per household, for a total system construction cost of about $14,000 for an average size scheme of 1,275 people.

As part of their formal role in program planning and implementation, the local authorities provide the required rights-of-way for the pipe line trenches, as well as the land where the water tower (where the tanks, pumps, sedimentation and filtration system, etc, are installed) is built. As the average size of the parcel of land required for the water tower is about 10 m^2, and land in rural areas costs about VND 200,000 per m^2, this is equivalent to a contribution of about VND 2 million (about US$125) on average. This represents about 1% of the total cost of all equipment and materials, and the construction contract for building the water tower and all of its components. However, local government support of the program planning and implementation is a valuable (albeit low cost) contribution to the success of the program. Nor does this 1% of the total system cost include the "legal" costs of pipeline rights of way, and the personnel cost EMW provides the great majority of the system financing, including that of supporting the EMW water program staff in their interactions with the beneficiary communities.

Note that when compared to similar rural water supply (and usually sanitation) projects funded by multi-lateral agencies such as the World Bank and the Asian Development Bank, the real community cost-sharing in the EMWF subprojects is considerably higher[27]. This is good in at least two respects. One is that it shows a strong willingness and ability to pay for improved water service. The second is that it demonstrates a sense of ownership in the water system. This is important or the long term sustainability of the system, as people that feel a strong sense of ownership are much more likely to properly operate, maintain and repair the system in which they have invested a substantial amount of their own money.

Another important indicator in the provision of rural infrastructure is the per capita cost of the new or improved service. World Bank / GOV Red River Delta Rural Water Supply and Sanitation (RRD-RWSS) Project that was designed in 2004-2005 and just recently received final approval by the GOV, the per capita costs for the water supply systems is in the range of US$ 35-45, compared to the EMWF per capita costs of about $10 (which does not include the approximately 25% management cost, which was somewhat less for older systems). Note that in some cases there is some difference in the quality of the water provided. This is because the RRD-RWSS Project systems have treatment including more sophisticated de-sedimentation, aeration where iron is potentially a problem, and chlorination of their water, while the older EMWF systems did not. However, mechanical filtration and chlorination are now being included in all new systems (as of 2006), and water sources are chosen and systems designed so as to be in better compliance with MONRE water quality standards for drinking water.

As explained in the section above, quoted costs did not include management overhead for salaries, benefits, logistical support (motorbikes, gasoline, field per diem, testing equipment, office rental, monthly utilities, etc. Overhead for these schemes is calculated as follows. A multiplier of 15% of line item costs is charged for staffing for engineering design, construction supervision and inspection, and materials and equipment. In addition, an administrative charge of 10% of line item cost plus staffing is also charged, which is therefore a total of 26.5% of all support costs. When that figure is applied to the $10 per capita base cost of the

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27 For example, in the first and second Water Supply and Sanitation for Low Incomes Communities (WSSLIC) Projects in Indonesia, required community cost-sharing was nominally 4% cash and 16% in-kind. However, the actual value of the 16% in-kind contribution (which included unskilled labor and local materials such as sand, gravel, wood (for construction forms) was typically way over-estimated, and contractors often provided these materials as part of their construction contracts.

EMW piped water systems, the overall per capita cost is about $12.65, which is still quite low compared to other RWS sectoral development agencies.

6.3. Impact of O&M Costs and Water Tariffs for System Management

O&M costs are typically low early in the life of a water system, but can increase dramatically over time. Here, one particular problem that can greatly increase O&M / repair costs is often highly variable voltage in the power lines, which can wreak havoc on the electric motors in pumps and mechanical filters. It will likely be necessary to increase the tariff over time to deal with such problems. As customers do not usually easily accept rate increases, the management contractor will need to explain to his customers why the costs have risen, and why it is necessary to increase tariffs accordingly. People may respond positively to these explanations, but only if the quality and quantity of water they are receiving is good. If not, they may be very reluctant to accept price increases, and may seek alternative water sources.

A common problem with setting sustainable water tariffs in Vietnam is that officially, the Provincial People's Committee (PPC) is responsible for setting maximum water tariffs. Historically, these tariffs have been much less (50% or more) that the actual cost of water production. This means that GOV water schemes usually collect less revenue than the amount required to cover O&M costs, let alone major repairs or replacement of expensive components such as pumps, water treatment and filtration equipment. This means that schemes are often not financially sustainable, and thus require subsidies from the local authorities. However, the water management contractor said that the local authorities would not interfere with the water tariff charged, as long the water consumers were willing to pay that amount (which they are, at least so far). This response is reasonable, but it is unlikely that if, for example, a cooperative was running this system, PPC would be unlikely to let the cooperative charge more that the standard PPC-set limit.

While water tariffs are usually a fixed amount per cubic meter, water scheme costs are based on a combination of both fixed and variable costs. Fixed costs include repayment of loans for water scheme construction (which doesn't apply in the EMW systems) and the cost of regular staff. Variable costs (for electricity, water treatment chemicals, etc.) depend upon how much water is produced and distributed.

Water demand increases over time, so managers have to plan for this. Population increases, new distribution pipelines are required as people move into the area, and water resources may change, requiring the development of another source. At one EMW site (Duy Vinh), a government infrastructure development project nearby required some families to be resettled in the EMW service area. Additional pipes were installed to provide water to the resettled people. The water management contractor agreed to pay the cost of pipe to the resettled households. Eventually, these costs will be reflected in the water tariff. If not, the contractor may decide that this is an unprofitable arrangement, and return it to the local authorities.

People at this site already have experience in private financing of public infrastructure. For example, two bridges were built all of partly financed with private funds. One was a floating bridge (from the mainland to a nearby island) that was built with both public and private funds, and another was a bamboo bridge that was build with private funds. User fees were collected for ten years to pay back the private investors. Now that the investment costs have been fully repaid, use of the bridges is now free to all users. Since government funding was limited, private investors contributed funds to extend the length of the bridge.

7. Institutional Arrangements, Roles and Responsibilities

This section describes roles and responsibilities for Water Managers (private or otherwise), local authorities, and EMW in the sustainable, management, financing, and monitoring and evaluation of EMW-financed water schemes. Only in about 2002 did GOV approve the Enterprise Law, which allows the private sector to formally participate in management of water supply systems, at least those owned by GOV. Details of institutional responsibilities for the full range of planning, financing and construction tasks were described in Section 4 above, and are briefly summarized for the reader's convenience in section 7.4 below. This section focuses on post-construction responsibilities.

7.1. Water System Management Tasks

This section is a brief summary of all the standard tasks that must be regularly carried out to ensure proper care and operation of a rural water system. The tasks are grouped into two sections, technical operation, maintenance and repair, and fee collection and accounting[28].

7.1.1. Operation, Maintenance (O&M) and Repair

Technical tasks required to keep a rural water supply scheme operating properly include:

- Operate the water system according to well-defined standard procedures.
- Make regular inspections of all equipment and civil works, including water source, intake or well, transmission / distribution piping, sedimentation or other tanks and civil works (e.g., slow sand filters), aerators, filters, valves, meters, electrical controls, etc.
- Carry out all required maintenance and corrective actions.
- Regularly monitor water quality to ensure that it meets the agreed upon standards, and periodically submit samples to a certified water quality laboratory for analysis.
- Record all necessary meter readings and keep records of all operation, maintenance and repair actions in accordance with agreed upon procedures.
- Monitor electricity consumption and consumption of all other consumables (chemicals, spare parts, etc.).
- Monitor water leakage a critical points throughout the system and at the outlet of the main storage tank, compare to customer water usage, and estimate system losses.
- Periodically liaise with community representatives to discuss quality of service and to resolve any potential disputes.
- As required, prepare plans for system expansion as new potential customers arise within the service area.

[28] A detailed discussion of these procedures is given in the *Handbook on Management, Operation and Administration of Piped Rural Water Supply Systems*, CERWASS, MARD, and Government of Vietnam, developed under the Support to the Implementation of the National RWSS Strategy.

7.1.2. Water Fee Collection and Accounting

Except perhaps for very small systems, it is generally recommended that there should be a separate accountant and a cashier. Financial and accounting tasks required to keep a rural water supply scheme operating properly include (this is just a brief summary):

- Prepare a budget to account for all anticipated expenses, including fixed costs (e.g., labor costs of regular full time employees, etc.) and non-fixed costs (repairs, parts replacement, purchase on new equipment and tools, etc.).
- Read water meters and collect water fees from each household.
- Maintain records of all customers and their monthly payments.
- Maintain the cash book and the project bank account(s) and statement(s).
- Receive and pay out cash as required for regular operation, maintenance and repairs.
- Provide financial and other data for annual audits and periodic financial reviews.
- Discuss potential problems with customers related to fee collection or meter disputes.
- Keep the cashbook, and prepare monthly accounts of receivables and payables.

7.2. Roles of Local Authorities

The local authorities are responsible to monitor the provision of water services in community to ensure that good quality water of sufficient quantity is provided at a reasonable cost to consumers. To do this, they need to know whether schemes are properly operated, maintained and repaired, and provide funding to deal with unusually costly repairs, expansion, or rehabilitation of water schemes. In particular, they are responsible to[29]:

- Expedite all required approval by the government, including access to and use of land (for the water tower), water (well drilling), power (electricity), rights of way for pipelines, and any other approvals that might be necessary during the construction and eventual operation of the EMW water system.
- Assign a Management Board to work with EMW on the water project construction and implementation.
- Actively meet with and motivate community members to sign up for connecting to the piped water system, and to inform them of their roles, responsibilities and schedule of activities (e.g., attending informational meetings, digging trenches, buying house connection materials and equipment) in the project preparation and implementation.
- Arranging for lodging and security for EMW staff (site supervisors, storekeepers, and other staff), materials and equipment, providing certain locally available materials and equipment, and facilitating project implementation wherever and as necessary.
- Provide maps of the service area and surrounding communities so that households could be identified and pipeline routes be developed accordingly.

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[29] Adapted from: *Memorandum of Understanding (MOU) between EMW and CPC of Que Xuan 1 Commune*.

- Encourage village leaders to supervise and expedite scheduling, mobilization and supervision of local people for construction tasks such as digging and backfilling trenches, and work closely with all sides to quickly resolve any problems that arise.

- Pay the first month's electricity bill for the system, prepare quarterly monitoring reports, have the water quality tested twice a year, and provide the results to EMW.

7.3. Roles of Communities

Work with the water management contractor to report any problems, cooperatively deal with the contractor to address those problems, be willing to accept reasonable (and expected) tariff increases as the water scheme ages and therefore requires more frequent repairs and replacement of equipment such as pumps.

- Attend periodic informational meetings to discuss the objectives, plans and requirements of the project.

- Work under the direction of the EMW construction supervisors to dig and, after the installation of the pipes by plumbers, backfill trenches for all necessary pipelines, according to the design specifications, according to the schedule specified by EMW with the concurrence of the Management Board.

- Pay for their house connections costs, including pipe, meter and valves.

- Promptly and fully pay the Water Managers for all water they consume, according to the amount consumed indicated by the water meter.

- Provide any information that is requested by EMW staff or the local authorities that is legitimately required for project monitoring and evaluation.

7.4. Roles of EMW Water Team

The current EMW Water Team consists of the following positions: Clean Water Program Director, Design Engineer), Site Supervisors (4) IT Specialist (1), Storekeepers (4), who are responsible for storing and managing equipment and materials such as pipe), and 4 plumbers (who connect and install the water pipes once the trenches are dug). There are two Water Managers responsible for O&M and revenue collection for each separate scheme. Clearly, a considerable number of additional staff in each of those categories will be required, if and when the proposed significant increase in program funding materializes.

7.4.1. Project Planning, Development and Administration

EMW Water Team staff is responsible to[30]:

- Work with the district (and to a lesser extent, provincial) and commune authorities to identify potential sites for new water systems.

30 Some material in this section was taken from the MOU (between EMW and the local authorities) to construct a water system in Que Xuan Commune of Que Son District, one of the excellent set of ten administrative and technical documents used in project feasibility, implementation, and post-construction monitoring and evaluation. I also added below some additional tasks (e.g., having to do with the Hygiene and Sanitation Behavioral Change component) that are recommended to be included in the revised Clean Water Program.

- Together with local authorities and site residents, identify and test the quality and output of potential water sources in the vicinity of the proposed site.

- Work with local authorities and prospective beneficiary community members to assess the technical, financial, and management feasibility of the proposed water system.

- Identify and confirm sources of funding for the water system construction.

- Conduct periodic informational meetings with community members to discuss roles and responsibilities of all parties in project planning and implementation.

- Assess the willingness of households in the prospective community to pay for piped water at a reasonable tariff level, obtain commitment from each household wishing to connect to the water system, and verify their readiness to pay for house connections, and dig and backfill pipe trenches.

- Work with all committed households to register their commitment to purchase house connections and water meters, and collect the money required to do pay for these items.

- Complete the Feasibility Study, and then get the required approvals from EMW senior management and the local authorities.

- Send site supervisors to the prospective site to coordinate with the local Management Board, supervise project implementation and construction, ensure quality control, and hold weekly meetings with the local authorities to ensure good cooperation.

- Hire, monitor the performance, and pay contractors responsible for building the water towers and installing associated equipment and instrumentation.

- In addition to regular site supervision, conduct periodic inspections prior to making payments to the construction contractor. Site supervisors also prepare weekly reports of construction progress and other activities such as meetings held with community members and the local authorities.

- Conduct a final system inspection, test the quality of water at the outlet of the water tower, work with the contractor, community representatives and local authorities to correct any problems, and then make final payment to the construction contractor.

- Prepare and turn over to the Management Board a very detailed and inclusive set of hand-over documentation, the contents of which are described in Section 4.3 above.

- Prepare quarterly (through the end of Year 1 after construction is completed) and thereafter annual monitoring and evaluation reports documenting the operational status of each system. After first year semi-annual reports, villagers given form and they fill out. Want to find out if problems.

- Carry out activities related to the hygiene and sanitation behavioral change program that will be proposed in the Evaluation Report for the EMW Clean Water Program.

- Develop and implement training programs targeted at particular groups (e.g., water managers, site supervisors, design engineers, hygiene and sanitation promotion specialists, and perhaps the local authorities – e.g., for project planning) to increase the overall positive impact of the Clean Water Program on participating communities.

- Expand the current program monitoring by establishing a formal and comprehensive Management Information System (MIS) to aggregate the numerous monitoring information that is already available to program management (including much of the data used in this evaluation report), but is not yet aggregated into a single unified information source that can be easily accessed in an electronic database.
- Periodically assess staffing levels, identify any needs for new positions to be filled, and any additional staff requirements for existing positions.

7.4.2. Strengthening Capacity/Capability to Manage Rural Water Systems

Right now, the EMW Clean Water Program is constructing about 15-20 water systems a year. Based on an assessment of all the water systems previously built by the program, each system provides an average of 52 m^3/day of water to an average of about 1,275 people. The total EMW staffing to support all of this consists of only about eight to ten people, only one of which is a water engineer who works part time. From each system, there are two appointed Water Managers, 45 of whom participated in a three-day training program in an EMW workshop in December 2005, where they learned about water system repair and maintenance, safe water handling, and village hygiene and sanitation. Apparently there was considerable exchange of information among the water managers that was quite useful. It is important to expand upon this initial training, not only to provide the training to Water Managers in new systems, but to enhance the skills and abilities of all the water managers to operate, maintain and repair their water systems.

The 2005 East Meets West Annual Report says that EMW built 15 new piped water systems last year that serve over 16,000 people[31]. The Water Team anticipates that they will complete about 15 new systems in 2006. While the water team members have done a commendable job so far, the additional skills and experience that they need in the future are mainly technical, particularly for water system design (especially as they are starting to look at building gravity schemes, which are quite different than pumped groundwater schemes), as well as to continue their on-going improvement of water treatment. Water treatment is especially important, as the groundwater in Quang Nam and Quang Tri is often quite poor (e.g., it often has high levels of sedimentation, iron, hydrogen sulfide, coliforms, etc.). Dealing with these problems in a cost-effective way requires additional skills.

The water team also needs to strengthen its currently limited capacity for engineering design, as there is only one part-time water engineer right now. Technical designs have improved over the years (e.g., switching to re-enforced concrete tanks instead of lower quality and shorter-lived brick and mortar tanks, and adding mechanical filters in addition to the standard de-sedimentation tanks), but perhaps with additional training, they could further improve the design and cost-effectiveness of new systems. One way of doing this is to provide some training in computerized design tools like WaterCAD. Of course, WaterCAD doesn't do anything that a good engineer could not accomplish with a calculator. WaterCAD just makes water system design easier, more accurate, and quicker (once competence with the program is developed). Once one or two water team staff become proficient in its use, it will also make it easier to optimize system variables such as storage tank sizing, and pipe sizing. Optimizing pipe and tank sizing could help to reduce construction costs.

[31] Actually, the data table I have shows 13 systems completed with a total of 17,808 beneficiaries.

Another area that will require training up water program staff is hygiene and behavioral change promotion, assuming that EMW management agrees to the hygiene and sanitation behavioral change program that will be proposed in the Evaluation Report. An alternative to training up existing staff is to subcontract out that activity to an organization that already has developed this capacity and capability in rural Vietnam, such as IDE/Vietnam and the Vietnam Women's Union, which has considerable experience and expertise in this particular area. The Provincial Center for Rural Water Supply and Sanitation (PCERWASS) is also a good local technical resource that EMW has been building a working relationship with. On one PCERWASS gravity flow water system in the mountains outside of Hue City, EMW contributed several thousand feet of PVC pipeline to complement the limited resources of PCERWASS. There may well be another future opportunities to build upon such cost-sharing arrangements. The EMW water team is working with the local authorities to identify other potential sites where EMW can cooperate with the local authorities to jointly develop improved water (and eventually sanitation) services (see the photo of one such site assessment by members of the evaluation team).

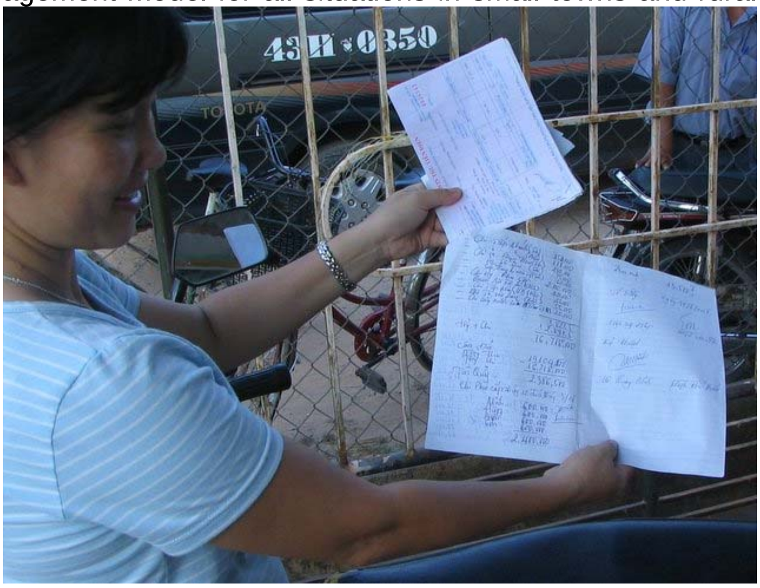
8. Management Models for Rural Water Systems

Management models are basically institutional arrangements used to manage water systems. To be effective and sustainable, a management model needs to include a range of qualified and motivated staff that together have the capacity, capability, funding, motivation and professionalism to provide reliable, good quality water services to their customers. For water systems, sustainability requires that the:

- Water system will provide users with a sufficient quantity of good quality water that meets existing water quality standards;
- Water will be reliably provided on a regular basis over the lifetime of the system, at a price that customers can reasonably afford; and
- Water tariffs will be set so that the water system manager has sufficient funds to carry out all required operation, maintenance, repair and expansion activities.

A wide variety of management models are used to manage water systems in Vietnam, including community-based organizations, cooperatives, State Owned Enterprises (SOEs), Provincial Water Supply Companies (PWSC, focused on medium and large towns, but also systems for some small towns which in other countries would be considered rural), and finally private enterprises such as Joint Stock Companies (JSC), Limited Liability Companies (LLC) and less formal private arrangements that are discussed in this report. Some of these models have shown themselves to be more effective than others, and some management models are more applicable in certain situations. A table summarizing typical advantages and disadvantages of these management models that are or could be used in Vietnam is given on the following pages. The table was developed for the recent preparation of the World Bank and Government of Vietnam (GOV) Red River Delta Rural Water Supply and Sanitation (RRD-RWSS) Project.

Various studies[32] have shown that management models that take a more customer-oriented approach, taking into account customer demand, willingness and ability to pay for better quality and more reliable water supply, and that use a participatory approach in system planning and development, are more likely to ensure water system sustainability. However, there is not necessarily a best management model for all situations in small towns and rural communes (which is where EMW water development activities are focused). Because water system management in Vietnam is steadily evolving away from traditional SOEs, cooperatives, and community based organizations, EMW requested that a separate paper on management models be added to the Consultant's Terms of Reference (TOR) for this program evaluation. Bookkeeping of water tariff collections and operation and maintenance expenses for the privately managed scheme in Tam Giang is shown in the photo.



Whichever model is chosen for a particular water system, it is important to recognize the need to develop a long term program to strengthen the capacity and capability of organizations responsible for managing water schemes, as well as local government institutions responsible for carrying out their state functions, including planning, regulation, monitoring, and ensuring quality control. This is true whether water systems are financed by large donor agencies such as World Bank, ADB, AusAID or Danida (all of which work in close coordination with the local authorities), or by NGOs such as EMW. Therefore, an effective training program is needed to strengthen the capacity and capability of the various agencies and organizations that work with and support the EMW Clean Water Program.

[32] *Small Towns Water Supply Management Models in Vietnam: Is there a best practice management Model?,* World Bank Hanoi, and *Vietnam: Evolving Management Models for Small Towns Water Supply in a Transitional Economy*, Carolyn Van Den Berg, ADCOM, World Bank, Jakarta, 2002.

Table 5: RRD-RWSS - Comparative Advantages and Disadvantages of Different Water Supply Management Models[33]

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PCERWASS	B – PCERWASS I - PPC O – Commune	National Target Program, loans and customer contribution up to 30%, tariffs capped by PPC	Long experience, but weak, highly variable, limited design experience and staff incentive	High compared to other management models due to long experience, but still limited	Relatively high, but limited ability to compensate and retain well-qualified staff	Few if any viable alternatives at this time, but low acceptance by many customers
Private - Joint Stock and Limited Liability Companies, and less formal arrangements	B – JSC I – JSC O – JSC and PPC (maybe customers over time)	High, as tariffs not necessarily capped by PPC, according to Enterprise Law	Unproven, could attract good quality people with good compensation	Unproven, maybe high, but uncertain	Unproven, depends upon compensation	High by donors and PPC, low by GOV. Customer acceptance high if good service, and may feel more control over privately managed RWS
Cooperative	B – Cooperative I – Cooperative O – Cooperative (selected group, not entire commune)	Low	O&M experience, weak performance, have to out-source (e.g., PCERWASS)	Experience with agricultural chemicals, and crop sales	Not much different than commune managed schemes	Low by donors, low by customers (based on field trip discussions)
Cooperative Group (Community-based)	B – Community Group I – CG (partial over time). O – (TBD). Community member shareholders so repay	Low, especially if community members are not willing to pay full O&M / repair costs	Highly variable, limited capacity and capability, especially for larger systems	Very limited, highly variable, except in Tien Giang, emphasis on reducing cost, not increasing value	Normally low, but high in some cases, weak management capacity in ND	High for bilateral donors, but maybe not so appropriate for smaller schemes
State Owned Enterprise	State, PPC in particular	Same as cooperative, tariffs capped by PPC	Extensive, but limited training and staff incentives	Long experience, limited training and staff incentives	Long experience, limited training and staff incentives	GOV policy no longer supports SOEs, most donors feel similarly

[33] From the *Red River Delta RWSS Project Preparation Pre-Feasibility Study* (DANIDA and World Bank), R. McGowan and C. Pendley, COWI, Feb. 2006.

8.1. Investors, Owners and Managers of Water Systems

It is useful to differentiate between investors and owners of rural water systems. Investors provide funding (or in kind contributions) for building systems. Owners are usually people who will eventually have to choose the management model they feel is most appropriate to ensure long term sustainability of their water system. The difference between investors and owners is more important when the capital investment funds are in the form of a loan (as in a World Bank or ADB project) instead of a grant (as for EMW). For EMW systems, investors include:

- EMW - provides funding for the great majority of the system cost, including construction contractors, equipment and materials, such as water towers, pumps, filters, aerators, electrical controls, meters, valves, and transmission and distribution pipelines.
- Beneficiary Communities – provide both cash (the cost of their house connections, including pipe, water meters and valves) and in-kind labor for digging and back-filling water pipeline trenches.
- Local Authorities – provide public land for water towers and associated equipment, rights of way for pipelines and electrical transmission lines, a transformer close to the water tower[34], and access to water resources (formally owned by the government).

After completion of construction of the water tower and associated equipment, laying of pipelines, and installation of the house connections, the water system is turned over to the local authorities, who become the owner of the system. The "local authorities" are usually at either the hamlet level ("*ban dan chinh thon*" – "the Peoples Group") or Commune level (Commune People's Committee). While usually it is the system owner who determines what management model is used, for EMW-financed schemes the management model may be specified in the MOU between EMW, the community, and the local authorities. At this time, the great majority of EMW water systems are managed by a team of two Water Managers trained by EMW to carry out O&M and basic repair tasks, and collect water tariffs from users to support O&M and repair. Some system owners have chosen to give management contracts to private business to perform all required scheme manage tasks. How this privatized management is being carried out is described below.

8.2. Promoting Privatization of Water System Management

The Government of Vietnam (GOV) and many of the external donor agencies such as World Bank and Asian Development Bank support (at least in principle) privatization of the provision and management of certain basic services, including water supply. Besides its ongoing use of private contractors to drill wells, construct water towers, and install equipment such as pumps and filtration systems, EMW is also interested assessing in the potential benefits of having private companies or individuals manage water schemes. This report summarizes the major issues involved, and hopefully will serve as the basis for further discussion of this issue.

In some provinces and cities (Danang is a good example), local authorities have given limited support for establishing management contracts for Public Private Partnerships (PSP) for

34 This is more important than it might initially appear, as poor quality transformers, or ones that are over-loaded, or too far away from the water tower, can (and have) lead to costly pump failures.

urban services, including solid waste management, septic tank pumping, and to a limited extent, water supply. This support is less common for rural water supply, perhaps because local authorities may feel that limited private sector management capacity and capability in rural areas might undermine scheme sustainability. However, in some provinces (particularly Tien Giang in the Cuu Long Delta[35]), local authorities have been supportive of private construction and management of rural water systems. Potential advantages of PSP include:

- Profit motivation – to provide a good quality service that people want and are willing to pay for (however, this may take time to convince water customers that better quality service is worth paying for;
- Mobilizing private capital investment - Additional funding can be made available from the private sector to capitalize and cover O&M costs (for example, for building bridges as we have seen in Tra Dong Commune);
- Competition among prospective private service providers could increase the quality and decrease the cost of service provision;
- Eliminate the need for subsidies - Private management operations do not depend upon subsidies from the PPC;
- Merit-based compensation and promotion - Without the constraint of very limited salaries typical in the public sector, PSPs are able to offer more competitive salaries to employees and therefore attract and retain more highly qualified staff; and
- Financial efficiency - Unlike government agencies which have few incentives to focus on improving operating or financial efficiency, private managers have a strong incentive to increase financial efficiency, and thereby increase profits.

Many issues remain to be resolved to encourage privatization, including assessing:

- What are the most appropriate arrangements for privatization, in terms of the roles and responsibilities of private service providers, local authorities, and beneficiary communities;
- How best to ensure that private service providers are properly regulated so as to provide good quality service at a reasonable price; and
- How best to ensure that privatized services that were traditionally the responsibility of the Government (such as water supply) are provided in an equitable and efficient manner, so as to ensure access by all sectors of society, but especially the poor and otherwise disadvantaged.

The current management arrangements for EMW-financed water systems are that every system is directly operated by two Water Managers who are appointed by the local authorities, with the approval of the EMW Water Team. These Water Managers are responsible for day to day system O&M and periodic collection of water tariffs, and are given some basic training to enable them to operate and maintain the systems. When more complex problems arise (e.g.,

[35] See the discussion below about private provision of rural water supply services in Tien Giang.

replacement of a burned out pump[36]), they often appeal to the EMW Water Team for support (sometimes both technical and financial support).

Table 3 above (Comparative Advantages and Disadvantages of Different Water Supply Management Models) does not include the option of management by Hamlets or CPCs. This is likely because Provincial Centers for Water Supply and Sanitation (pCERWASS, under MARD) are nominally responsible for all rural water systems within a province. In fact, pCERWASS is usually only responsible for certain systems that were funded under the National Target Program (NTP) for RWSS. This will change dramatically when the World Bank / GOV Red River Delta RWSS Project, which will be managed through MARD with technical support from CERWASS, starts in late 2006. There is a bit of a turf battle here for ownership and management of rural water schemes. This overlapping claim of responsibility is exacerbated by the Ministry of Construction's (MOC) altogether different perspective, namely that all water schemes in the province (Class V towns and up[37]) should be the responsibility of the MOC's Management Board for Urban Technical Infrastructure Development Projects (MABUTIP). Class V towns are defined[38] as towns with:

- Population size ranges from 4,000 - 30,000 inhabitants (2,000 inhabitants in mountainous areas);
- Sixty percent of the labor force is not engaged in agricultural activities;
- Construction of public facilities and technical infrastructure in early stages;
- Average population density is 6,000 inhabitants/km^2, or 3,000 inhabitants/km^2 in mountainous areas.

Then there are "townlets", which are defined as population centers that have:

- Minimum population of 2,000 inhabitants (1,000 inhabitants in mountainous areas);
- At least forty percent of the labor force is engaged in non-agricultural activities;
- Initial construction of main public services and technical infrastructure39;
- Average population density of 3,000 inhabitants/km^2 (or 1,000 inhabitants/km^2 in mountainous areas).

Of the 67 piped water schemes completed so far by EMW for which data is currently available, the largest population served by an EMW water system so far is 3,400 people. The average size of population served by all 67 piped water systems built so far is 1,275. There are about 15 EMW systems that serve about 2,000 people or more, and so might be considered

36 Unfortunately this is not unusual, partly due to poor quality electricity from transformers owned by local electric utilities. High voltage variations can easily burn up pump motor. Pumps do not like high sediment levels commonly encountered in groundwater in Quang Nam.

37 Unfortunately, this overlaps with the National Rural Water Supply and Sanitation Sector Strategy to 2020 (NRWSS-2020), which claims Class V towns to be within the purview of pCERWASS.

38 Small Towns Water Supply Management Models in Vietnam: Is there a best practice management model? World Bank Vietnam, Hanoi, 2002.

39 Examples of public services and technical infrastructure are transport, water supply, sewerage and drainage, electricity, markets, shops, health centers, schools, small industries, sports/entertainment services, and cultural and information facilities.

"townlets" as described above, depending upon the population density. These numbers do not include about 15 new schemes that are planned for completion in 2006.

8.3. Community Based Groups

In other projects, groups of people from the community are selected to be on a Community Water Committee, or something similar[40]. They are often given basic technical and accounting training, with the understanding that the local government (or perhaps the original donor) will be available to provide some assistance in the event of any serious problems. The arrangement for the management of EMW financed rural water supply schemes is that once the system is turned over to the hamlet or commune (see more on this distinction below), the two Water Managers selected by the local authorities, and approved and trained by EMW, are largely responsible for day to day operation, maintenance, periodic repairs, and perhaps expanding service to un-served households, if additional funds become available.

These activities, and the compensation for the Water Manager (which is typically a fairly modest VND 150,000 – 300,000, or $10-20 per month), are financed by the collection of water tariffs from all the households connected to the system. For extraordinary expenses (e.g., failure of a major system component such as a water tank, pump, filter, etc.), the local authorities usually agree in the MOU to cover any extraordinary costs. In addition, EMW often provides financial and/or technical support if problems cannot easily be solved using the water tariff fund e.g., replacing an old leaking brick and mortar water tank with a new steel re-enforced concrete tank. Thus, communities are taking little or no risk by keeping tariffs low.

8.4. Cooperatives

Commune-level cooperatives have been used extensively to manage certain critical agricultural and other (e.g., water supply) community functions in Vietnam. They typically have some experience with financial management as a result of their purchasing and re-selling of fertilizers, crops, etc. However, water systems managed by cooperatives do not always have a very positive experience in terms of water system sustainability. There are several reasons for this. First, cooperatives do not often have a history of particularly strong financial management and accountability. They are likely to be reluctant to raise water tariffs to the levels needed to cover actual O&M and repair costs, because it is politically and socially not easily acceptable to do so. Second, cooperatives often manage their operations (e.g., buying and selling fertilizer, pesticide, marketing produce, etc.) from a single overall budget. If one component of their operations is a losing proposition, it may be cross-subsidized from a more profitable area.

For example, an water O&M fund financed by reasonable water tariffs may be diverted to cover shortfalls in, say, fertilizer purchases or crop sales. That means that water tariffs, even if they are adequate to cover normal O&M and repair requirements, may not be available for that purpose if and when needed. Third, cooperatives typically have little technical experience in operating water supply systems. Therefore, it is not recommended to use a cooperative model for EMW water system management.

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[40] See the CERWASS Report on *Management Models for Rural Water Systems in Tien Giang Province*, Bui Minh Giap, and GOV/MARD Center for Rural Water Supply and Sanitation, July 2002.

8.5. Provincial Water Supply Companies and State Owned Enterprises

In preparing large-scale RWSS projects such as those funded by World Bank, there is considerable debate about how RWSS systems can most effectively be managed. There are those who argue that the lower the level of management (e.g., by the CPC or community group), the lower the capacity and capability for properly operating, maintaining and repairing the water system. Instead, they may suggest that it might be best to have all rural (and small towns and urban) water systems managed by the Provincial Water Supply Company (PWSC, or sometimes the Provincial Water Supply and Drainage Company – PWSDC), so that qualified and experienced professional technicians could provide management and technical support to all piped water schemes in the province.

While this might be true in principle, in practice, qualified technical support and sufficient water tariffs to pay for that high level of support are often quite limited, especially in less developed provinces. Part of the reason is that provincial government (PPC) are usually unwilling to agree to full cost recovery tariffs[41], even though it is government policy to do so according to documents such as the National Rural Water Supply and Sanitation Sector Policy up to 2020 (NRWSS-2020). The problem is often not the water customer's willingness to pay for reliable, good quality water, but the PPC's typical unwillingness to charge for it. In addition, it is often the case that the capacity and capability for properly operating, maintaining and repairing rural water systems is quite limited in many rural areas. New rural water supply (and sanitation) projects that the GOV has already approved (e.g., the RRD-RWSS Project) include basic rules such as the following[42]:

- Full Cost Recovery – Tariffs are set to include not only all operation, maintenance and repair costs, but also the investment cost and a reasonable profit for investors (although there is no loan repayment in EMW schemes).
- Demand Responsive Decision Making – All decision making regarding provision of improved RWSS services must be demand responsive. This means that customers must be able to choose what RWSS services they want and are willing to pay for.
- Community Participation – Communities where Project-financed infrastructure is to be built must be fully consulted before any decisions are made with regard to infrastructure, management models, and proposed tariffs.
- Private Sector Participation – Reflecting GOV, World Bank and ADB policy, private sector participation in provision of project-financed services is strongly encouraged.
- Informed Choice of Water Management Models – Customers will have an opportunity to make informed choices of their preferred water system management model.

This demonstrates GOV agreement to and support for moving from the traditional top-down management and decision making structure, to a more bottom-up participatory approach. This is also reflected in GOV policy towards State Owned Enterprises (SOEs), the days of

[41] Full cost recovery tariffs are set high enough to pay for all recurrent costs of water production and distribution, including administration, management, operation, maintenance, repair, replacement of failed system components, and sometimes system expansion.

[42] *Overall Project Framework*, R. McGowan et al, RRD-RWSS Project Preparation, Danida, World Bank and MARD, January 2005.

which are numbered. The GOV has formally recognized that the typically inefficient SOEs will receive diminishing state support, and will be phased out as much as possible over time. Certainly no new projects should consider introducing SOEs for water system management. Therefore, a compromise solution is required for new rural water systems. Where community willingness and ability to pay (ATP) for qualified technicians to manage their water schemes exists, private water management is a promising solution.

8.6. Private Enterprise Management

Interestingly, at least one scheme (Tra Dong Hamlet in Duy Vinh Commune of Quang Nam Province), with an estimated 2,535 water customers and a water tariff of VND 2,000 / m^3, has already taken a different approach. After the water scheme was completed by EMW and then turned over to the local authorities, the water tariffs collected were insufficient to cover the scheme operating expenses, under the government scheme management arrangements. There were likely various reasons for this, but these were not discussed. After discussions with some local private entrepreneurs, the local authorities agreed to tender a bid for a management contract for the water scheme. An open bid of about 7-8 prospective bidders took place, and the winning bidders were three men who agreed to buy the management contract for VND 2 million.

While they were not engineers or technicians per se, each of the men had certain technical or business skills that were relevant to the routine operation of the schemes. One of them, while not an engineer or system designer, has had five years experience managing a water scheme, and is also an experienced well driller. He is also a builder, and so has access to a construction crew to help with maintenance or perhaps scheme expansion. He and his son take care of system repairs as required. His wife has taken responsibility for collecting the water tariffs. All three of them received any training in water scheme management from EMW last year.

EMW should consider providing some training to the private management contractors, if this becomes a more common arrangement in other project areas. There are apparently no other privately managed water schemes in Quang Nam at this time, although there is seems to be no particular reason that might prevent someone else from using this approach. We discussed the extensive positive experiences with privately managed (and owned) rural water schemes in Tien Giang Province, which has received considerable acclaim for the success of many privately managed water schemes there. EMW should promote private management of water systems, in particular by providing technical and accounting training to private water management groups.

8.7. A Privately Managed EMW Water System

In the Tra Dong privately managed water system, the local authorities and the private contractor agreed in the contract that the private contractor would carry out all required O&M and repair, collecting water tariffs from the connected households, and paying the government a “rental fee” of VND 12-16 million for the four separate water schemes that are included in the management contract which lasts for five years). This rental fee will be used by the local authorities to expand the water schemes, and carry out necessary repair/replacement of system components (e.g., pumps) when required. The contractor collects water tariffs to cover the costs of routine scheme management, O&M, the rental fee, and a reasonable profit. Both parties (government and management contractor) agreed that if unexpectedly large costs were incurred through catastrophic failure of major system components, that the government would pay the cost of major repair or component replacement.

The system management did not start out this way. The private management contractor said that over the first two months of system operation after the EMW-financed construction was completed, the four water systems were operated by the local authorities, and were losing money. The contractor who now operates the system determined that the local government's operating costs were about VND 12-16 million per month for all four systems, based on assumptions about the amount of water that users would consume. From these calculations, the private contractor decided to charge a water tariff of VND 2,000/m^3 initially. They later decided that was too much, and reduced it to VND 1,800/m^3. The contractor's expected tariff collections are based on the following assumptions:

- About 650 families (about 2,535 people) in the 4 schemes.
- Average family water consumption of about 4 -5 m^3.
- Water tariff is VND 1,800 /m^3, so one family pays about VND 8,100 per month.
- Therefore, the average monthly tariff collection for the entire operation (4 schemes) is about VND 8,100 x 650 = VND 5,265,000. This is the total revenue available for scheme operation, maintenance, repair, expansion, or rehabilitation, and periodic payments against the VND 12 million system "rental fee".
- Average monthly O&M costs plus Water Manager salaries ($10-20), plus the system "rental fee" of VND 12-16 million paid to the local government authorities.
- In addition to their salaries, their monthly profit from the system management was about VND 2 million (US$ 125).

9. Procurement, Contracting, Supervision, Inspection and Quality Control

9.1. Procurement and Contracting Approach

Donors such as World Bank emphasize the importance of economy, efficiency, fairness, reliability, transparency, accountability and ethical standards in procurement[43]. Economy means that the purchaser (e.g., EMW) gets the best value its money. Merely choosing the lowest bid may not result in the lowest lifetime cost of the system, as lower quality equipment or materials will very likely result in higher operation, maintenance, repair and replacement costs. Efficiency means that the procurement can be quickly and easily completed. This is particularly important here in Vietnam as many GOV procurements result in significant delays in project implementation (e.g. about 2 years for ADB-financed water supply projects here). Fairness means that all potential suppliers should compete on a level playing field, without any special consideration. Transparency means that procurement is above board, bid evaluation follows recognized procedures, and is "not only fair, but seen to be fair" to all bidders, with no hint of collusion or inappropriate awarding of contracts to less qualified bidders. Accountability means that people are held responsible for the results of their decisions, especially in the case of choosing an inappropriate procurement source, poor quality goods, materials, or unqualified service providers.

[43] *Bank-Financed Procurement Manual* (draft), World Bank Procurement Policy and Services Group, Operations Policy and Country Services, January 2003.

EMW does not use open and competitive bidding procedures to hire contractors for construction of the water towers, and installation of pumps, filters, or electrical controls, nor for purchase of materials such as cement and pipes, as is always required for multilateral (World Bank, ADB) and bilateral (AusAID, DANIDA, etc.) donors. While that may seem irregular, in fact their procurement processes have evolved over time to be apparently efficient and effective. Several initial problems with poor contractor performance (for building water towers and installing equipment) and less than specified quality of materials (e.g., low quality PVC pipe) were resolved, and subsequent procurement of contractors, equipment and materials has resulted in generally good quality water systems.

The choice of construction contractor should be based on previous performance and demonstrated skills and experience, not simply the lowest price bid. Contractors must be evaluated on their work, and penalized for poor performance, including blacklisting firms if necessary to ensure full compliance with GOV construction standards. In effect, the EMW Water Team appears to have done this informally, and now only gives contracts to companies that have demonstrated their competence and reliability on previous contracts.

The EMW Water Team sometimes experiences procurement constraints. For example, because of the relatively small size of its systems and the relatively small value of the construction contracts (a water tower contract is only for about $5,000), it is sometimes difficult to find enough interested and qualified contractors. Given the building boom in much of the country, especially around larger cities such as Danang and the neighboring areas, it may become more difficult to attract and retain the services of qualified and experienced local contractors for such small contracts, unless they can be assured a steady stream of contracts over the long term.

Early on in the program, EMW hired a range of available local contractors, some were good and some were not so good. The contractors who performed well were awarded repeat contracts, and two others who didn't do well were dropped. Initially EMW used only 2-3 local contractors, some of whom did a good and some of whom did not. Now EMW has ongoing agreements with 3-5 contractors (3 in Quang Nam, and 1-2 in Quang Tri) who have proven themselves to be both reliable and reasonably priced, and EMW offers them as much work as they were willing and able to take on. If access to good quality contractors becomes more of a problem, it could well result in steadily inflating cost of construction.

9.2. Supervision, Inspection and Quality Control

Quality assurance and quality control (QA/QC) is necessary to ensure that all resources (human, financial, technical and political) are properly planned for, coordinated and utilized to provide maximum benefit to participating communities in terms of improved water (and hopefully, eventually sanitation) services that meet their demand, willingness and ability to pay. Quality control procedures must be followed at each step of the planning, development, implementation and operation processes to ensure that:

- There are clear and accepted definitions of the roles and responsibilities of all people and agencies involved in the project (*there are*);
- People accept and properly carry out those assigned responsibilities (*they do*);
- Appropriate and accepted technical procedures for cost estimation, engineering design, construction, supervision and inspection are carried out (*these could be improved by providing appropriate technical training to current staff, and by hiring additional experienced engineering staff, especially if the proposed significant increase in program scope takes place*);

- Procurement procedures are designed and applied so as to ensure that all goods, materials, equipment, construction and consulting services meet required specifications, and give best value in return for investments by donors, community members, and local government authorities (*this seems to be the case*); and

- Objective and independent monitoring and evaluation of all program activities provide program management and beneficiary groups with the information they need to readily identify any shortcomings in program planning and implementation, so that any shortcomings can be quickly addressed to minimize adverse impact on the program, its beneficiaries, and its management. (*EMW willingness to evaluate the program shows its support for this objective*).

Based on my field visits to numerous beneficiary communities, discussions with the local authorities and with many project beneficiaries, and the results of the Customer Satisfaction Survey, EMW appears to have done a reasonably good job in carrying out appropriate measures for:

- System planning, in coordination with beneficiary communities, the local authorities, and site supervisors;

- Design (*although EMW needs to strengthen its in-house capabilities in this area either through upgrading existing staff, or hiring additional staff with the requisite experience and knowledge*);

- Construction activities;

- Enforcement of procedures, contractual terms and conditions

- Regular inspection, monitoring, and now by financing this external evaluation of the program;

- Making clear and coherent the roles and responsibilities of all involved agencies and individuals, especially through the use of various Memoranda of Understanding (MOU)s to ensure that all parties understand and agree with their respective roles and responsibilities.

Since the beneficiary communities are co-financing construction of their water systems, it seems that it would be useful to ensure that all Project transactions (financial and otherwise) be openly and transparently carried out with the full participation and knowledge of all Project stakeholders, and that all relevant standards (construction, water quality, financial disclosure) are always fully complied with in all project activities. This will especially be of help when it eventually becomes necessary to increase water tariffs. People will know (and hopefully, more easily accept) why tariffs have to be raised so that the water system maintains its technical and financial sustainability.

Regular periodic water quality tests are an important component of ongoing quality control for water systems. An annual water quality test is recommended (or more frequently if some apparent problem arises more frequently), and should be paid for with the water tariff funds.

Periodic inspections of all water scheme components must be regularly carried out to ensure proper operation and delivery of quality service. It is not enough to wait until something breaks to fix it. Community members should demand that regular inspections be carried out by Water Managers to ensure continuing reliable service, and they should be willing to pay the cost of these inspections. Similarly, Water Managers should be required to properly document scheme operation, maintenance and repair costs using open and transparent accounting procedures accessible by water customers, if desired. Periodic monitoring and evaluation of scheme operation, as well as the cost and results of other project component activities, is important to enable the Clean Water Program and its beneficiaries to determine lessons learned and best practices that can be applied to maximize Project benefits and minimize costs for new water systems.

Other issues that were not specifically addressed in any detail during this evaluation include:

- Preparation of bidding documents;
- Preparation engineering design cost estimates;
- Assessment of the qualifications of construction contractors;
- Contract administration;
- Procedures for contractor payments after periodic inspections; or
- Whether or not there has been any audit of the program finances.

10. Overall Program Cost Analysis

10.1. Additional Staff and Logistical Support Required

The need for additional staff (managerial, technical, health and hygiene, community development, and administrative support), equipment and materials, technical and management training, logistical support (e.g., computers and software, motorbikes, a car or two, and the associated O&M costs) to support the proposed expansion of the EMW Clean Water Program, have been described in different sections of this report. A detailed spreadsheet describing the estimated cost of the proposed program expansion is given on the following page, based on an assumed ten year budget of $10 million. The proposed budget is broken down on an annual basis into the main categories of:

- Personnel - the cost of identifying, mobilizing and training additional staff to meet the need for expanded management, administrative, accounting and auditing, technical, MIS, reporting, hygiene and sanitation behavioral change, and equipment and materials storekeeping personnel.
- Transportation and Logistical Support – including vehicles and required operation and maintenance.
- Computers, Printers and Software – for management, accounting, engineering design, hygiene and sanitation behavioral change (HSBC) promotion, and program monitoring, evaluation, and MIS.
- Water System Design, Construction, Supervision, and Inspection –construction of water (and sanitation) systems, expanding at an estimated rate of 12% per year, with the end target of about 351 water systems built over a ten year period with an estimated 516,000 new beneficiaries of piped, treated water.
- Staff Training – a detailed breakdown of the estimated cost of staff training has not been prepared, but training costs are likely to be relatively minor compared to construction, equipment and materials costs.

10.2. Estimated Cost of Program Expansion

The total estimated cost of the expanded ten year program is about US$9.7 million, which does not include the possible cost of an expatriate Program Manager / Water and Sanitation Engineer that may be required for providing management, technical and financial support to the program. The main cost categories (largest to smallest) are:

- Construction equipment, and materials, with an estimated cost of US$ 9.2 million;
- Personnel (not including the proposed expatriate program manager and water engineer) with an estimated cost of $378,000;
- Transportation and Logistical Support (car, motorbikes, and associated O&M) with an estimated cost of $91,500; and
- Computers, printers and associated hardware and software, with an estimated cost of $9,000.

The estimated detailed budget breakdown is shown on the following page.

11. Monitoring and Evaluation

11.1. Current Monitoring and Evaluation Approach

As described above in Section 4.4 above, the Water Team already has a fairly comprehensive monitoring and evaluation (M&E) process in place, including the forms for Evaluation of the Clean Drinking Water System, the Weekly Construction Progress Reports, and the Quarterly and Semiannual Water System Status Reports. In addition, at the completion of construction and after handover of ownership to the local authorities, a Project Completion Report is prepared, copies of which are provided to the beneficiary communities, the local authorities, and the donor(s) who co-financed the water system. These reports are apparently being produced on a fairly regular basis, with quarterly progress reports regularly produced for at least the first year after completion of construction, but only annual reports thereafter. This is quite sufficient. If reporting requirements are perceived by Water Managers or the local authorities as being too onerous, they will often simply be ignored. In fact, the current level of M&E detail in the EMW Water Program is more comprehensive than any rural water supply project that I have worked on for clients such as ADB, World Bank or USAID (although that may have changed since I last managed a long term water project).

Table 6: Budget for 10-Year Expansion Plan

East Meets West Clean Water Supply and Sanitation Program

Estimated Budget for Proposed Expanded Program Budget of $10 Million

Estimated Cost Breakdown for Proposed Water Program Expansion							**Estimated New Budget**			**$10,000,000**		**(starting 2007)**		**Version >>**	8/17/2006
A. Overall Program Cost Estimates by Category			**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	Subtotal	**Totals**
1. Personnel Required by Task	Persons	Unit Cost (US$)													
Program Director	1			*	*	*	*	*	*	*	*	*	*	*	
Project Management	1	$625		$8,125	$8,125	$8,125	$8,125	$8,938	$8,938	$8,938	$8,938	$9,831	$9,831	$87,913	
Engineering Design	2	$625		$8,125	$8,125	$8,125	$8,125	$8,938	$8,938	$8,938	$8,938	$9,831	$9,831	$87,913	
Construction Supervision	5	$500		$6,500	$6,500	$6,500	$6,500	$7,150	$7,150	$7,150	$7,150	$7,865	$7,865	$70,330	
MIS, Reporting, Promotional Brochures	1	$375		$4,875	$4,875	$4,875	$4,875	$5,363	$5,363	$5,363	$5,363	$5,899	$5,899	$52,748	
HSBC (hygiene/sanitation) Promotion	2	$375		$4,875	$4,875	$4,875	$4,875	$5,363	$5,363	$5,363	$5,363	$5,899	$5,899	$52,748	
Equipment / Materials Storekeeping	5	$188		$2,438	$2,438	$2,438	$2,438	$2,681	$2,681	$2,681	$2,681	$2,949	$2,949	$26,374	**$378,024**
2. Transportation and Logistical Support		Unit Cost (US$)													
Car (?? - 1 in in 2007, 1 more in 2012)	2	25,000		$25,000	0	0	0	0	$25,000	0	0	0	0	$50,000	
Car O&M (annual)	1	800		$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$8,000	
Motorbikes (10 in 2007, 10 more in 2012	10	1,375		$13,750					$13,750					$27,500	
MB O&M (annual)	10	600		$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$6,000	**$91,500**
3. Computers, Printers, Software		Unit Cost													
Program Management / Accounting	1	750		$750	$0	$0	$0	$0	$750	$0	$0	$0	$0	$1,500	
Technical Support Staff	2	750		$1,500	$0	$0	$0	$0	$1,500	$0	$0	$0	$0	$3,000	
HSBC Promotion	2	750		$1,500	$0	$0	$0	$0	$1,500	$0	$0	$0	$0	$3,000	
MIS, Reporting, Promotion	1	750		$750	$0	$0	$0	$0	$750	$0	$0	$0	$0	$1,500	**$9,000**
4. Construction, Equipment, Materials	(Cost estimates based on current PC		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total Est. Systems Built**	
Est. Number of Systems (12% annual increase in # of systems built)			17	19	21	24	27	30	34	38	42	47	53	**351**	
Est. Number of Beneficiaries/System	(Assumes 2% p.a. population increa		1,300	1,326	1,353	1,380	1,407	1,435	1,464	1,493	1,523	1,554	1,585	**Total Est. Beneficiaries**	
Est. Total Beneficiaries by Year			22,100	25,247	28,842	32,949	37,641	43,001	49,125	56,120	64,112	73,241	83,671	**516,050**	
Est. Unit Cost per System	(Assumes 2% p.a. PCC increase)		$20,527	$21,356	$22,219	$23,117	$24,051	$25,022	$26,033	$27,085	$28,179	$29,318	$30,502	**Total Construction Cost**	
Est. Total Costs of Systems this year			$348,959	$406,624	$473,818	$552,115	$643,351	$749,663	$873,544	$1,017,895	$1,186,100	$1,382,101	$1,610,490	**$9,244,659**	
* **Note** - Costs incl. EMW expenditures for construction, equipment, materials, but not monetized value of community labor to dig trenches or house connections (about $10/HH, so about $2,800 for average systems serving about 280 families.															
5. Office Space	Based on an estimated cost of space for 15 staff			$800	$800	$800	$800	$800	$920	$920	$920	$920	$920	$920	**$9,520**
B. Details of Personnel, Equipment and Other Cost Assumptions														**Total Estimated Program Cost for 10 Years =**	**$9,723,183**
														Overall Per Capita Cost (including all program overhead costs)=	**$18.84**
1. Personnel Costs (Revise as appropriate)	Salary (VND)/mo	US$		**Construction Cost Assumptions:**										(Not including land from GOV or house connections from individual households)	
Program Manager	10,000,000	$625		1. First year (2007) construction costs are based on Per Capita Cost (PCC) for EMW systems (except clearly expensive outliers) built in 2004 and 2005.											
Design Engineer	10,000,000	$625		2. Thereafter, base construction costs increase at 5% per year starting in 2007.											
Construction Supervisor	8,000,000	$500		**Other Cost Assumptions**											
Storekeeper	3,000,000	$188		1. Materials for Hygiene and Sanitation Behavioral Change (HSBC) promotion program are available from CERWASS / DANIDA for cost of reproduction.											
HSBC Promoter	6,000,000	$375		2. Need to add some funds for training and institutional strengthening.											
Accountant/Auditor	7,000,000	$438													
MIS	6,000,000	$375		Note that these totals include both the cost and the number of systems and beneficiaries from program activities in 2006. Excluding 2006 systems and costs would leave the following important parameters >>>>>>											
Report Writer	9,000,000	$563													
2. Equipment Costs and O&M Costs	VND	US$													
Motorbike	22,000,000	$1,375		**334**		systems									
Annual Motorbike O&M (monthly cost $50)	9,600,000	$600		**493,950**		beneficiaries									
Car (basic sedan not 4WD)	400,000,000	$25,000		**$8,895,700**		construction cost									
Car O&M	12,800,000	$800		**$9,383,744**		total cost									
Computer	9,000,000	$563													
Printer	6,000,000	$375	(assumption: 1 printer for every two computers)												
Survey Transit	3,200,000	$200													
Water Quality Test Kit (*need detail specs)	40,000,000	$2,500													
		Year >	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**		
3. Construction Costs (current per capita costs (PCC) +2%		**PCC >**	$15.79	$16.11	$16.43	$16.76	$17.09	$17.43	$17.78	$18.14	$18.50	$18.87	$19.25		
		$15.79 is based only on the cost of 2004-2005 systems, except for dropping the two highest cost schemes that appear unrepresentative of typical costs													
4. Office Space in Danang	$1,200 per month in Hanoi for an office of about 15 people				$800										
(sample cost from ADB/Hanoi office)	so perhaps about $800-$900 per month for similar office space in Danang						**Foreign Exchange Rate (VND/US$)**				**16,000**	as of July 2006			

For documenting the completion of the water system, the handover documents listed in Section 4.5 are quite detailed, and will no doubt prove useful to the communities and Water Managers over time. These documents will be especially useful when it become necessary to increase water tariffs to reflect actual O&M and repair costs over time. Water customers are often hesitant to accept increased tariffs without clear documentation of the rationale for the tariff increase. The handover documents will help to support the reasons for the increased tariffs, especially if cost details are included, so that the community members have a clear understanding and appreciation of the level of funding provided, and its sources.

This evaluation is an important component of program and project M&E, as it shows the openness and understanding by EMW senior staff of the need to periodically review programs such as this, not only for planning prospective program expansion, but also to assemble all of the important information about a program into a single reference document that is accessible for review by interested parties. Often in my experience, this kind of information only lives in the minds of individuals working on the program. If they leave for a new position, much of the information leaves with them, and becomes inaccessible.

11.2. Recommended Modifications of the M&E System

As part of this evaluation, a considerable amount of data was assembled from various sources, including the annual Clean Water Reports, Completion Reports for each water system, results of the Customer Satisfaction Survey (CSS), and other sources. Much of this information is now on two large spreadsheets. The first contains all the responses from the 75 questionnaires filled out during the CSS, including data on household cash and in-kind contributions toward water system construction cost, water tariffs, water consumption, monthly water bills, household income, sanitation facilities, hygiene behavior (e.g., hand-washing with soap), user perception of water quality, and many other variables. The second spreadsheet contains certain data on every water system built by EMW, including parameters such as site name, location (province, district), total expenditure on the project at that site[44], number of beneficiary families and individuals, year of completion, per capita cost, and other variables.

It is recommended that EMW management directs the CWP IT specialists to integrate these spreadsheets, include other costs of planning, development and management of the CWP (e.g., management, administration, logistics[45], training, equipment, and other costs directly related to the Clean Water Program), and prepare a proper Management Information System (MIS) to bring the information together in one place. As much of this information has already been entered into the spreadsheets, this would not be an onerous task, and could probably be completed by two persons in several weeks between high priority tasks. Once completed, all subsequent performance data on Clean Water Program could be periodically entered (probably annually) into the MIS. It would also not be difficult to prepare and periodically update a computerized map (not necessarily a GIS, which might be a bit extravagant) indicating the system location and number of beneficiaries, essentially a slicked-up version of the large map on the wall as you walk into the EMW office in Danang. This information would then be readily available to generate relevant sections of the EMW annual reports. Prospective donors would be impressed, and hopefully up their contributions accordingly.

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44 This only includes the cost of equipment, materials and construction contracts paid by EMW. It does not include land (for the water tower), rights of way provided by local authorities, house connections (pipe, meter, valves) paid for by individual families, digging/backfilling pipe trenches, labor by water team staff, or site-based staff like water managers, plumbers and storekeepers.

45 Such as motorbikes, water quality testing equipment, computers, technical reference materials, etc.

The Customer Satisfaction Survey carried out during this evaluation should be done periodically (say, every 2-3 years) to determine whether the Clean Water Program was meeting it goal and objectives. This would not likely consume scarce human and financial resources. The questionnaire is already available, and several EMW staff have participated in the previous survey, and now fully understand how to do the surveys and analyze the data. Subsequent surveys could probably be completed in two weeks of field time, and another week or two to write up the results. Doing this survey periodically would help the Water Team to make periodic adjustments to its planning and development approach, if required. EMW should also consider whether it would be helpful to carry out Customer Satisfaction Surveys for its other programs, with the intention of redirecting program activities and resources to better meet the requirements of program beneficiaries.

Lastly, EMW should make a more concerted effort to spread the word on what it is doing, and the success of its efforts. I have seen several press releases that mention what the writers think are the major players in rural water supply and sanitation in Vietnam, and seldom is EMW recognized for its significant contribution thereto. If for no other reason, it is important for EMW's donors to know that their efforts are being recognized, not only by the beneficiary communities, but by the larger donor community as well. EMW could start by becoming active participants in the Hanoi-based NGO Rural Water and Sanitation Working Group[46], not only to learn what other sectoral NGOs are doing, but to better disseminate information about the approach and success of the Clean Water Program. The Working Group is comprised of participants from international NGOs, bilateral donors, the United Nations network, and the Vietnamese government. All participants share common programmatic goals of contributing to an effective and efficient water and sanitation sector in Viet Nam.

11.3. Summary of Results of Water User Satisfaction Survey

The survey results show that there was a generally high level of beneficiary satisfaction with the water schemes developed under the EMW Clean Water Program. Using a very participatory and community based approach, and in regular consultation with the local authorities, EMW water program staff have been largely successful in providing reasonably good quality piped water to project beneficiaries.

Partly due to lack of access to alternative water sources (dug wells, drilled wells, surface water, or springs), customer willingness to pay for good quality, reliable piped water was generally high. Beneficiary communities were actively involved in both planning and construction (digging and back-filling pipe trenches), and paying for house connections and monthly water bills. Water Managers and storekeepers (for construction materials) were trained and do a reasonably good job. Construction supervisors appear to be somewhat stretched as the program accelerates, and additional technically qualified supervisors (and design engineers) will certainly be needed if the proposed program expansion occurs. Problems identified in the survey were well known to EMW program staff. In most cases, significant efforts had already been made to rectify problems related to:

- Water quality (which is a major constraint in much of Quang Nam Province);
- System design modifications (related to tank design, and sedimentation / filtration), construction standards (which have been improved over time);

46 Email contact: watsan-wg@ngocentre.org.vn, and the website: www.ngocentre.org.vn/watsan.

- Contractor performance (some contractors initially involved in the program have been dropped due to inadequate performance), but the current set of contractors (who are responsible to build the water towers, and install pumps, electrical controls, valves, mechanical filtration equipment) are doing a reasonably good job, especially as their experience and technical capability grows over time.

- Quality of materials (some initial problems with low quality PVC pipe were rectified) and equipment (pumps, controls, filtration systems are being steadily improved); and

- Insufficient technical design resources, - additional engineering design and supervision support and training is required, especially if the CWP scope is expanded significantly.

Surveys in the 75 selected households showed that the EMW CWP has been largely successful in planning and developing improved water supply for thousands of project beneficiaries, largely in Quang Nam, and to a limited extent in Quang Tri. Close working relationships have been developed with local authorities, who have in turn actively supported CWP, and have carried out their agreed upon responsibilities to help ensure CWP's success. On the basis of these surveys, visits to other existing EMW water system locations, review of some sites for prospective new water schemes (e.g., around Hue), and extensive discussions with program staff, specific comments and recommendations for improving and expanding the water program here in Central Vietnam will be given in the overall program evaluation report.

12. Proposed Hygiene and Sanitation Behavioral Change Component

12.1. Rationale for Addition of Sanitation and Hygiene Behavioral Change

RWSS studies and the experience of numerous projects supported by multilateral donors such as World Bank and ADB and bilateral donors such as AusAID, DANIDA, and USAID have shown that improved sanitation and hygiene behavioral change can have a significant positive impact upon community and families, largely by reducing the frequency of diarrheal disease. Provision of improved water supply has a clear positive impact upon communities such as those assisted by the Clean Water Program. Supporting the expanded development and use of sanitary latrines, and promoting hygiene behavioral change such as more frequent hand washing with soap, is a relatively inexpensive incremental investment that has been shown to have a significant positive impact on community and family health.

12.2. Promoting Latrines by Increased Awareness of Sanitation, Hygiene and Health Linkages

To maximize community health impacts of improved RWSS facilities, it is recommended that the CWP support a community and school-based Information, Education and Communication (IEC) program to improve hygiene behavior and support for sanitation activities aimed at reducing water related diseases (e.g., diarrhea, skin diseases, worm diseases, etc.)[47]. The IEC will focus on improving hygiene practices such as hand washing with soap, community-level environmental sanitation, household level wastewater drainage (not sewerage) programs and community level solid waste management. Women, teachers, community leaders and

[47] Information in this section has been adapted from the *Pre-Feasibility for the Red River Delta Rural Water Supply and Sanitation Project* (GOV and World Bank, Rick McGowan et al. January, 2005.

local authorities and the poor will be encouraged to get involved in and benefit from IEC activities. The close working relationships already developed by EMW with local authorities in Quang Nam would help facilitate the implementation of such a program component.

EMW need not spend significant resources to develop such a program. Several RWSS donors in Vietnam have already prepared and implemented appropriate programs that could be suitably adapted by EMW staff. Alternatively, EMW could subcontract out this activity to suitably qualified and experienced NGOs (see below). IEC implementation should be done in parallel with and follow up on the construction of water and sanitation facilities to ensure maximum project benefits to participating communities. Activities should be implemented for specific target groups—women, mothers of young children, boys and girls at school age, out-of-school children, and the poor. This component could take full advantage of existing IEC materials developed by CERWASS in part with Danida support. If agreed to by EMW management, this Clean Water Program component should follow the following guidelines:

- Shift away from a usual approach of just latrine construction to comprehensive behavior change and establishing sustainable social structures to support those changes, e.g. elimination of open air defecation, hand washing with soap at specific times, safe handling of water and maintaining a clean living environment.

- Develop local markets and private capacity to promote sanitation and hygiene services; to provide households with various technical, cost and financing options to enable people (including the poor) to access various sanitation options according to their willingness and ability to pay, and personal desires.

- Provide services to households that are driven by user demand, with no upfront subsidies on the capital cost of household sanitation facilities. Provision of services to households will be driven by user demand and the principle of full cost recovery.

12.3. Apparent Reluctance to Invest in Household Latrines

Some people interviewed during the evaluation said that there was not strong demand for improved sanitation in many communities where the EMW CWP has been implemented. The Customer Satisfaction Survey carried out during this evaluation showed that:

- 61% of survey respondents said that they had some kind of latrine, meaning that 39% had no latrine at all, and presumably that they defecated in open ground, forests, rivers or the ocean.

- 7% said that they only had a temporary latrine (typically, a hole dug in the ground, with four bamboo poles and burlap or plastic wrapping / covering for privacy) that would be covered over and a new one dug nearby when the old one was full.

- 4% said that they had a proper pit latrine (a dug pit, surrounded with some kind of privacy fencing or wooden walls, with a floor and a hole to access the pit.

- 47% said that they had a proper pour-flush latrine, often with a septic tank that required periodic de-sludging.

Similarly, when people were asked about how regularly they washed their hands with soap, 84% of respondents said they washed their hands with soap at certain times, specifically:

- After going to the toilet (81%);

- After coming home from work (72%);

- Before eating (48%, but note that many people said that they washed their hands after eating, not before); and
- After taking care of small children (63%).
- If they did not already have a latrine, only 27% would be willing to take a loan to build one (no loan conditions or costs were specified, but some people said a good latrine typically costs about VND 1.6 million). If people can afford it, they often prefer to build a latrine and bathing (shower) combination facility, which costs about VND 4-5 million.

It seems clear that many families are reluctant to take a loan to build a latrine. Many people in Quang Nam feel that loans should only be taken out to finance income generating activities. However, provision of targeted loans is not the only way to promote improved latrines.

12.4. Private Sector Sanitation Delivery

Some donors (e.g., DANIDA and AusAID), NGOs (e.g., IDE) and GOV agencies (e.g., The Vietnam Women's Union) have achieved some success in promoting the adoption of improved latrines and improved hygiene through more frequent hand washing with soap. There is no apparent reason that EMW could not adopt their experience and programs to bring greater positive impact of the existing program of providing clean water to beneficiary communities. An explanation of how this has already been done, and particularly done in Quang Nam, is given in the box below[48].

> In two Vietnam provinces, International Development Enterprises (IDE) developed various low-cost sanitation options and stimulated a network of local masons to market and deliver them to rural communities. As a result, the sanitation access rate increased markedly in these areas, even among the poor. The project highlights the importance of not underestimating willingness to pay for sanitation, if quality products and services are offered and their usefulness is effectively communicated.
>
> From September 2003 through June 2005, IDE implemented a rural marketing pilot project targeting about 54,000 households in Thanh Hoa and Quang Nam Provinces on Vietnam's central coast. By June 2005, more than 9,300 investments in latrines were made in the project areas. Using the December 2002 access rate as the baseline, communities in the experiment group achieved more than 100 percent increase in the rate of household access by December 2004, whereas the control group achieved only a 41 percent increase. According to GOV criteria, nearly one-fifth of households in the two provinces are categorized as "poor" and thus receive social assistance. The reality of widespread poverty poses a significant challenge to delivering sanitation services in these areas.
>
> Unlike the conventional approach normally applied in Vietnam, the piloted approach was fully market-driven, offering customers no capital cost subsidies and using external resources to catalyze market-based improvements in sanitation services and promotion of improved hygiene behaviours. IDE's approach focused on stimulating weak rural sanitation markets and helping these markets become viable. Emerging evidence from Vietnam suggests that utilizing a market-based approach can accelerate access to sanitation among underserved rural populations, enhance sustainability of services, and deliver these services more efficiently compared to a non-market based approach.

Therefore, it is recommended that EMW contact IDE (and other NGOs with similar experience, particularly in Quang Nam), and discuss how best to integrate IDE's private sector sanitation delivery approach into the CWP (and Improved Hygiene and Sanitation) Program.

48 Private Sector Sanitation Delivery in Vietnam: Support to Small-Scale Private Sector Development and Marketing for Sanitation in Rural Areas Final Report, IDE, Danida Ref. No. 104.Vie.30m, September 2005

13. Overall Conclusions and Recommendations

13.1. Conclusions

The EMW Clean Water Program has been successful in providing improved piped water supply to 67 communities in Quang Nam (where nearly all the systems were built) and Quang Tri Provinces. Another 15 piped water systems are expected to be completed by the end of 2006. The field visits, meeting with beneficiary communities and local authorities, discussions with Clean Water Program staff, and results of the Customer Satisfaction Survey, show that there was a generally high level of beneficiary satisfaction with the water schemes developed under the EMW Clean Water Program. Using a participatory and community based approach, with frequent consultation with local authorities, EMW staff have been largely successful in providing reasonably good quality piped water to project beneficiaries.

Partly because of the general lack of access to alternative water sources (dug wells, drilled wells, surface water, or springs), customer willingness to pay (WTP) for good quality, reliable piped water was generally high. Beneficiary communities were actively involved in planning and construction (digging and back-filling pipe trenches), and paying for house connections and monthly water bills. Water managers and storekeepers (for construction materials) were trained and are doing a reasonably good job. Construction supervisors appear to be somewhat stretched as the program accelerates, and additional technically qualified supervisors (and design engineers) will be needed if the proposed program expansion occurs. Problems identified during the survey were already well known to EMW program staff. In most cases, significant efforts had already been made to rectify problems related to:

- Water quality (which is a major constraint in much of Quang Nam Province);
- System design modifications (related to tank design, and sedimentation / filtration), construction standards (which have been improved over time);
- Contractor performance (some contractors initially involved in the program have been dropped due to inadequate performance), but the current set of contractors (who are responsible to build the water towers, and install pumps, electrical controls, valves, mechanical filtration equipment) are doing a reasonably good job, especially as their experience and technical capability grows over time.
- Quality of materials (initial problems with low quality PVC pipe have been rectified) and equipment (pumps, controls, filtration systems are being steadily improved); and
- Engineering design resources appear to be barely sufficient, so that additional engineering design and supervision support and training is required, especially if the program scope will be expanded significantly.

Overall, surveys in 75 selected households showed that EMW's water program has been largely successful in planning and developing improved water supply for thousands of project beneficiaries, largely in Quang Nam, and to a limited extent in Quang Tri Provinces. Close working relationships have been developed with the local authorities, who have in turn actively supported the program, and have carried out their agreed upon responsibilities to help ensure the success of the program. On the basis of these surveys, visits to other existing EMW water system locations, review of some sites for prospective new water schemes (e.g., around Hue), and extensive discussions with program staff, recommendations for improving and expanding the water program here in Central Vietnam given in this overall program evaluation report.

13.2. Recommendations

A brief summary of recommendations is given below:

- There is a tremendous need for improved water (and sanitation) services in Quang Nam Province and surrounding areas, and the EMW water program is a major supplier of water services in rural Central Vietnam. It is strongly recommended that EMW management and its major donors consider significantly expanding the water supply and the proposed hygiene and sanitation behavioral change program.

- More technical staff are needed even within the current level of activities. In particular, it would be very helpful to have a full-time experienced water supply engineer to work with the Water Team to improve engineering design capability, and train up existing staff to gain experience in system design, and construction supervision and inspection.

- It is strongly recommended that in order to maximize community health benefits from the program, that a hygiene and sanitation behavioral change program be developed and carried out in all EMW assisted villages.

- EMW has begun to support private management of community water systems to a limited extent. This approach is strongly supported by large donor agencies such as World Bank and ADB. EMW should continue to track the progress of these limited number of private management contracts, and where it appears promising, support this approach in future water system development activities.

- EMW has made initial inroads into coordinating its water activities with other agencies (e.g., PCERWASS in Hue). Opportunities to work with other GOV agencies (e.g., the Central Vietnam Division of Hydrogeology and Engineering Geology – CEVIHEGEO) and private geophysical companies (e.g., FrOG Tech) to expand EMW water services to larger rural communities and small towns is under discussion. EMW should pursue collaboration with such organizations to develop a proposal for a Feasibility Study[49], possibly co-financed by sectoral donors in Vietnam (e.g., ADB, World Bank, Danida, AusAID, etc.) to assess the possibility of developing deep groundwater sources to enable EMW to provide better quality services to larger communities.

[49] Ref: *Draft Proposal for a Feasibility Study of Deep Groundwater Development for Larger Villages and Small Towns Using the EMW Clean Water Program Approach* (draft), R. McGowan, August 2006.

Appendices

Appendix 1 – Consultant's Terms of Reference

Appendix 2 – List of Villages Visited During Evaluation

Appendix 3 – Conclusions and Recommendations from the EMW and WFP (Water for People) Hygiene Improvement Workshop

Appendix 3 – Water Supply Manuals Available from American Water Works Association

Appendix 4 – Administrative and Monitoring and Evaluation Documents of EMW Clean Water Program (in order of their use in the project)

- Water Project Investigation Form (relevant local authorities, socioeconomic, demographic and technical data of proposed site/hamlet).
- Questionnaire (pre-selection summary of water family-specific site conditions, including socioeconomic descriptors, current and potential water source(s) and utilization patterns).
- Criteria for Ranking Water (for site ranking and selection).
- Request for Clean Water System Construction Funding (required components, site location, number of beneficiaries, project activities, cost estimate, water needs assessment, and required inputs from community).
- Water Quality Test Results (separate forms for chemical/ biological tests).
- List of Equipment Required for System Design (e.g., water quality testing equipment for specified parameters, and equipment to measure electricity quality, well production, distance and elevation measurements, etc.)
- Letter of Commitment (household committing to participate in project).
- Registration Form for Installing Water Meters and Fittings (individual families confirming their intent to pay for house connections with meters).
- Weekly Status Report (activities accomplished in previous week, activities scheduled for next week, and status of completion of planned objectives – e.g., total meters of piped to be installed, or pipeline trench to be done, and amount completed this week, and amount planned to be completed for next week, and notes on difficulties/problems encountered). This is written by the site supervisor.
- Evaluation Form (post-construction quantitative description).
- Project Summary (post-construction narrative).