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GHANA: DESIGN FOR REUSE – HARVESTING THE VALUE OF EFFLUENT AND NUTRIENTS FOR SUSTAINING THE OPERATION OF SANITATION FACILITIES

APPRAISAL REPORT

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May 2010

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LIST OF ACRONYMS

ADB, AfDB	-	African Development Bank
AMA	-	Accra Metropolitan Assembly/Authority
ASIP	-	Accra Sewer Improvement Project
AWF	-	Africa Water Facility
BOD	-	Biochemical oxygen demand
BOT	-	Build, Operate, Transfer
CBOs	-	Community Based Organisations.
CDM	-	Clean Development Mechanism
CGIAR	-	Consultative Group on International Agricultural Research
DA	-	District Assembly
DALY	-	Disability adjusted life year
EFB	-	Empty Fruit Bunches (palm oil processing waste)
EHSD	-	Environmental Health and Sanitation Directorate
EPA	-	Environmental Protection Agency (Ghana)
ESP	-	Environmental Sanitation Policy
ESMP	-	Environmental and Social Assessment Management Plan
FS	-	Faecal sludge
FSTP	-	Faecal sludge treatment plant (settlement pond system)
GIDA	-	Ghana Irrigation Development Authority
GPRS	-	Growth and Poverty Reduction Strategy
GSS	-	Ghana Statistical Service
HRD	-	Human Resource Development
IWMI	-	International Water Management Institute
JMP	-	Joint Monitoring Programme
KNUST	-	Kwame Nkrumah University of Science and Technology
M&E	-	Monitoring and evaluation
MDGs	-	Millennium Development Goals
MA / MMDA	-	Metropolitan Assembly / Metropolitan, Municipal and District Assemblies
MOFA	-	Ministry of Food and Agriculture
MLGRD	-	Ministry of Local Government and Rural Development
MWRWH	-	Ministry of Water Resources Works and Housing
NCB	-	National Competitive Bidding
NDPC	-	National Development Planning Commission
NGO	-	Non-Governmental Organisation
NPK	-	Nitrogen, Phosphorous, Potassium (main plant nutrients)
O&M	-	Operation and Maintenance
Presec	-	Presbyterian Boys' Secondary School, Accra
PPP	-	Public Private Partnership
PSC	-	Project Steering Committee
PSP	-	Private Sector Participation
RFP	-	Request for Proposals
SC	-	Steering Committee
TA	-	Technical Assistance
TP	-	Treatment Plant
TREND	-	Training, Research and Networking for Development Group
UCB	-	University of California, Berkeley
UESP	-	Urban Environmental Sanitation Project
UV	-	Ultra Violet
WRC	-	Water Resources Commission
WSP	-	Waste Stabilisation Pond
WW	-	Wastewater
WWTP	-	Wastewater Treatment Plant

CURRENCY EQUIVALENTS

(as of February 2010)

Local Currency	:	Ghanian Cedis (GHS)
1 Euro (EUR, €)	:	1,99 GHS
		1,40 USD
		0,90 UA

TIMEFRAME (KEY MILESTONES)

Application	September 2009
Appraisal	February 2010
Approval	June 2010
Effectiveness	September 2010
Completion	March 2013
Last disbursement	September 2012

ii LOGICAL FRAMEWORK

HIERARCHY OF OBJECTIVES	EXPECTED RESULTS	REACH	PERFORMANCE INDICATORS	TARGETS AND TIMEFRAME	ASSUMPTIONS / RISKS
Goal	**Impact**	**Beneficiaries**	**Impact Indicators**	**Baseline and Indicative Targets**	**Risks and Mitigation**
Dramatically improve public health and environmental integrity throughout (peri-) urban areas of Ghana through the provision of reliable and complete[1] sanitation.	Public health and environmental integrity in (peri-)urban Ghana is improved. Preparedness of sanitation systems towards climate variability is improved.	Urban and peri-urban residents of Ghana	i. Incidence of waterborne diseases ii. Access to complete sanitation iii. Volume of treated wastewater and faecal sludge *Sources :* National Health Statistics, Urban water and sanitation statistics	i. Reduced by 100% in 2025 *, ** ii. Increased to 100% by 2025 *, *** iii. Increased to 100% by 2025 *, **** (*) Ghana Water Vision, 2009 (**) 28 500 DALYs predicted from 4 waterborne diseases (Accra Urban Water system, 2010) (***) < 25% in 2006 (****) < 10% in 2007	*Assumption :* Economic progress and political stability *Risk :* Insufficient human and financial resources. Insufficient awareness *Mitigation :* Development and dissemination of knowledge on cost reducing approaches
Purpose	**Outcome**	**Beneficiaries**	**Outcome Indicators**	**Baseline and Indicative Targets**	**Risks and Mitigation**
Demonstrate the benefits of the reuse of nutrients and water in improving sanitation schemes in Ghana by - Shifting the design focus from disposal to productive reuse - Capturing the economic, social and environmental benefits that will provide incentives and help finance robust sanitation schemes - Strengthening the human and institutional capacity for reuse-oriented sanitation and preparing against climate variability	- Rehabilitation of additional TPs for reuse and respect of WHO standards and establishment of farmland demonstration plots - Replication of implementation plans lead to increased revenue based on researched value chains - Local planners and decision makers apply design for reuse	Farmers at WWTPs, Consumers of fresh produce in Accra Local government agents, planners and engineers	i. Number of additional WW and FSTPs that have plans to retrofit or design for reuse ii. Contribution of reuse to O&M costs iii. Number of sanitation strategies and policies revised to include increased reuse focus *Sources :* Surveys, reports and statistics of WRC, EPA, MoLG, MoA	i. 4 additional plants by 2018 ii. Over 30% of O&M costs covered in at least 2 value chains by 2018 iii. Draft resource recovery policy for the sanitation sector by 2018	*Assumption :* Local demand for fish, irrigation, compost, etc. can generate net benefits *Risk :* Advanced design of large disposal oriented sanitation schemes. *Mitigation :* Partnering with ASIP and UESP

[1] Complete sanitation includes: (1) safe defecation; (2) collection and treatment of human waste; and (3) safe disposal or preferably productive end use of treated waste. This definition is broader than that adopted by the JMP and MDG; but is increasingly understood to be the goal for sanitation that adequately protects human and environmental health. (UN Millennium Project. 2005; World Water Assessment Program 2009)

Inputs and Activities	Outputs	Beneficiaries	Output Indicators	Baseline and Indicative Targets	Risks and Mitigation
Component 1 : Effluent reuse in irrigation – Construction of value chain and rehabilitation of Presec pilot site	- Assessment and design of WWTP rehabilitation for reuse including contractual arrangements for partial O&M cost recovery from reuse - Rehabilitation carried out and effluent used for irrigation - Monitoring of plant operation and reuse benefits - Transferable road map for reuse in irrigation value chain - Dissemination and replication training	- Presec, users and downstream neighbours - Back-end users - Planners and designers	i. Assessment and Design reports, re-use contracts ii. Proportion of O&M costs generated from reuse iii. Effluent and product quality norms respected iv. Results publicly available v. Training for replication carried out *Sources :* Design report, O&M reports, Lab reports, Progress and final reports	i. Reports and contracts (M 4) ii. Over 30% of O&M costs covered through reuse (M 36) iii. Effluent respects relevant WHO guidelines fit for consumption (M 36) iv. Reuse case study and transferable road map at WRC and IWMI web site (M 30) v. Proceedings of one reuse in irrigation workshop (M 30)	*Risk :* Delay of implementation Reluctance to contribute to O&M costs Under-achievement of cost effectiveness *Mitigation :* Transparent partnership approach initiated and thorough preliminary investigations carried out
Component 2 : Aquaculture in maturation ponds – Construction of value chain and implementation plan for Tema and Kumasi WWTPs	- Implementation plans for pilot locations based on confirmed assessment of WW, fish market, cost benefit analysis for different fish species, analysis of alternative incentive models - Transferable road map for aquaculture integration into stabilisation ponds - Dissemination and replication training	- Plant owners, users and downstream neighbours - Back-end users - Planners and designers	i. Aquaculture implementation plans ii. Transferable road map for aquaculture in WW ponds iii. Training for replication carried out *Sources :* Progress and final reports	i. 2 implementation plans (M 12) ii. Reuse case study and transferable road map at WRC and IWMI web site (M 18) iii. Proceedings of one aquaculture workshop (M 24)	*Risk :* Unsuitable wastewater quality (industrial effluents) *Mitigation :* Consider alternative sites
Component 3 : Use of compost and biogas– Construction of value chains and implementation plan for Sekondi-Takoradi FSTP and Legon WWTP *Total cost :* 498 000 Euro	- Implementation plans for compost and biogas pilot locations based on cost benefit analysis for different levels of equipment and alternative incentive models - Transferable road maps for land application and biogas use - Dissemination trainings	- Plant owners, users and downstream neighbours - Back-end users - Planners and designers	i. Compost / land application implementation plan ii. Biogas implementation plan iii. Transferable road maps for compost and biogas iv. Training for replication carried out *Sources :* Progress and final reports	i. 2 implementation plans after (M 24) ii. Compost and biogas case studies and transferable road maps at WRC and IWMI web site (M 30) iii. Proceedings of one compost / land application workshop (M 30) iv. Proceedings of one biogas workshop (M 30)	*Risk :* Unsuitable cost benefit analysis / equipment *Mitigation :* Consider alternative reuse

0 EXECUTIVE SUMMARY

0.1 **Background:** The rationale for the project is the current inadequate operation and maintenance of wastewater (WW) and faecal sludge (FS) treatment plants (TPs). Less than 10% of the existing treatment plants in Ghana operate as designed based on the findings of survey carried out in 2008. The 55 existing WWTPs and 7 municipal FSTPs in the country have a total design capacity to serve about 25% of the urban population but discharge into the environment without any effective treatment is dominating. In terms of individual access to "improved" sanitation, a statistic that is monitored as one of the Millennium Development Goals (MDGs), Ghana has an average national coverage of between 40% and 45%; however, achieving the environmental and public health benefits that are associated with improved sanitation, demands adequate collection, treatment and disposal/end use of the waste in addition to the provision of toilet facilities.

0.2 **Objectives:** The overall objective is to improve public health and environmental integrity throughout urban and peri-urban areas of Ghana through the provision of reliable and complete[2] sanitation. The medium term outcomes expected from the project are: (i) the rehabilitation of one WWTP including reuse for irrigation; (ii) knowledge products based on action research for aquaculture and biogas value chains, and (iii) the training of local planners on design for reuse.

0.3 **Description:** Through piloting the rehabilitation of a wastewater treatment plant for reuse of effluent in irrigation and action research, the project will introduce a market- and end-user oriented planning approach that simultaneously closes the water and nutrient loops called "Design for Reuse" in order to effectively capture the economic value of wastewater and faecal sludge nutrients to help finance, operate and maintain treatment facilities. The external benefits of reuse such as increased yields and earnings in agriculture, environmental protection, reduced pressure on freshwater resources have been widely demonstrated but this project will demonstrate reuse as a business model through constructing and implementing value chains between treatment plants and back-end users to share the economic value of reuse with the plant operator.

0.4 The project will be implemented in three components on a pilot scale that comprises four value chains and capacity building. **Component 1** consists of the value chain for effluent reuse in irrigation and includes the rehabilitation of a pilot site. **Component 2** comprises the value chain for aquaculture in maturation ponds with an implementation plan two treatment plants. **Component 3** deals with the use of compost and biogas value chains and implementation plans.

0.5 The project will be implemented through a participatory approach, including consultation and active engagement with key stakeholders in the Ministries of Water Resources, Works and Housing (MWRWH), Local Government and Rural Development (MLGRD), local consulting engineers, and targeted back-end users, such as farmers and industry. Active support from the owners and operators of each pilot TP was a critical factor in their selection.

0.6 **Cost and financing:** AWF will contribute € 498 000, representing 88 % of the total project cost of € 559 800. The Project is expected to start in July 2010 and will have a total duration of 30 months.

0.7 **Recommendation:** It is recommended that an AWF Grant not exceeding € 498 000 be extended to the WRC for the implementation of the project described in this report.

[2] Complete sanitation includes: (1) safe defecation; (2) collection and treatment of human waste; and (3) safe disposal or preferably productive end use of treated waste. This definition is broader than that adopted by the JMP and MDG; but is increasingly understood to be the goal for sanitation that adequately protects human and environmental health. (UN Millennium Project. 2005; World Water Assessment Program 2009)

1 BACKGROUND

1.1 Origin of the Project

1.1.1 The state of urban wastewater and faecal sludge management in Ghana is similar to many other countries of Africa: the supply of human waste far out-strips the existing capacity of treatment facilities, and among treatment plants that do exist, most are in disrepair. Ghana, located on the Gulf of Guinea in West Africa, has a total population of about 20 million people, and approximately 44% reside in urban settlements. Greater Accra, the main agglomeration comprised of Accra and Tema, has about 2.9 million people (GSS 2002).

1.1.2 In 2008, the International Water Management Institute (IWMI) undertook a nationwide assessment of the state of wastewater (WW) and fecal sludge (FS) treatment plants (TPs) in Ghanaian cities. 55 WWTPs, ranging from community to municipal scale, and 7 municipal FSTPs in the country have been identified. These facilities have a total design capacity to serve about 25% of the urban population but fewer than 10% are operational[3]. Thus, more than 85% of WW and FS are discharged into the environment without any effective treatment. In terms of individual access to "improved" sanitation, a statistic that is monitored as one of the Millennium Development Goals (MDGs), Ghana has an average national coverage of between 40% and 45%[4][5]; however, achieving the environmental and public health benefits that are associated with improved sanitation, demands adequate collection, treatment and disposal/end use of the waste in addition to the provision of toilet facilities. This comprehensive system is considered complete sanitation.

1.1.3 Diarrhoeal diseases are ranked the second greatest public health problem after malaria for most communities of Greater-Accra[6]. Consumption of food contaminated with polluted irrigation water is one of the most common vectors of disease transmission. It is estimated that consumption of salad prepared from wastewater irrigated lettuce accounts for an annual loss of about 12 000 healthy life years (DALYs) in Ghana's major cities – equivalent to nearly 10% of the WHO reported DALYs in urban Ghana[7].

1.1.4 The environmental impacts of inadequate sanitation are also severe. Accra's largest lagoon, the Korle Lagoon, is fed by the Odaw River, which receives over 60% of Accra's untreated greywater and WW, in addition to solid waste[8]. The lagoon once supported a

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[3] Wastewater Irrigation and Public Health: From Research to Impact – A Road Map for Ghana. International Water Management Institute, Accra, 2009, prepared for Google.org.

[4] Preliminary National Environmental Sanitation Strategy and Action Plan (NESSAP). Government of Ghana, Ministry of Local Government, Rural Development, Accra, 2008.

[5] "Joint Monitoring Programme for Water Supply and Sanitation. Coverage Estimates: Improved Sanitation in Ghana." WHO-UNICEF, 2008. 2009, from http://www.wssinfo.org.

[6] Ministry of Health: Facts and Figures. Accra, 2009, from http://www.moh-ghana.org /moh/ docs/ health_service/ SUMMARYOFTOPTWENTYCAUSESOFOUTPATIENTMORBIDITY2007.pdf.

[7] Ghana Demographic and Health Survey 2003. Calverton, Maryland, Ghana Statistical Services, Noguchi Institute, ORC Macro, 2004.

[8] Biney, C. A. (1996). "The threat of pollution to the coastal zone of the Greater Accra Metropolitan Area, Ghana." Ghana Journal of Science(31-36): 47-54.
Boadi, K. O., Kuitunen, M. (2002). "Urban Waste Pollution in the Korle Lagoon, Accra, Ghana." The Environmentalist **22**: 301-309.

thriving fishery, and is slated to become a recreational area, but it is considered one of the most polluted places globally.

1.1.5 Historical approaches to securing household-level demand for complete sanitation, and to achieving cost recovery through user fees, have failed in Ghana, among other countries. This failure is in part because the private benefits of sanitation to households effectively stop at the point of waste collection, i.e. access to a toilet or latrine. Thus, households have very limited willingness to pay for WW treatment despite the enormous (public) costs of inadequate sanitation. The costs of supplying WW and FS treatment in Ghana are largely borne by local governments; environmental sanitation (i.e. solid and liquid waste management) consumes more than 35% of the budgets of municipal governments in Ghana, preventing them from funding and improving the development of other services in communities, towns, and cities (MLGRD 2008). None the less, current levels of financial and human resource investment are far from sufficient, as demonstrated by the poor operational status of the majority of WW and FSTPs in Ghana.

1.1.6 The goal of this project is to improve the long-term operation and integrity of wastewater and faecal sludge treatment plants in urban Ghana. *A novel, market- and reuse-oriented approach to sanitation called Design for Reuse will demonstrate* that effectively capturing and allocating the resource value of WW, FS, and treatment byproducts can serve to finance and incentivize *robust sanitation systems that simultaneously close the water and nutrient loops*. Back-end users as key stakeholders in sanitation planning and operation will be included as partners in creating robust urban sanitation systems in Ghana and elsewhere. Pilot plants located in Greater-Accra, Sekondi-Takoradi and Kumasi, will progressively transfer the Design for Reuse model to other cities in Ghana and Africa at large. Another key objective of the project is to train local engineers and planners to employ a reuse-oriented planning process for the design and implementation of future WW and FSTPs based on the earlier results of the project.

1.2 Sectoral Priorities

1.2.1 The Government of Ghana is dedicated to improving the status of sanitation throughout the country. In 1999, the Ministry of Local Government and Rural Development (MLGRD) launched the first edition of its Environmental Sanitation Policy (ESP), setting the goal of providing 90% of the population with a domestic toilet by 2020 and the remaining 10% with access to hygienic public facilities; pan latrines are to be phased out by 2010. The ESP has since been amended and an Action Plan for its implementation was put in place in 2008. In addition to these previous initiatives, the MLGRD is championing the Strategic Environmental Sanitation Investment Plan; it will facilitate gradual reversal of the deficits in services through effective implementation at the district level. The project is designed to greatly support that effort by developing innovative models for improving the financial sustainability of sanitation facilities.

1.2.2 Importantly, this pilot study builds directly on two large-scale, government led initiatives currently underway to improve urban sanitation: the Accra Sewerage Improvement Project (ASIP) and the Urban Environmental Sanitation Project-2 (UESP-2), supported by the African Development Bank and World Bank, respectively. ASIP and UESP-2 aim to expand sanitation coverage and to build the technical, managerial, and institutional capacity of the managing stakeholders. The Accra MA embarked on the five year ASIP in 2005. The outputs are to include two new WWTPs, which are considered as

pilot plants in this proposal because of the high visibility of the ASIP. Models which prove successful under its auspices are likely to be institutionalized and transferred to future projects. The FSTP being constructed at Sekondi-Takoradi under the UESP-2 has been selected to demonstrate the benefits of reuse-oriented sanitation in a very visible arena, and to integrate the techniques for planning and implementing reuse-oriented sanitation into UESP-2's existing capacity-building platforms.

1.3 Problem Definition

1.3.1 This project has been conceived and will be implemented through a participatory approach, including consultation and active engagement with key stakeholders in the Ministry of Water Resources, Works and Housing (MWRWH), MLGRD, local consulting engineers, and targeted back-end users, such as farmers and industry. Active support from the proprietors/managers of each pilot WW/FSTP was a critical factor in the plant selection. There is a joint commitment to designing sanitation systems in which treated effluent, biogas, sludge or other output are marketable products and are no longer considered as disposal problems. This marks a dramatic shift from the planning processes undertaken so far, and the outcomes are expected to represent decisive improvements over the status quo performance of Ghana's WW and FSTPs. Reuse-oriented sanitation systems, like all successful products, must be tailored to meet the needs of end users, including considerations of location, quality and state (such as dry solids content of sludge).

1.3.2 The Design for Reuse approach (as outlined in Fig. 1) is an effort to establish the sanitation sector as an active contributor to local economies. Design for Reuse is a market-oriented approach that puts back-end-users (i.e. people who exert demand for WW effluent or FS for productive use for irrigation, aquaculture, fertilizer, or fuel) at the center of the planning process in order to simultaneously achieve urban sanitation objectives and to capture and allocate the local economic and social value of WW, FS, and treatment byproducts. Back-end users will be formally incorporated into the financial and O&M model of each target treatment facility and the specific demands of back-end users for the outputs of sanitation systems will be met in exchange for direct payment and/or in-kind labor (maintenance) at the treatment plant. This *additional* source of *revenue* and/or labor *will ease the burden of financing WW and FS treatment on households and government and improve the incentives and financial capacity for continuous operation.*

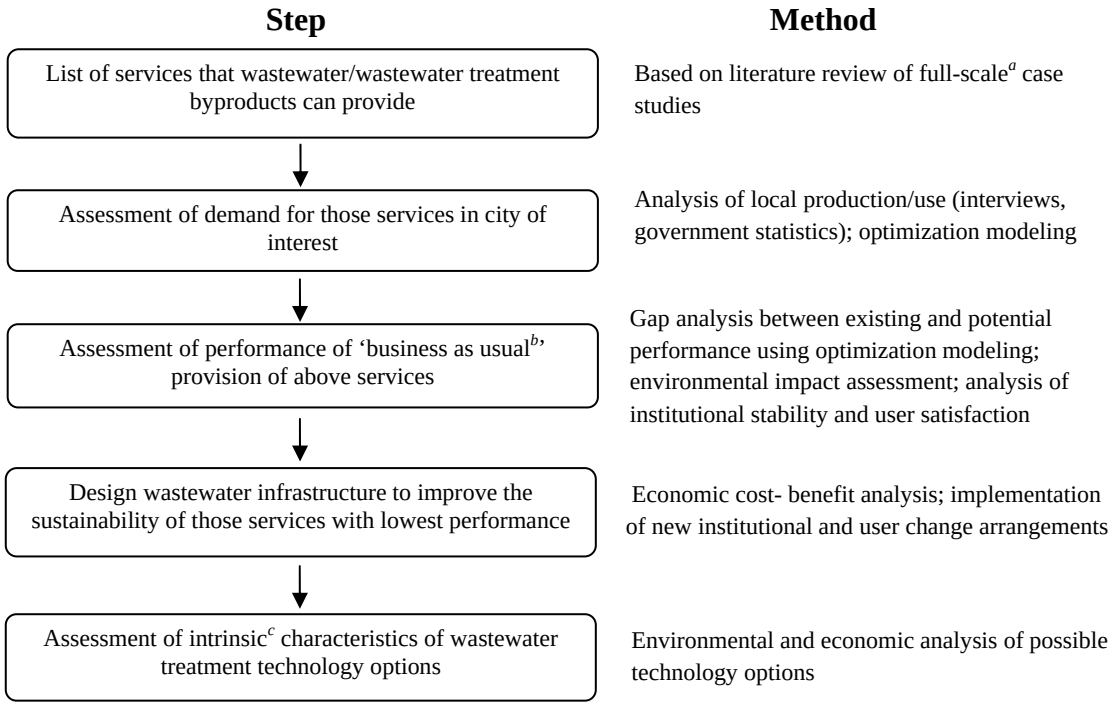
1.3.3 Treatment plants are capable of providing numerous services, including treated wastewater for agriculture and/or aquaculture, faecal sludge for land application as a soil enhancement and fertilizer, as well as the generation and recovery of biogas for cooking, heating, or lighting. Case studies from around the world have demonstrated significant economic returns to associated with WW and FS reuse; for example, crops irrigated with wastewater have yields 20-50% higher than the same crops grown with freshwater[9]. The reliability and frequency of wastewater flow can also dramatically improve farmers' livelihoods by providing a year-round source of irrigation water, and thus the opportunity

[9] Mohammad, M. J., Ayadi, M. (2005). "Forage yield and nutrient uptake as influenced by secondary treated wastewater." Journal of Plant Nutrition **27**(2): 351-365;
Lopez, A., Pollice, A., Lonigro, A., Masi, S., Palese, A.M., Cirelli, G.L., Toscano, A., Passino, R. (2006). "Agricultural wastewater reuse in southern Italy." Desalination: Integrated Concepts in Water Recycling **187**(1-3): 323-334;
Kiziloglu, M., Turan, M., Sahin, U., Angin, I., Anapali, O., Okuroglu, M. (2007). "Effects of wastewater irrigation on soil and cabbage-plant (brassica olerecea var. capitate cv. yalova-1) chemical properties." Journal of Plant Nutrition and Soil Science **170**(1): 166-172.

to increase the number of annual crop cycles[10]. While each of the aforementioned reuses are practiced in various places around the globe, it is seldom the case that treatment plants are explicitly designed or optimized for reuse[11], and it is even rarer for facilities to recover any of the value of the productive services they provide for society. For example, many farmers around treatment facilities freely exploit the resource value of effluent (adequately treated or not) with no formal obligation or payment to the treatment facilities; this represents a consumer surplus that could be more equitably allocated among farmers and the facilities if a market were established. This project thus takes the novel market-oriented step of *constructing and implementing value chains* (Fig. 1) between treatment plants and back-end users to harness the economic value of the service(s) a plant provides and to invest this value directly into the operation of the treatment plant.

Figure 1: Design for Reuse planning process

Design for Reuse is a five-step planning approach that results in a site-specific, reuse-oriented sanitation scheme. The ultimate reuse (or "service") of the wastewater/faecal sludge is the starting point for the planning process; each of the five steps and corresponding methods are shown below.



[a]Meaning reuse options that have been demonstrated at a scale beyond pilot studies; [b]Meaning the performance of a particular service (e.g., irrigation) without the use of wastewater effluent to supplement or replace the existing source; [c]Meaning the fixed characteristics of a treatment technology, such as footprint, energy consumption per volume water treated, and cost.

[10] Huibers, F., Van Lier, J. (2005). "Use of wastewater in agriculture: the water chain approach." Irrigation and Drainage **54**(S1): S3-S9;
Raschid-Sally, L., Carr, R., Buechler, S. (2005). "Managing wastewater agriculture to improve livelihoods and environmental quality in poor countries." Irrigation and Drainage **54**: S11-S22.

[11] Tunisia is a notable exception, where wastewater and sludge reuse is an integral component of all sanitation projects and is planned for at the outset of the design process (Bahri, A. (2009). "Managing the other side of the water cycle: Making wastewater an asset", TEC Background Papers No. 13. Sweden, Global Water Partnership).

1.3.4 This project will be implemented on a pilot basis that comprises four value chains for reuse: 1. Reuse in irrigation; 2. Incorporation of aquaculture into maturation ponds; 3. Large-scale land application of faecal sludge; and 4. Biogas recovery. In addition, the project includes extensive capacity building covering all value chains, through developing and publishing planning protocols, and hosting interactive training workshops.

1.4 Beneficiaries and Stakeholders

1.4.1 The direct beneficiaries of the project include plant owners, farmers, downstream neighbours and consumers of food of the rehabilitated pilot plant as well as the local government agents, planners and engineers trained under the capacity building funded by the project. Their main benefits include improved health and environment, as well as reduced operation cost and quantified costs and benefits of the studied value chains. Through this project, farmers around the Presbyterian Boys' Secondary School's (Presec) rehabilitated WWTP will have access to a high quality, reliable and convenient water source for irrigation, dramatically decreasing the degree of pathogen contamination on produce, and thus the risk of spreading diarrheal disease to consumers, as shown by ex-ante risk assessments[12]. Farmers will also be protected from contracting waterborne disease through their close contact with water.

1.4.2 This project will quantify the allocation of economic benefits from four different productive reuses, demonstrating the respective potential gains for the Government of Ghana, other treatment plant proprietors, and public and private sector end users. The positive outcomes of this project will spread far beyond the lifespan of its funding. Capacity development will strengthening the ability of immediate project partners and other planners, engineers and decision makers across Ghana to strategically plan and implement market-based sanitation systems.

1.4.3 With the primary objective of the project being to implement complete sanitation systems that are effective, and have long-term operational integrity, Accra's broader urban population will reap the benefits of fewer vectors of diarrheal disease transmission, a cleaner and safer working environment, and improved food safety. Every day more than 200,000 residents of Accra consume salad greens from street-food vendors that were grown with untreated wastewater – often the only source of water that is available to urban farmers.

1.5 Objectives of the Project

1.5.1 The project aims at improving the public health and environmental integrity in urban and peri-urban Ghana through the provision of reliable and complete sanitation which will lead to reduced incidence of waterborne diseases, improved access to complete sanitation and increased volume of treated wastewater and faecal sludge. In addition, the increased reuse of treated effluent and nutrients will improve the preparedness of sanitation systems towards climate variability through reduced pressure on limited freshwater resources.

1.6 Justification of AWF Support

1.6.1 The recovery of value from wastewater and faecal sludge through reuse focused treatment is an applied research project with focus on innovation and knowledge which

[12] IWMI (2009). Wastewater Irrigation and Public Health: From Research to Impact-A Road Map for Ghana. Accra, Ghana, International Water Management Institute prepared for Google.org

will in the longer term equally contribute to Improved Service Delivery. It falls primarily under the water knowledge pillar of the AWF mandate. Through contribution to the operation costs from reuse, it relates to the strengthening of the financial base and the pilot rehabilitation touches on meeting water needs through investments. Reuse of wastewater can significantly contribute to improved resource protection and water governance at a later replication stage. Reuse reduces pressure on surface water resources and contributes to prepare eco-systems for increased climate variability.

1.6.2 Funding from the AWF will enable the project to explore the most promising value chains in greater detail and implement one WWTP pilot rehabilitation focused on reuse in irrigation. The project has received co-financing from the University of California – Berkeley in the form of a research grant. Improved operation of treatment plants at reduced cost will make an important contribution towards sustainability of waterborne sanitation in Ghana and beyond.

2 THE PROJECT

2.1 Impacts

2.1.1 The incidence of waterborne diseases is reduced, the access to complete sanitation is improved and the volume of treated wastewater and faecal sludge is increased through the improved operational and financial sustainability of WW and FSTPs. The increased reuse of treated effluent and nutrients has improved the preparedness of sanitation systems towards climate variability through reduced pressure on limited freshwater resources by providing a transferrable planning approach and implementation plans for rehabilitating and designing market- and reuse-oriented sanitation systems.

2.1.2 As a result of the above impacts, this project and those modelled after it in the future will offer dramatic improvements in public and environmental health through the reduction of highly polluted discharge of human waste from households and dysfunctional treatment facilities.

2.2 Outcomes

2.2.1 The rehabilitation of one WWTP at the Presbyterian Boys Secondary School in Accra will include the reuse of effluent for irrigation and the respect of WHO standards. For the establishment of farmland demonstration plots 8 ha are available which can use the nutrients and water of the treated effluent to maximise crop yields with an estimated doubling of profitability.

2.2.2 The knowledge products based on action research for the aquaculture, compost and biogas value chains will provide implementation plans for existing treatment plants in Kumasi, Sekondi-Takroradi and Accra (Legon) as well as transferable road maps for plants with comparable conditions.

2.2.3 Each of the four studied value chains and related knowledge products that are developed by the project will be presented to local decision makers, planners and technology vendors in specific workshops on the design for reuse which will include site visits to the treatment plants covered by the action research.

2.3 Outputs

2.3.1 The project will provide action research on four reuse value chains – irrigation, aquaculture, compost and biogas – and include piloting of reuse of effluent in irrigation through the rehabilitation of a wastewater treatment plant.

2.3.2 The reuse of effluent in irrigation (*Component 1)* comprises the construction of a value chain and a pilot rehabilitation (of the Presec WWTP) and will provide the following outputs:

- Assessment and design of WWTP rehabilitation for reuse,
- Rehabilitation carried out and effluent used for irrigation,
- Contractual agreement between WWTP owners and farmers including partial Operation and Maintenance (O&M) cost recovery from reuse,
- Farmers and/or WWTP operators trained and equipped to conduct routine O&M,
- Plant operation and reuse benefits monitored,
- Cost-benefit analysis of incorporating reuse for irrigation compared to baseline of effluent disposal by WWTPs and rain-fed irrigation by farmers including quantified return on investment/payback period,
- Transferable roadmap for constructing a value chain between a WWTP and the farmers who will use effluent for irrigation, including stakeholder organigramme.

2.3.3 Aquaculture in maturation ponds (under *Component 2)* includes the construction of a value chain and implementation plans for WWTPs in Tema and Kumasi with outputs as follows:

- Confirmation of preliminary assessment of wastewater quality and local fish market made in the project preparation phase,
- Cost benefit analysis for different fish species,
- Comprehensive implementation plans for two pilot locations for dual use WWTP with aquaculture facilities,
- Transferable roadmap for constructing the value chain for combining WWTPs and aquaculture at other facilities in Ghana, including an organigramme of all public and private project stakeholders (government agencies, fish suppliers, fish farmers/purchasers),
- Develop and analyze alternative incentive models for redirecting economic value of aquaculture to support sustainable operation and maintenance of WWTP (e.g. rights to harvest, sell and restock ponds are given to plant operators or entrance fees to facility are charged to local fishermen to harvest fish at designated times).

2.3.4 The production and use of compost and biogas investigated in *Component 3* provides for the construction of the respective value chains and implementation plans for the Sekondi-Takoradi FSTP and the Legon (Accra) WWTP with the following outputs:

- Confirmation of preliminary assessments,
- Cost benefit analysis for different levels of equipment,
- Comprehensive implementation plans for selected treatment plants including pricing models that will enable the economic value of compost and biogas to contribute towards treatment cost,
- Transferable roadmaps for constructing the value chains between the TPs and users, including organigrammes of stakeholders,

- Cost-benefit analysis of large-scale land application of FS compared to baseline of FS disposal by FSTPs and conventional fertilizer application at palm oil plantations; Quantification of return of investment/payback time on infrastructure,
- Analysis of alternative models for redirecting economic value of biogas to support the treatment cost such as fee for biogas or in-kind labour at treatment plant.

2.3.5 The experience and results of all components will be made available and disseminated through knowledge products as follows:

- Reuse-oriented planning protocols for irrigation, aquaculture, land application of faecal sludge and biogas recovery,
- Training series of four workshops (5 days) that will include provision of planning protocols, classroom lectures by subject-area experts, participatory exercises, and field trips to associated pilot plants,
- Draft of Resource Recovery Policy and Strategy based on preliminary results of research and pilot implementation of selected value chains.

2.4 Activities

Reuse in agricultural irrigation – Component 1

2.4.1 This module capitalizes on IWMI's core expertise in irrigation as well as their existing knowledge and past experience with farmers and urban agriculture in Ghana. A preliminary assessment of the WWTP of the Presbyterian Boys Senior Secondary School (Presec) in Accra as pilot site has shown the availability of 100 m3/d of wastewater from the 2100 students and staff and the availability 8 ha of land under control of the school where currently only rain-fed agriculture can take place. The activated sludge plant built in 1976 has not operated effectively over the last ten years but still serves a primary treatment.

2.4.2 All infrastructure implementations will fall under environmental/social category 2 because the project will not lead to significant negative impacts. These impacts will be site specific and easily mitigated. As such, Environmental Management issues will be taken care of by complying with Environmental Protection Agency (EPA) regulations and procedures in project baseline studies and designs. The individual site-specific information shall be compiled at plant level. The project team, with the plant owners, will ensure that an Environmental and Social Assessment Management Plan (ESMP) is prepared and environmental permits are obtained.

2.4.3 The required activities have been identified as follows:

- Verification of preliminary demand assessment: current yields and projected water application and cultivation patterns under irrigation (interview farmers),
- Wastewater quantity and quality (BOD, nutrients, pathogens): monitor variation of wastewater flow and quality, determine required retention time for treatment, determine NPK content of influent and quantify expected effluent concentration to assess fertilizer offset,
- Assess the potential for connecting unserved residential buildings in the vicinity of the WWTP,
- Determine size and location/distribution of storage reservoirs,
- Rehabilitate treatment plant for reuse in irrigation: re-size reactors for anaerobic treatment, assess and select pathogen removal technology (i.e. maturation pond, UV disinfection), implement conveyance infrastructure from WWTP to fields/storage reservoirs,

- Develop and implement a model to direct the added value from reuse in agriculture back to the plant to contribute to treatment cost (e.g. payment by farmers to use the land or in-kind labour by farmers),
- Train farmers and plant operators,
- On-going monitoring of plant operation and agricultural yields (effluent, demonstration plots, NPK and microbiological content of the farm products),
- Confirm preliminary cost benefit analysis,
- Develop a transferable road map for reuse in irrigation value chain,
- External farmer visits to the WWTP and demonstration plots.

Incorporating aquaculture at waste stabilization pond – Component 2

2.4.4 Preliminary assessment of treatment plants in Tema and Kumasi has shown a high potential for operation cost recovery and interest of plant owners and operators. Aquaculture will take place in maturation ponds, the fourth and final pond in the treatment series. Private sector involvement will depend on the integrity of ponds and sewers to deliver WW.

2.4.5 The identified activities include the following:

- Confirm preliminary assessments on wastewater quality and local fish markets (Dissolved Oxygen, BOD, temperature, heavy metals, ammonia, nitrite, nitrate and pathogens will be monitored weekly, and periodic fish-flesh quality testing throughout the cultivation period will take place),
- Cost-benefit analysis of different fish species (in particular tilapia, catfish and their combination) for the given water quality in maturation ponds and the local demand for perspective fish species. (Catfish will be grown primarily, as they command a higher price on the market in Ghana, are faster growing, and do better than Tilapia in low oxygen conditions. The protein needs of the catfish expected to be covered from the sludge but depending on the observed growth supplementing the system with high-protein agricultural-waste feeds, such as groundnut or soy nut hulls will be considered),
- A Hazard Analysis and Critical Control Point (HACCP) Plan will be developed; this is a monitoring and quality assurance tool used throughout the food industry including conventional aquaculture,
- Feasibility assessment of reusing maturation pond effluent for irrigation,
- Develop protocol for stocking and harvesting fish based on determining factors, including size of maturation ponds, desired effluent quality of treated wastewater, climate,

Large-scale land application of faecal sludge compost – Component 3a

2.4.6 This module capitalizes on IWMI-Ghana's extensive work on faecal sludge composting for land application and will draw on the technical and marketing lessons learned from those projects. Furthermore, lessons from Module 1 will be used in the feasibility assessment and implementation plan for effluent reuse in irrigation. A preliminary assessment of the Sekondi-Takoradi Municipal FSTP which is currently under construction has identified its potential for composting and a 6000 ha oil palm plantation located in a distance of 40 km where fertilizer is the largest expenditure and the enrichment of soil with organic matter is expected to boost potential yields further. Empty fruit bunches from the processing plant could offer potential for co-composting with FS.

2.4.7 The following activities will be carried out:

- Verification of preliminary demand assessment: FS quality meets requirements for composting and land application on palm plantations, determine land requirement and optimal frequency of application, quantify willingness to pay for finished product, identify additional end users (if necessary),
- Determine composting technology suitable for composting municipal FS and for co-composting of FS with empty fruit bunches (EFBs) including cost-benefit analysis of these two alternatives and identification of inputs into composting (need and source),
- FS analysis (NPK, carbon and microbiological), quantification of nutrient value and potential commercial fertilizer offset,
- Devise transportation plan and schedule (costs and required equipment for transport, storage and application),
- Develop pricing and payment structure, establish contractual terms between Norpalm and the Sekondi-Takoradi Municipal Assembly.

Biogas production and use – Component 3b

2.4.8 The Legon Waste Stabilisation Pond (WSP) with a capacity of approximately 9,000 m^3/d is built under the Accra Sanitation Improvement Project (ASIP) and there is great interest in external support for exploring the feasibility of incorporating biogas recovery and use at this plant. Activities under the Design for Reuse approach will include:

- Water quality monitoring (influent BOD),
- Quantify potential biogas generation and composition given influent wastewater/faecal sludge characteristics,
- Develop a cost-benefit matrix of all biogas collection and end-use options given expected biogas production such as direct use for cooking or water heating, bottling, conversion to electricity,
- Assess technical efficiency, technology cost, return on investment for each option at a given level of biogas production,
- Feasibility assessment of establishing a Clean Development Mechanism (CDM) project for each biogas collection-end-use option.

Capacity Building and Knowledge Sharing

2.4.9 Action research under all components will generate knowledge which shall be applied to capacity building and the dissemination of knowledge products developed under the following activities:

- Develop and publish reuse-oriented sanitation planning protocols for the four value chains studied in the project: irrigation, aquaculture, land application of composted faecal sludge, and biogas recovery,
- Develop and pilot a series of workshop on reuse-oriented sanitation planning,
- The learning objectives of the workshops will focus on:
  1. Understanding of the potential economic and environmental benefits of designing sanitation systems for reuse;
  2. Ability to conduct a demand assessment and select to the most viable productive reuse for the products of a given treatment facility;
  3. Ability to develop and implement value chains for four productive end uses;

4. Ability to develop and implement financial models that will direct the value harnessed from productive end use back into the recurring costs of the WW/FSTP,

- The workshops will mainly target the following audience: local sanitation engineers, planners and decision makers, technology vendors,
- Work towards institutionalizing reuse-oriented sanitation in Ghana through engagement with project partners, especially local decision and policy-makers.

2.5 Risks

2.5.1 Continued socio-economic progress depends on economic growth and political stability but a lack human and financial resources or awareness on the benefits of improved complete sanitation can delay or impede reaching the projected improvements of public health and environmental integrity. The development and dissemination of knowledge on both the benefits as well as on cost reducing approaches to achieve such progress are the best available mitigation measures.

2.5.2 On the outcome level, local demand for the potential by-products of facilities designed for reuse such as fish, irrigation, compost, etc. at a level that can generate net benefits is the central assumption. The main risk for the wider uptake of the project outputs would be the advanced design of large disposal oriented sanitation schemes where reuse cannot be conveniently added. The project has started and will continue to partner with both ASIP and UESP to maximise the potential for further dissemination and practical application of the approaches tested. Ghana needs to import fish and it is quite unlikely that demand for fish will drop in the near future. Concerning social sensitivities, preliminary market surveys, and previously published theses suggest that Ghanaians are willing to consume WW-fed fish. Any social stigma toward the products will be addressed with public awareness raising activities and strategic marketing.

2.5.3 The outputs of the reuse for irrigation component could be undermined by the delay of implementation, the reluctance of farmers to contribute to the operation cost of the treatment plant and the under-achievement of the planned cost effectiveness. The mitigation considered in the project design is the consistent application of the transparent partnership approach which has already been initiated during the preliminary assessment and the assurance of thorough investigations prior to implementation.

2.5.4 The main risk to achieve the outputs of the aquaculture value chain appears to be unsuitable wastewater quality due to toxic industrial effluents. Alternative sites would be considered as most appropriate mitigation measure. The results of the compost and biogas value chains could be impeded by unsuitable cost benefit analysis or complexity of required equipment. This can be mitigated by consideration of alternative focus of reuse at the concerned sites.

2.6 Cost and Financing plan

2.6.1 The overall Design for Reuse project budget amounts to 559 800 €. Funding for student research grants has been secured from University of California, Berkeley (UCB). The funding from AWF amounts to € 498 000. The breakdown is shown in Table 1. The detailed budget is shown in Annex 1.

Table 1: Total Project Cost Estimates by Component (*) and Sources of Financing (in Euros)

Component	Total Cost	AWF	UCB
Component 1 - Irrigation	201 800	183 200	18 600
Component 2 - Aquaculture	146 000	124 400	21 600
Component 3 - Compost and Biogas	130 000	108 400	21 600
Component 4 - Project Management	48 900	48 900	0
Total Base Cost	**526 700**	**464 900**	**61 800**
Contingency 7%, rounded	33 100	33 100	
Total Project Cost	***559 800***	***498 000***	***61 800***
Percentage	100%	89%	11%

(*) Including Capacity Building and Research Staff: C 1: 20 - 30 %, C 2: 40 - 35 %, C 3: 40 - 35 %

2.6.2 Component 1 includes the design, supervision and works of the rehabilitation of a pilot WWTP for reuse of the effluent in agricultural irrigation. In addition, laboratory analysis, capacity building and research staff make up this component as they do for the three additional value chains under Components 2 and 3.

2.6.3 Project management in Component 3 covers financial management and other project administration by the WRC as well as the inception, mid term and final workshops and Project Steering Committee meetings.

3 IMPLEMENTATION

3.1 Recipient

3.1.1 The Water Resources Commission (WRC), an agency of the Ministry of Water Resources, Works and Housing of the Republic of Ghana will be the Recipient of the Grant. The Grant Agreement will be signed with the WRC which will be in charge of financial management and procurement while all research activities will be executed by the International Water Management Institute (IWMI).

3.1.2 The WRC was established by an Act of Parliament[13] as the government agency charged with the regulation and management of the country's water resources and the coordination of policies in relation to them. The Commission is composed of the major stakeholders involved in the water sector including representatives of institutions relating to Water Research, Environmental Protection, Water Supply, Irrigation Development, Hydrological Services, Hydro power generation, Forestry, Minerals, Traditional Chiefs, NGO's, and Women interests. The Commission therefore provides a forum for integration, cooperation and collaboration of the different interests in the water sector. These interests are involved in the dissemination of project results.

3.1.3 The Commission Secretariat is headed by an Executive Secretary and supported by a seasoned team of full-time technical professionals in the areas of surface water and groundwater resources management, water quality, ecosystem management, environmental law, resource economics, and river/basin management. These technical persons are ably

[13] Act 522 of 1996

supported by well functioning accounting and administrative sections, and a communication specialist. To complement these resources, there exists a collaborative mechanism that makes it easy for the WRC to mobilize the necessary external material and human resources to manage the project. The structure of the WRC provides a platform for integration, cooperation and collaboration among different interests in the water and sanitation sector in Ghana. A number of the partners for this project are long-time collaborators with the WRC including IWMI, Environmental Protection Agency, Ministry of Local Government and Rural Development (MLGRD), and Ministry of Food and Agriculture (MoFA).

3.1.4 The Executive Secretary submits periodic administrative and management reports to the Commission about the general progress of its programmes. The day-to-day internal control of WRC management operations is based on a well established and functioning financial system, the Navision Financial System, which conforms to the Ghana Government Financial Administration Act[14].

3.1.5 Procurement procedures are managed transparently within the WRC. The internal mechanism for procurement using government or donor funds has generally been under the authority of an Entity Tender Committee, which operates under the rules and regulations of Public Procurement Act[15]. Furthermore, the WRC has and is executing similar donor supported projects such as the Danida supported 5-year Integrated Water Resources Management Component involving four (4) other partners, and the UN-Habitat, Water for African Cities project with 4 partners. Subsequently,'s human and material resources are firmly established to allow this project to be executed from an institutional 'platform' rather than on individual 'initiatives'.

3.1.6 The WRC will be supported in the project by its parent ministry (Ministry of Water Resources Works and Housing, MWRWH) and the:

- Accra-based Africa Office of the International Water Management Institute (IWMI)
- University of California, Berkeley (UCB)
- Ministry of Local Government and Rural Development (MLGRD) through its Municipal and Metropolitan Waste Management Departments, contracted treatment plant operators, Environmental Health and Sanitation Departments etc.
- Ministry of Food and Agriculture (MoFA)
- Ghana Environmental Protection Agency (EPA)

The Water Resources Commission therefore has the capacity and capability to execute the project. A brief on the Water Resources Commission is presented in Annex 3.

3.2 Implementation Arrangements and Capacity

3.2.1 The project is a partnership between the WRC and IWMI. The Executive Secretary of the WRC will act as a Project Coordinator and IMWI will be in charge of all research activities to be carried out. A Project Steering Committee (PSC) will monitor and guide the implementation and include the most relevant sector players in the country, in particular the Water Directorate of MWRWH and the newly created Environmental Health and Sanitation Directorate of MLGRD, the Ministry of Health, the Environmental Protection Agency (EPA), the Department of Fisheries of the MOFA and the Ghana Irrigation Development Authority (GIDA) as well as the WRC and IWMI.

[14] Act 654 of 2003
[15] Act 663 of 2003

3.2.2 The Steering Committee will meet half-yearly to examine quarterly progress reports, work plans and budgets, discuss implementation challenges and solutions to the Project Coordinator. The level of achievement in relation to the project objectives and expected results shall be reported and cover the technical, financial and administrative aspects.

3.2.3 The Project Manager will be assisted by all professional and support staff of the WRC as required, in particular by the Accountant and Procurement Officers. Local facilitation and training and the accompanying research will be outsourced to IWMI and UCB who will work with local research partners in Ghana. A graphical representation of relevant partners for all value chains is shown in Annex 4.

3.2.4 Research will be provided mainly by the International Water Management Institute, in cooperation with the Kwame Nkrumah University of Science and Technology (KNUST). The University of California, Berkeley will co-finance research grants. IWMI is one of 15 international research centres supported by the Consultative Group on International Agricultural Research (CGIAR), a network of 60 governments, private foundations and international and regional organizations.

3.2.5 IWMI is a world-class knowledge centre on water, food and environment with the mission to improve the management of land and water resources for food, livelihoods and nature. It is a non-profit organization with a staff of 350 and offices in over 10 countries across Asia and Africa and Headquarters in Colombo, Sri Lanka. IWMI targets water and land management challenges faced by poor communities in the developing world/or in developing countries and through this contributes towards the achievement of the UN Millennium Development Goals (MDGs) of reducing poverty, hunger and maintaining a sustainable environment.

3.2.6 Research is the core activity of IWMI. The research agenda is organized around four priority Themes including Water Availability and Access; Productive Water Use; Water Quality, Health and Environment; and Water and Society. Cross cutting activities in all themes include, assessment of land and water productivity and their relationship to poverty, identification of interventions that improve productivity as well as access to and sustainability of natural resources, assessment of the impacts of interventions on productivity, livelihoods, health and environmental sustainability. IWMI works through collaborative research with many partners and targets policy makers, development agencies, individual farmers and private sector organizations.

3.3 Performance Plan

3.3.1 The supervision of the project implementation shall be based on the logical framework indicating the goal and objectives related to the expected results.

3.3.2 The performance of Component 1 will be mainly measured by the proportion of productively used nutrients and effluent from the rehabilitated pilot plant, the proportion of the O&M costs generated from reuse and the respect of effluent and product quality norms.

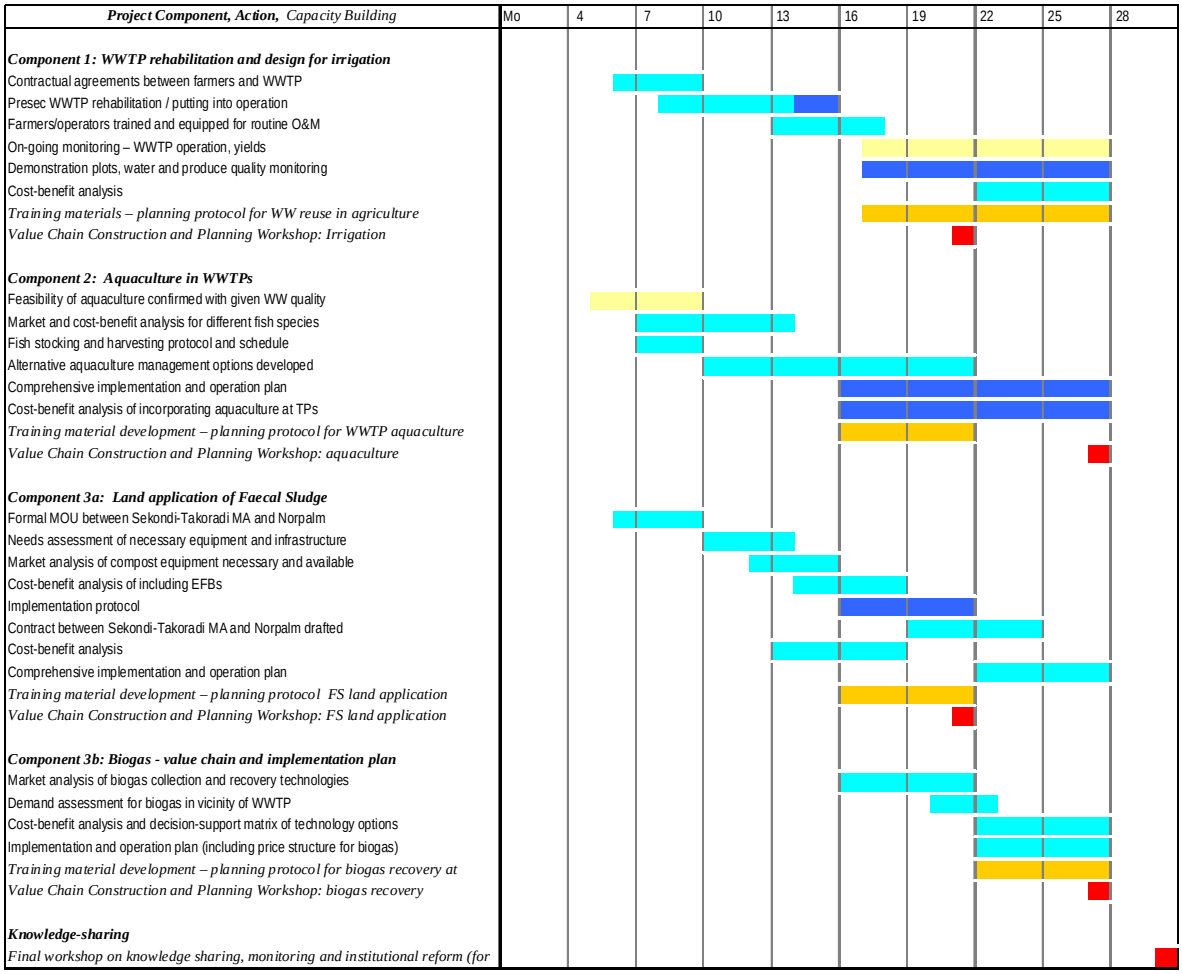
3.3.3 Components 2 and 3 will be measured by the respective implementation plans (for reuse in aquaculture, compost and biogas) and transferable roadmaps. Training for replication is a performance indicator for all 3 components.

3.3.4 Project management performance will be assessed by the set up and operation of the project steering committee as well as the regular technical and financial progress reports.

3.4 Implementation Schedule

3.4.1 The project will be implemented over a duration of 30 months from Grant Signature with 3 months foreseen for the Grant Agreement and fulfilment of conditions. The implementation period of each value chain is shown in Table 2. Implementation will start with components 1 and 2 which are expected to be the most attractive for widespread replication.

Table 2: Project Implementation



3.5 Procurement and Execution

3.5.1 All procurement of goods, works and acquisition of consultancy services financed by AWF shall be in accordance with the AWF's Operational Procedures, the Bank's *Rules and Procedures for Procurement of Goods and Works* or as appropriate, *Rules and Procedures for the Use of Consultants*, using the relevant Bank Standard Bidding Documents. The procurement arrangement is set out in Table 3 below.

Table 3: Procurement Arrangements (all amounts in Euro – excluding taxes)

Description	*QCBS*	*NCB*	*Other (*)*	*Total*
CONSULTANT SERVICES				
Design and Supervision, Pilot Rehabilitation	10 700			10 700
Aquaculture, compost and biogas specialists			4 400	4 400
Professional Research			269 000	269 000
Research students - AWF funded (**)			21 200	21 200
Training Modules Development			11 800	11 800
Laboratory analysis			40 700	40 700
Training workshops			8 200	8 200
GOODS				
O&M equipment			3 700	3 700
WORKS				
Rehabilitation of Pilot Plant		75 000		75 000
Land preparation			900	900
PROJECT MANAGEMENT			52 400	52 400
TOTAL (**)	**10 700**	**75 000**	**412 300**	**498 000**

(*) Shopping, Operating Costs, SSS
(**) UCB funded (additional) 70 000 USD

3.5.2 The responsibility for procurement of goods, works and the acquisition of services rests solely with WRC. The modalities and conditions will be embedded in the grant agreement with AWF. It is WRC's obligation to ensure that the AWF funds are used in a cost efficient manner and only for eligible project expenditures. The project will involve three (3) categories of expenditure: the procurement of goods, works and services, including operating costs. Equipment for operation and maintenance of the pilot WWTP is included in the plant rehabilitation.

Goods

3.5.3 Total contracts for goods are valued in aggregate at Euro 3 700. Procurement of equipment for on-going operations and maintenance will be through Shopping (SH) procedure. One such contract valued at € 3 700will be awarded. Shopping is an appropriate procurement method as the goods are readily available off-the-shelf items and standard commodities in quantities of small value. The goods could be procured locally as there are enough qualified local suppliers to ensure competition.

Works

3.5.4 The total contracts for civil works are valued at Euro 75 900. Two (2) contracts will be awarded. One such contract will be awarded valued at € 75 000 using National Competitive Bidding (NCB), for the rehabilitation and construction of a Waste Water Treatment Plant (WWTP) for reuse. Another contract using Shopping method of procurement, valued at € 900 will be used for land preparation for agriculture.

Services

3.5.5 Services to be sourced from the Grant are valued in aggregate at Euro 337 600. Short listing using Quality and Cost-Based Selection (QCBS) and Single Source Selection (SSS) will be used. The latter shall be used for assignments which are highly specialized.

3.5.6 The consultancy service to design and supervise the rehabilitation and construction of a Waste Water Treatment Plant (WWTP) is valued at € 16 200. One such contract will be awarded using QCBS.

3.5.7 Total number of five (5) service contracts selected through SSS are valued in aggregate at Euro 337 600. The consultants include research institutions, an NGO and universities. They have relevant, unique and exceptional experience and their participation is critical to the project implementation. The method of procurement for their engagement will be by direct negotiations, using SSS as it presents clear advantages over competition. Majority of the assignments are of small amounts not exceeding Euro 50 000 and are for very short duration. One such contract will be awarded each for KNUST aquaculture specialist; KNUST biogas specialist; IWMI compost specialist; and the development of training manuals for capacity building. Training materials and workshops will be co-prepared and organized by IWMI and the NGO TREND (Training, Research and Networking for Development), which specializes in capacity building and knowledge transfer.

3.5.8 Two Research staff will be engaged through direct negotiations using SSS, as they have specialized skills and experience critical to project implementation. The principal investigator and the supervisor, both from IMWI, will be engaged at a value of € 225 000 and € 27 000 respectively (including overhead costs). The two research staff will have oversight responsibilities and give assistance to the research students. In addition to these core project staff, IWMI-Ghana has vast in-house expertise related to working with local farmers, faecal sludge composting, and aquaculture. The two will carry out and support various assignments on the project. Their CVs shall be reviewed by AWF before project start up.

Operating Costs

3.5.9 Procurements for the operations of the project is valued at Euro 122 500. Shopping, direct negotiation and purchase will be the methods of procurement. Operating costs will be used to support research students (masters and doctoral students) from an external partner institution, UCB, and a local university, KNUST. The research students will be selected on the basis of merit. One master's student will be assigned to each of the four (4) value chains, and each will be responsible for the majority of the field work for that component. Operating costs are also allocated to laboratory analysis, stakeholder training workshops, WRC project management and administration, steering committee activities, travel expenses and other general and miscellaneous costs.

3.5.10 Prior Review: Contracts for Consultancy Services, Goods or Works of value higher than € 50 000 will be subject to prior review by the AWF. The following documents are subject to review and approval by the AWF before promulgation, under prior review: Specific Procurement Notices (SPN), tender/ bid documents or requests for proposals from consulting firms, tender/bid evaluation reports or reports on evaluation of consultants' proposals.

3.5.11 Post Review: Contracts for Consultancy Services, Goods or Works of value € 50 000 or less will be subject to post review by the AWF, and will be processed under the

full responsibility of WRC. Ex-post technical verification and ex-post financial control systems will be used in these instances to expedite procurement of goods, works and the acquisition of consulting services. Procurement documents, tender/bid documents or request for proposals, tender/bid evaluation reports as well as signed contracts will be kept by WRC for periodic review by the AWF supervision missions and audits.

Procurement Plan

3.5.12 WRC is responsible for preparing and submission of a procurement plan before Grant Effectiveness to AWF. The Procurement Plan shall be on the AWF excel-based format. The plan shall set forth (a) the particular contracts for goods, works and consulting services for at least the initial eighteen (18) months of the life of the project; (b) the proposed methods of procurement; and (c) the related AWF review procedures (prior or post review). WRC shall update the procurement plan annually or as needed throughout the duration of the project. Any revisions proposed to the Procurement Plan shall be furnished to the AWF for its prior approval. WRC shall implement the Procurement Plan in the manner in which it has been approved by the AWF. The updated annual procurement plan will form part of the annual work plan and budget report.

3.6 Disbursement Arrangements and Expenditure Schedule

3.6.1 The grant will be disbursed using the Special Account method of disbursement, in line with Bank rules and procedures. WRC will open a Special Account denominated in Euro at a bank acceptable to the AWF.

3.6.2 The proceeds of the Grant shall be disbursed by the AWF in two instalments or tranches, based on the implementation schedule and progress. The estimated amounts are as shown in the following table. The first tranche will be disbursed when the conditions for Grant Effectiveness are satisfied. The second tranche will be disbursed upon drawdown of the Special Account estimated to be within 18 months after grant signature.

Table 4: AWF Expenditure and Disbursement Schedule (amounts in Euros)

Category of Expenditures	*Tranche 1*	*Tranche 2*	*Tranche 3*	*Total*
Goods	3 700	0	0	3 700
Works	75 000	0	0	75 000
Services	121 300	198 000	100 000	419 300
Total	*200 000*	*198 000*	*100 000*	*498 000*
Percentage	60%	40%	40%	100 %

3.6.3 Obligations of the AWF to make the first disbursement of the Grant shall be conditional upon the opening of a Special Account, the nomination of a Programme Coordinator acceptable to the AWF and the approval of a procurement plan. The supporting documentation for the replenishment of the Special Account will include a statement of receipts and expenditure of funds supported by bank statements, justifying that at least 50% of previous disbursement has been utilised and an updated work program. All

detailed documents related to the utilisation of AWF funds will be held by the Recipient for subsequent verification and confirmation by the external auditors.

3.7 Accounting and Audit Arrangements

3.7.1 The Recipient shall be responsible for the financial management of the project. WRC has secured sufficient qualified and experienced financial management staff. They will maintain an accounting system and books of account specifically for the AWF project components, and will prepare quarterly financial statements in accordance with ADB procedures. These statements will be submitted together with the quarterly progress reports. All payments will be endorsed by the Program Coordinator. Segregation of duties shall be maximised between authorising, accounting and bank signatory functions.

3.7.2 The AWF will recruit and retain an auditor for a term of one-year renewable for not more than three years. The auditor will perform ex post evaluation or a review of supporting documents and audit the project. The costs of such audit shall be charged to AWF and are not involved in the Grant. Project audits will be conducted annually.

3.7.3 All detailed documents related to the utilization of AWF funds will be held by WRC for subsequent verification and confirmation by the external auditors. The AWF will require that a statement of expenditure and supporting documents review be performed and certified by the independent auditor at predetermined intervals to ensure that funds have been utilized in line with the grant agreement.

3.8 Monitoring, Evaluation and Reporting Arrangements

3.8.1 The supervision of the project by AWF will include regular communication and correspondence with the Recipient and IWMI, as well as the review of the Quarterly Progress Reports and other documents. AWF may undertake a field supervision mission at any time, as may be needed. Two supervision missions are anticipated.

3.8.2 The monitoring of project progress and performance shall be based on the Logical Framework matrix during implementation and after completion. The monitoring of the project will be done by the Steering Committee semi-annually. This will be assisted by the scheduled inception, mid term and completion workshops.

3.8.3 The Recipient shall submit to the AWF the reports and documents noted in the following table. The project completion report shall include details on project activities and a comprehensive expenditure report on the utilisation of the Grant. All documents shall be transmitted to the AWF by email, with hard copies to follow subsequently. Year means calendar year unless agreed otherwise and quarters end with the calendar months of March, June, September and December.

Table 5: AWF Reporting Requirements

Documents to be Submitted to the AWF	*Reporting Schedule*	*AWF Action*
1. Procurement Documents as noted in Section 3.5	As noted in Procurement Section	Review and "no objection"
2. Quarterly Progress Report in AWF format (with report on expenditures)	Within one month of end of quarter	Review and comment
3. Annual Report including audited accounts	End of 1st quarter of following year	Review and comment
4. Project Completion Report in AWF format	3 months before end of project	Review and acceptance
5. Minutes of Steering Committee Meetings	Within 15 days of meeting	Review and comment
6. Minutes of any other project meeting or workshop	Within 15 days of meeting	For information / action

4 PROJECT BENEFITS

4.1 Effectiveness and Efficiency

4.1.1 The action research approach of the project seeks to apply results of academic research to the operation of selected model wastewater and faecal sludge treatment plants in Ghana. In close cooperation with interested plant owners and operators improved sustainability will be demonstrated through the financial contribution of reuse towards the operation costs.

4.1.2 The sharing of knowledge is aimed at the widespread acceptance of the four value chains. The financial and economic analysis developed in the project will provide recommendations under which conditions similar and larger projects are likely to be successful. It is expected that up to half of the operation costs could be covered through reuse if several value chains could be combined.

4.1.3 Reducing the operation cost of treatment plants through harvesting the reuse value effluent nutrients and water offers the potential of sustainable operation at lower user tariffs or subsidy. The development of business models and opportunities based on effluent reuse will provide leverage for public private partnership and more reliable services.

4.1.4 The successful replication of the constructed value chains will be assisted by the knowledge component, i.e. the provision of planning protocols and training workshops. The rising costs of nitrogen fertilizers, food and energy make all the reuses to be explored highly relevant.

4.1.5 The project contributes to the improvement of sanitation through *capacity building*, *institutional reform*, *knowledge building*, and *environmental management*, which are among the national priorities. The proposed project touches many aspects of the AWF mandate, mainly knowledge generation and innovation but additionally has aspects of strengthening the financial base, resource management and adjustment to climate change.

4.2 Sustainability

4.2.1 Improved quality of surface water resources will mainly benefit the poor, women and children and contribute to improved environment. Simultaneously, the recycling of

water and nutrients is an important contribution towards adjustment to climate change and variation. Women and children are considered to bear the greatest burden of inadequate sanitation due to privacy, safety and women's health issues. Institutionalizing a sanitation model that is robust and reliable over the long-term will have far-reaching public benefits to both sexes but especially for women and children. The pilot implementations and transferable road maps will promote the participation of women and unemployed youth.

4.2.2 Environmental Management issues are central at the conceptual level of the Design for Reuse approach. Closing nutrient and water cycles together with improved quality monitoring of wastewater and (by-) products will improve the ecological conditions or create pressure to take such action. Through the same mechanisms the risks posed by climate change and variability will be reduced if the widespread adaption of the reuse options to be researched by the project are taken on a wider scale.

4.2.3 Environmental Management issues will be addressed through an environmental and social management plan. These issues will be taken care of by complying with Environmental Protection Agency (EPA) regulations and procedures as follows:

- The EPA in Ghana has clearly laid out procedures for ensuring compliance with regulations. These require environmental assessments and registration, preparation of environmental management plans where required, ongoing monitoring and routine tracking and reporting on environmental actions.
- In compliance with environmental regulations, the individual site-specific information on the pilot rehabilitation shall be compiled using the recommended checklists.
- During the rehabilitation design the designer and project team will work closely with the treatment plant owners to ensure that the requisite environmental permits are obtained; and to develop and implement environmental and social management and monitoring plans as well as capacities for requisite reporting.

4.2.4 This project enjoys active support of several local partners from the public and private sector. It is they who will take ownership of the outcomes, give them institutional roots, and facilitate the propagation of reuse as a business model for financing the sanitation sector.

4.2.5 Reuse in agriculture has long-term viability; even as the city develops, urban agriculture is a salient feature of Accra, and the same holds for other peri-/urban settlements of Ghana. As a sector, agriculture comprises 36% of Ghana's GDP and urban agriculture contributes to urban food security, access to perishable vegetables, and to the earning opportunities of rural migrants. On the other hand, farmers live in a constant state of flux as a result of insecure land tenure, and their yields are often a mere fraction of what could be produced with an adequate and reliable source of irrigation water. Provisions for addressing cultural sensitivities and the institutional development of fiduciary component and the wider adoption of the developed reuse models will be addressed in the dissemination workshops and Project steering Committee.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 The proposed pilot study is a response to the persistent failure of WW and FSTPs in Ghana and to the public health problems and environmental devastation caused by their inadequate operation. This project will demonstrate an innovative approach to designing and implementing sanitation systems that will increase the reliability of TP operation and maintenance. The design for reuse introduces a business model for financing treatment plants by incorporating back-end users into the design and operation of sanitation facilities, and capturing their demand for the outputs in the form of payment and/or in-kind labor. Design for Reuse, a market and end-user oriented planning approach, will be applied to optimize the redesign of treatment plants for beneficial use and to construct reliable and profitable value chains between FS/WWTPs and end users.

5.1.2 While the primary goal of this project is to improve the performance of WW and FS treatment plants, another key public health objective is to promote safe resource recovery, such as irrigation with treated instead of untreated wastewater. The project seeks to introduce and integrate the Design for Reuse approach into the planning, rehabilitation and decision-making processes, and will do so by working closely with local partners, publishing training materials, and hosting interactive training workshops.

5.1.3 The total project cost is € 559 800 of which the AWF is requested to fund € 498 000, constituting some 89%. The remainder is covered through research grants as financial contribution of a project partner, the University of California, Berkeley.

5.2 Recommendations

5.2.1 It is recommended that a grant not exceeding € 498 000 from the African Water Facility resources be extended to the Water Resources Commission of Ghana for the implementation of the project as described in this appraisal report.

5.2.2 Obligations of the AWF to make the first disbursement of the Grant shall be conditional upon (i) the nomination of a Project Steering Committee, acceptable to the AWF, and (ii) the opening of a Special Account in a bank acceptable to the AWF.

ANNEX 1 – Detailed Budget

Budget Item	Unit	Quantity	Rate	Total	*UCB*
Component 1 - Irrigation, Presec WWTP					
Presec WWTP supervision consultancy	day	20	350	7 000	
Presec WWTP design consultancy	day	30	100	3 000	
WWTP rehabilitation and adaptation for reuse (desludging, pipes, pumps, repair, sludge drying beds, maturation pond / storage)	LS	1	70000	70 000	
Equipment for O&M	total	1	3500	3 500	
Agricultural labour / land preparation	day	20	40	800	
Laboratory analysis	sample	350	40	14 000	
Subtotal				*98 300*	
Component 2 - Aquaculture, Tema and Kumasi WWTP					
KNUST Aquaculture specialist	day	15	140	2 100	
Laboratory analysis	sample	500	40	20 000	
Subtotal				*22 100*	
Component 3 - Compost and Biogas, Sekondi-Takoradi FS, Legon WWTP					
IWMI Compost specialist	day	10	140	1 400	
KNUST Biogas specialist	day	5	140	700	
Laboratory analysis	sample	100	40	4 000	
Subtotal				*6 100*	
Capacity Building					
Stakeholder training workshops	days	5	1400	7 000	
Materials printing	workshop	5	140	700	
Development of Training Modules	day	100	110	11 000	
Subtotal				*18 700*	
Research Staff					
Principal investigator (IWMI)	day	500	360	180 000	
IWMI overhead for PI		180 000	25%	45 000	
Supervisory staff (IWMI)	day	40	540	21 600	
IWMI overhead for Supervisor		21 600	25%	5 400	
UCB Master student	year	2	22900	45 800	*45 800*
KNUST Master Student	year	4	4300	17 200	*16 000*
KNUST PhD Student	year	1	8600	8 600	
Student operating costs	year	3	3000	9 000	
Subtotal				*332 600*	
Total (Components 1 to 3)				***477 800***	
Component 4 - Project Management					
WRC Administration	*rounded*		7,5%	36 000	
Workshops (inception, mid term, final)	workshop	3	3500	10 500	
Steering Committee meetings	meeting	6	400	2 400	
Subtotal				*48 900*	
Total Base Cost				**526 700**	
Committed funds from partners (UCB)				*61 800*	*61 800*
AWF Base cost				**464 900**	
Contingency (inflation and physical)	*rounded*		7,1%	33 100	
AWF Grant				**498 000**	
TOTAL PROJECT COST				**559 800**	

ANNEX 2 – Schedule of Tasks

Project Component	*Action*	*Start (month)*	*End (month)*
Project Management	• Steering committee established	1	3
	• Mutual agreement of task distribution	2	3
Module 1: WWTP rehabilitation and design for irrigation	• Contractual agreements established between farmers and WWTP proprietors	3	6
	• Presec WWTP in rehabilitated	4	9
	• Presec WWTP in operation	10	12
	• Farmers/operators trained and equipped with necessary tools for routine O&M	10	14
	• On-going monitoring - WWTP operation, yields	12	24
	• Demonstration plots, monitoring of the quality of the water and the produce	12	24
	• Cost-benefit analysis including environmental, economic, and social benefits and costs of reuse-oriented sanitation compared to the baseline status of the facilities.	18	24
Capacity Building	• Training materials – DFS, planning protocol for WW reuse in agriculture	12	24
	• Value Chain Construction and Planning Workshop: Irrigation	18	18
Module 2: Aquaculture incorporation at WWTPs - value chain construction and implementation plan	• Feasibility of incorporating aquaculture given influent WW quality confirmed	2	6
	• Market analysis of demand for different farmed fish species; cost-benefit analysis of fish species options	4	10
	• Fish stocking and harvesting protocol and schedule	4	6
	• Alternative aquaculture management options developed	6	18
	• Comprehensive implementation and operation plan	12	24
	• Cost-benefit analysis of incorporating aquaculture at TPs	12	24
Capacity Building	• Training material development – planning protocol for incorporation of aquaculture at WWTP	12	18
	• Value Chain Construction and Planning Workshop: aquaculture	24	24
Module 3a: Land application of FS - value chain construction and implementation plan	• Formal MOU between Sekondi-Takoradi Metro Assembly and Norpalm	3	6
	• Needs assessment of necessary equipment and infrastructure	6	10
	• Market analysis of compost equipment necessary and available for FS w/o inclusion of EFBs	8	12
	• Cost-benefit analysis of including EFBs	10	14
	• Implementation protocol	12	18
	• Contract between S-T MA and Norpalm drafted	16	20
	• Cost-benefit analysis of incorporating large-scale land application of FS including environmental, economic, and social benefits and costs of reuse-oriented sanitation compared to the baseline status of the facilities	10	15
	• Comprehensive implementation and operation plan	18	24
Capacity Building	• Training material development – planning protocol for FS land application	12	18
	• Value Chain Construction and Planning Workshop: land application of FS	18	18
Module 3b: Biogas generation and recovery at WWTP - value chain construction and implementation plan	• Market analysis of biogas collection and recovery technologies	12	18
	• Demand assessment for biogas (e.g., for direct cooking, fuel tank, heating, electricity) in vicinity of WWTP	16	19
	• Cost-benefit analysis and decision-support matrix of technology/recovery options vs. biogas generation	18	24
	• Construct comprehensive implementation and operation plan (including price structure for biogas product)	18	24
Capacity Building	• Training material development – planning protocol for incorporation of biogas recovery at WW/FSTP	18	24
	• Value Chain Construction and Planning Workshop: biogas recovery	24	24
Knowledge-sharing,	• Final workshop on knowledge sharing, monitoring and institutional reform (for Modules 1 – 3)	30	30

ANNEX 3 – The Water Resources Commission (WRC)

Definition
The Water Resources Commission is an agency of the Ministry of Water Resources, Works and Housing (MRWH) of the Republic of Ghana. The WRC will serve as the grant recipient and executing agency.

Institutional and Legal Status
The WRC was established by an Act of Parliament i.e. Act 522 of 1996 is the government agency of the Republic of Ghana, charged with the regulation and management of the country's water resources and the coordination of policies in relation to them. The WRC will disburse AWF funds pursuant to the requirements of the African Develop Bank's Disbursement Handbook and pursuant to contracts.

The WRC main functions and activities (beyond the role it will play in this project) are as follows:

(a) Propose integrated water resources management plans for the utilization, conservation, development and improvement of water resources;
(b) Initiate, control and co-ordinate activities connected with the development and utilization of water resources;
(c) Grant water rights;
(d) Collect, collate, store and disseminate data or information on water resources in Ghana;
(e) Engage water user agencies to undertake scientific investigations, experiments or research into water resources in Ghana;
(f) Monitor and evaluate programmes for the operation and maintenance of water resources;
(g) Advice the Government on any matter likely to have adverse effect on the water resources of Ghana; and
(h) Advise pollution control agencies in Ghana on matters concerning the management and control of pollution of water resources.

Organization and Management
i). Structure, Staffing and Management of the WRC:

The Commission is composed of the major stakeholders involved in the water sector including representatives of institutions relating to Hydrological Services, Water Supply, Irrigation Development, Hydro power generation, Water Research, Environmental Protection, Forestry, Minerals, Traditional Chiefs, NGO's, and Women interests. This structure of the Commission provides a forum for integration, cooperation and collaboration of the different interests in the water sector.

The Commission generally supervises the WRC Secretariat which is headed by an Executive Secretary and supported by a team of full-time professional staff including the following: Water Resources Engineer; Water Resources Economist; Water Quality Specialist; Information Technology Specialist; Hydrogeologist (2); Ecologist (2); Legal Officer; Public Relations Officer; Accountant; and an Administrative Officer. Furthermore, a Basin Officer is in charge of each of the three (3) established river basin offices. Middle level staff supports the professional staff. Currently, such middle level personnel are employed in the areas of compliance monitoring (2), planning (1) accounting (2), library services (1), and administration (1).

ii) Financial Management, Governance and Capacity

The day-to-day internal control of WRC management operations is based on a well established and functioning financial system, the Navision Financial System, which conforms to the Ghana Government Financial Administration Act 654 of 2003.

However, the main existing system for the internal control of management operations is the periodic administrative and management reporting to the Commission by the Executive Secretary about the general progress in activities. It is the mechanism for obtaining approval and opinion on making adjustments in implementation if required. The reporting also facilitates the Commission's general monitoring requirements, including the financial status of WRC. This internal control system also applies to donor-supported programmes. The WRC accounts have been well managed such that its annual accounts have been approved with only minor comments by the independent auditors appointed by government. The management of procurement procedures is managed transparently within the WRC. The internal mechanism for procurement using government or donor funds has generally been under the authority of an Entity Tender Committee, which operates under the rules and regulations of Public Procurement Act 663 passed in 2003.

iii) Financial Reporting and Auditing

The financial accounts of WRC are open and available to independent public and private external audit systems. Section 26 (2) of the Water Resources Commission Act 522 of 1996 stipulates that the books and accounts of the Commission, shall be audited annually by the Auditor General of Ghana or an auditor appointed by him within three months of the end of the immediately preceding financial year. The financial accounts of the Commission have accordingly on a yearly basis been made available and audited by an auditor appointed by the Auditor General. This procedure has been followed since WRC started its operations in 1999. Furthermore, copies of these audited accounts are submitted to the parent ministry, i.e. the Ministry of Water Resources, Works and Housing, which in turn submits them to Parliament as stipulated in Section 27 (1) of the WRC Act. The accounts of the WRC that relate to donor inflows are made available and audited appropriately by a private external auditor is appointed independently by the donor. The audited accounts submitted to the Ministry and subsequently to parliament are the consolidated accounts of government and donor funds to WRC.

Work on Donor Funded Projects

Three projects that serve to illustrate the capacity of the WRC to carry out the proposed action are identified as follows:

i) Support to the Water Resources Commission

Designed to support the WRC clarify its roles and functions towards IWRM and develop its operational tools as well as build capacity of staff and public awareness raising activities. This was a DANIDA supported project for a 3-year period from 2001 to 2003. The total budget was EUR 1,700,000 made up of WRC administered budget of EUR 600,000 and International technical assistance of EUR 1,100,000.

ii) Integrated Water Resources Management Component

Another DANIDA supported 5-year project (2004-2008) under the Ghana Water and Sanitation Sector Support Program. The aim was to provide a further strengthening of the procedures and work routines of WRC towards the general aim of introducing IWRM at all appropriate levels of society. The total cost of the project was EUR 2,980,000. WRC administered budget was EUR 1,900,000 and International technical assistance was EUR 1,080,000.

iii) Development of National and River Basin Integrated Water Resources Management Plans

The project is designed to develop national and river basin IWRM Plans. Other partners are the Water Research Institute (WRI); and Hydrological Services Department (HSD) of Ghana. It is being implemented under the European Commission's 9th European Development Fund with a total amount of EUR 1,798,400.

ANNEX 4 – The International Water Management Institute

The International Water Management Institute (IWMI) is one of 15 international research centres supported by the network of 60 governments, private foundations and international and regional organizations collectively known as the Consultative Group on International Agricultural Research (CGIAR). It is an international nonprofit organization with a staff of around 300 and offices in over 10 countries across Asia and Africa and Headquarters in Colombo, Sri Lanka. IWMI's mission is to improve the management of land and water resources for food, livelihoods and the environment. IWMI targets poor communities in developing countries and through this contributes towards the achievement of the UN Millennium Development Goals (MDGs) of reducing poverty, hunger and maintaining a sustainable environment.

IWMI-West Africa is engaged in numerous action-based research projects related to wastewater and excreta reuse. In Ghana, IWMI has ongoing work in Greater Accra and Tamale addressing health risk management associated with reuse, including a project analysing adoption drivers and cost-effectiveness of different treatment and non-treatment risk-reducing options. Other work, involves evaluating technology options for co-composting organic solid waste and human excreta and integrated use of freshwater, storm as well as wastewater for agriculture. IWMI West Africa's team of experts bring to bear decades of knowledge and experience. The region's current knowledge domains include: Ecology, Hydrology, Economics, Geography, Social Sciences, Water Quality, Health & Sanitation, Soil Science, Agronomy, Water Resources Management, Remote Sensing & Spatial Analysis, and Irrigation & Agricultural Engineering.

In 2008, the World Bank gave IWMI an 'outstanding' rating for performance. IWMI is one of four centers in the CGIAR to receive this rating which is the highest of three performance categories. Centers were assessed on the basis of their 2008 performance in the CGIAR performance measurement system. The Bank plans to continue its results-based funding approach in the new CGIAR.

A comprehensive overview of activities is given in the Annual Report. The 2008 edition has been consulted during the project appraisal.

The launch of the International Water Management Institute in 1984 was set in motion by two significant events. One was a proposal to the Bellagio Group – an international group of experts and donors – stressing the importance of water management in agriculture and the second was a joint proposal by the Ford and Rockefeller Foundations to carry out multidisciplinary research on irrigation technologies, the economics of water management at national and farmer levels and water policy issues at national and international level.

The need for water management research was evident as issues of water management continued to surface through the 1970's at Technical Advisory Committee (TAC) meetings of the U.S. based Consultative Group on International Agricultural Research (CGIAR). The Consultative Group on International Agricultural Research (CGIAR), established in 1971, is a strategic partnership of countries, international and regional organizations and private foundations. It currently supports the work of 15 international Centers.

By 1979, water management was one of TAC's key recommendations to the Bellagio Group for future research funding. Eventually, through the efforts of a CGIAR-appointed team that visited numerous countries and irrigation projects in 1982, recommendations were made by TAC for the establishment of International Irrigation Management Institute (IIMI), funded by the CGIAR.

The CGIAR was reluctant at that time to add to the number of centers already funded by them as the numbers had already increased from 5 centers to 13 centers between 1969 and 1982. However, the CGIAR promoted the establishment of IIMI without formal sponsorship by them. Interested CGIAR members asked the Ford foundation to act as the implementing agency to establish IIMI and Ford sent a team to India, Sri Lanka, Pakistan and the Philippines to determine how interested those countries were in hosting the Institute.

There was strong support for the IIMI proposal from all four countries. The IIMI Support Group that evolved for the purpose of establishing the Institute authorized the Ford Foundation to enter into negotiations with the Government of Sri Lanka. The choice of Sri Lanka appears to have been more than just a coincidence. Sri Lanka is a country with a long history of irrigation management, first carried out by its ancient kings and seen in the numerous man-made reservoirs, anicuts and other irrigation structures built across the island. On 1st September 1983 a Memorandum of Understanding (MOU) was signed by the Government of Sri Lanka and the Ford Foundation acting on behalf of the Support Group.

The Charter was ratified on 31st May 1984, Dr. Thomas Wickham was appointed Director General and IIMI began formal operations. The headquarters of IIMI were established at the Digana Village, 14 kilometers east of Kandy, in the central highlands. On 1st January 1985, IIMI's Board and staff assumed full responsibility for the Institute and its operations. IIMI's initial mandate was to improve irrigation system management. Much of the Institute's work involved a large technical assistance component and research was sometimes only a by-product of that work. Under the leadership of Dr. Wickham, IIMI established projects and placed staff in 5 countries, namely Sri Lanka, Pakistan, Indonesia, Nepal and the Philippines. IWMI also laid the basis for expansion into more countries.

In 1991, IIMI became a member of the CGIAR system and the first External Program and Management Review (EPMR) carried out in 1994 recommended a shift to more strategic research, seeing the potential of IIMI's work. By this time IIMI was also working in India and Africa -particularly West Africa. 1991 also marked the relocation of IIMI Headquarters from the Digana Village in Kandy to Battaramulla which lies on the outskirts of Colombo. IIMI's new office building was located in a picturesque setting close to the country's parliament. The building was a gift to the institute from its host country, with the generous assistance of the governments of Canada, Switzerland, and the Ford Foundation.

In 1996 -2000, under the leadership of Dr. David Seckler who was the Director General at that time, IIMI transformed itself into a "strong science-based organization concerned with the more effective and productive use of water as a key resource for improved food production. This saw the birth of the "More Crop per Drop" concept. The Institute also changed its name from the "International Irrigation Management Institute" (IIMI) to the "International Water Management Institute (IWMI) with a new mandate to "contribute to food security and poverty eradication by fostering the sustainable increases in the productivity of water through the management of irrigation and other water uses in the river basin". The research programs began to address water management and irrigation issues at the basin scale with a focus on regional water scarcity.

While "more Crop per Drop" focused on water productivity, IWMI began to increasingly view it as inadequate and this was expressed in the 2004 to 2008 Strategic Plan. Under the leadership of Prof. Frank Rijsberman who was IWMI's Director General from 2000 to 2007, IWMI expanded its mission to "Improve the management of land and water resources for food, livelihoods and nature". The Institute also refined its research agenda to incorporate 4 themes covering basin water management, land water and livelihoods, agriculture, water and cities and water management and environment. IWMI built up strategic alliances with national and international partners and CG centers, and aimed to become a world class knowledge center on water, food and environment through knowledge generation, dissemination, brokering and application. At the same time, business systems were reengineered and administrative processes streamlined through quality management procedures. An organizational culture of impact, performance and service was established.

Today IWMI has an expanded mandate which helps contribute to the Millennium Development Goals of reducing poverty and hunger and maintaining a healthy environment. In these three areas, access to water and land are contributing factors. IWMI concentrates on water and related land management challenges that poor rural communities face. IWMI also enjoys greater international and national visibility, as water is high on the world development agenda. It is a

modern, robust institute that has adapted to the needs of the 21st century through organizational transformation.

A new IWMI Director General, Dr. Colin Chartres, an Australian scientist with over 30 years experience in water and land management took office in October 2007. Around 110 researchers currently work for IWMI and the institute has a presence in more than 10 countries in Africa and Asia. The Institute is well positioned to meet water research challenges of the coming years.

For the Design for Reuse project, IWMI has nominated Ms Ashley MURRAY, PhD as lead researcher. Her curriculum vitae is shown below.

Ashley MURRAY

Education

Ph.D. Energy and Resources Group, University of California at Berkeley, May 2009 Dissertation: Don't Think of 'Waste'water: Evaluation and Planning Tools for Reuse-Oriented Sanitation Infrastructure

M.S. Energy and Resources Group, University of California at Berkeley, May 2006 Masters Project: Health, Hygiene and Safe Drinking Water: A Process Documentation of an Education and Technology Intervention in the Behram Slum, Mumbai, India

M.S. Environmental Engineering, University of California at Berkeley, May 2005

B.S. Biology (minor in Economics), Bates College, May 2002; Phi Beta Kappa

Research Interests

• Urban sanitation: mainstreaming reuse-oriented systems; planning & design; technology selection with emphasis on low-cost options; long-term operation & maintenance

• Strategic planning and decision-making (with emphasis on water and sanitation and its role in the broader urban context): development and adoption of sanitation planning tools; local capacity building; industrial ecology and integrated urban planning

• Measuring and monitoring sustainable development: sustainability indicators and frameworks; lifecycle analysis; integrating sustainability objectives into policy-making

Current Position

Postdoctoral Fellow, Institute of Urban and Regional Development, University of California, Berkeley, based at the International Water Management Institute-Ghana. Piloting sanitation planning tools developed for Ph.D. that are aimed at designing reuse-oriented wastewater treatment systems.

Work and Volunteer Experience

Co-founder -Director, Waste Enterprisers Ltd. Accra, Ghana. January 2010-present
Researcher, China Energy Group, Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory, Berkeley, CA. September 2008-present.
Researcher, Institute or Urban and Regional Development, UC Berkeley; based at the International Water Management Institute-Ghana, Accra, Ghana. June 2008-present.
Water Quality Analyst and Trainer; Sarvodaya, Sri Lanka. August 2005.
President, Engineers for a Sustainable World-Berkeley, UC Berkeley. May 2004 – May 2005. (Executive Board member 2003-2006).
Project Founder, Haath Mein Sehat (Health in Hands): Hygiene Education and Safe Drinking Water, Bheram Slum, Mumbai, India. (www.hmsindia.org). 2004.
Water Resources Project Coordinator, Keepers of the Waters; Beijing, China. Spring 2002 – Spring 2003.

Grants, Fellowships and Other Recognitions

• **Sustainable Products and Solutions Program, UC Berkeley** – PI on funded proposal "Toolkit for the 21st-Century Sanitation Planner." $215,000 (GSR salaries, Post-Doctoral salary, travel). August 2008-December 2011.

• **Chang-Lin Tien Scholar – Graduate Fellowship in Environmental Sciences and Biodiversity** - Two year stipend. 2006-2008.
• **Young Scholar, Berkeley Delegate** – Represented UC Berkeley at the International Alliance of Research Universities workshop: "Sustainable Water Management at the Local, Regional and Global Scales," Australia National University, March 2007.
• **National Science Foundation Graduate Research Fellowship** – Three year stipend plus tuition for graduate study in science or engineering. 2003-2006.
• **Ann Campana Judge Foundation** - Ggrant for Haath Mein Sehat project in Mumbai, India. $4000. May 2005.
• **Howard Hughes Medical Grant** - Scientific research award for undergraduate thesis on constructed wetlands for wastewater treatment in China. $3000. Fall 2000.

Publications

Published or in review:
Murray, A. and Drechsel, P. (*in review*) "Positive Deviance in the Sanitation Sector in Ghana," with Pay Drechsel, International Water Management Institute-Ghana.
Murray, A. and Ray, I. (*accepted*). "Back-End Users: The Unrecognized Stakeholders in Demand-Driven Sanitation." *Journal of Planning Education and Research*.
Murray, A. and Ray, I. (2010). "Wastewater for Agriculture: A Reuse-Oriented Planning Model and its Application in China." *Water Research* 44(10): 1667-1679.
Murray, A. and Buckley, C. (2010). "Designing Reuse-Oriented Sanitation Infrastructure: the Design for Service Planning Approacg." Wastewater Irrigation and Health: Assessing and Mitigating Risks In Low-Income Countries. P. Drechsel, C.A. Scott, L. Raschid-Sally, M. Redwood, A. Bahri, eds. UK, Earthscan-IDRC-IWMI.
Murray, A., Ray, I., Nelson, K. (2009). "An Innovative Sustainability Assessment for Urban Wastewater Infrastructure and its Application in Chengdu, China." *Journal of Environmental Management,* **90:** 3553-3560.
Nelson, K. and Murray, A. (2008). "Sanitation for Unserved Populations: Technologies, Implementation Challenges, and Opportunities." *Annual Review of Environment and Resources,* **33:** 119-151.
Murray, A. and Price, L. (June 2008). "Use of Alternative Fuels in Cement Manufacture: Analysis of Fuel Characteristics and Feasibility for Use in the Chinese Cement Sector." Ernest Orlando Lawrence Berkeley National Laboratory: LBNL-525E. pp 63
Murray, A., Horvath, A., Nelson, K. (2008). "A New Hybrid Life-Cycle and Cost Analysis Approach to Assessing Sewage Sludge Treatment and End-Use Scenarios: A Case Study from China." *Environmental Science and Technology,* **42:** 3163-3169.

Selected Presentations

"Cost Recovery Through Reuse…Where are the Opportunities?" Bill and Melinda Gates Foundation: Water Resources and Reuse Workshop. Portland House Bressenden Place, London, February 24, 2010.
"Don't Think of **Waste**water: Towards Reuse-Oriented Sanitation," Energy and Resources Group Colloquium, UC Berkeley, April 29, 2009.
"Design of Wastewater and Fecal Sludge Treatment Plants for Reuse in the Ghanaian Context," Invited Speaker, International Expert Consultation on Wastewater Irrigation: Consumer Health Risk Assessment, On-Farm and Off-Farm Options for Health Risk Mitigation, and Wastewater Governance, International Water Management Institute-Ghana, Accra, Ghana, October 6-9, 2008.
"Water Pollution: Sources, Control and Interventions," Guest lecturer, Water and Development, UC Berkeley, September 23, 2008.
"Economic and Environmental Optimization of Biosolids Management," Invited speaker, Northwest Biosolids Management Conference: Biosolids Pride and Predudice, Stevenson, WA, September 7-9, 2008.
"Design-for-Service Planning Framework for Sustainable Urban Sanitation: Development and Application in China," Poster presentation at The Sanitation Challenge: An International Conference on New Sanitation Concepts and Models of Governance. Wageningen, The Netherlands, May 19-21, 2008.
"Use of Alternative Fuels in Cement Manufacturing: Global Best Practices and Feasibility Assessment for China," Oral Presentation, 5th Asia Pacific Partnership for Clean Development and Climate Task Force Meeting, Charleston, S.C., May 12-16, 2008.

"Design for Service: Towards Sustainable Urban Sanitation - Framework and Application in Chengdu, China," Invited Speaker, SWITCH-China Project, 1st Learning Alliance Meeting, Beijing, China, May 9, 2007.
"Climate Change, Water Resources, and Sanitation Feedbacks." Guest lecturer, Environmental Health and Development, UC Berkeley. November 15, 2007.
"End Use of Sewage Sludge in Cement Manufacturing: Potential Economic and Environmental Benefits," Invited Speaker, China Building Materials Academy Delegation Visit, Lawrence Berkeley National Laboratory, Berkeley, CA, October 1, 2007.

Student Supervision and Mentorship

Research supervisor for Kia Alexander, hired to conduct institutional analysis and market demand analysis in Accra. Funded by SPSP grant June 2009-August 2009.
Research supervisor for Alisar Aoun, hired as Graduate Student Researcher to conduct lifecycle analysis of wastewater treatment technologies. Funded by SPSP grant September 2008-May 2009.
Research supervisor for Peerapong Pornwongthong, hired as Graduate Student Researcher to develop industrial reuse demand assessment for the Design for Service planning approach.
Funded by SPSP grant January-May 2009.
Research supervisor for Andrea Silverman, hired as Graduate Student Researcher to modify and pilot Burden to Capacity Sustainability Assessment for use in Ghana. Funded by SPSP grant September-October 2008.
Research supervisor for Chen Xia, hired as a Research Assistant for conducting field surveys and interviews in Chengdu, China. Summer 2006-Summer 2008.
Graduate Student Instructor, Design for Sustainable Communities, UC Berkeley. Spring 2006.

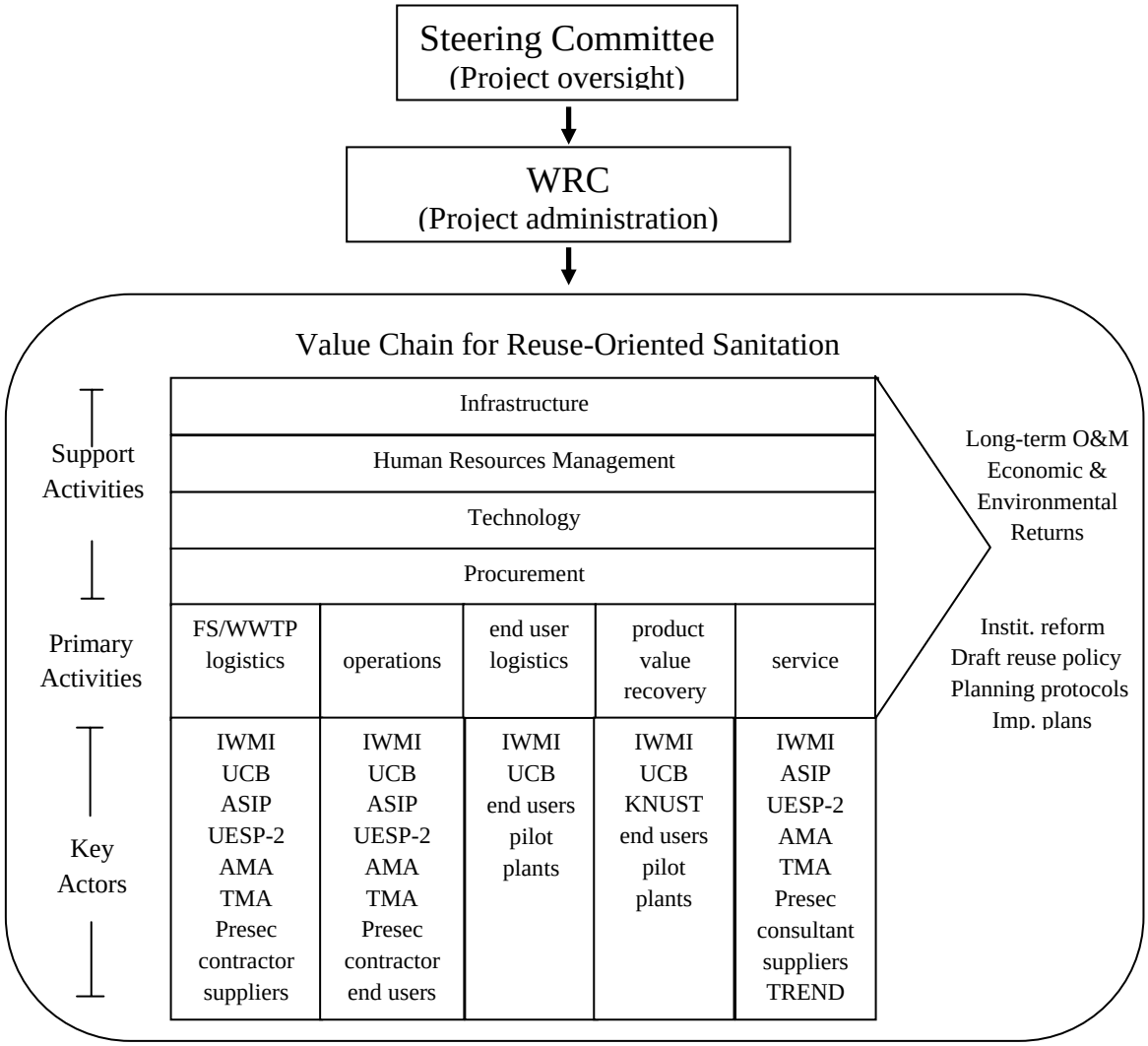
Professional Service and Society Memberships

Referee: Environmental Science and Technology; IWA Young Water Professional Conference abstract/paper/poster selection committee; PLoS ONE (Public Library of Science); Journal of Infrastructure Systems; Resources, Conservation and Recycling; Water Resources Management; Scientific Research and Essays, Sustainability.
Memberships: IWA, WSSCC, Engineers for a Sustainable World, Phi Beta Kappa

Language Skills

Mandarin Chinese - advanced spoken language, intermediate reading and writing
Twi (Ghanaian language) – basic conversation

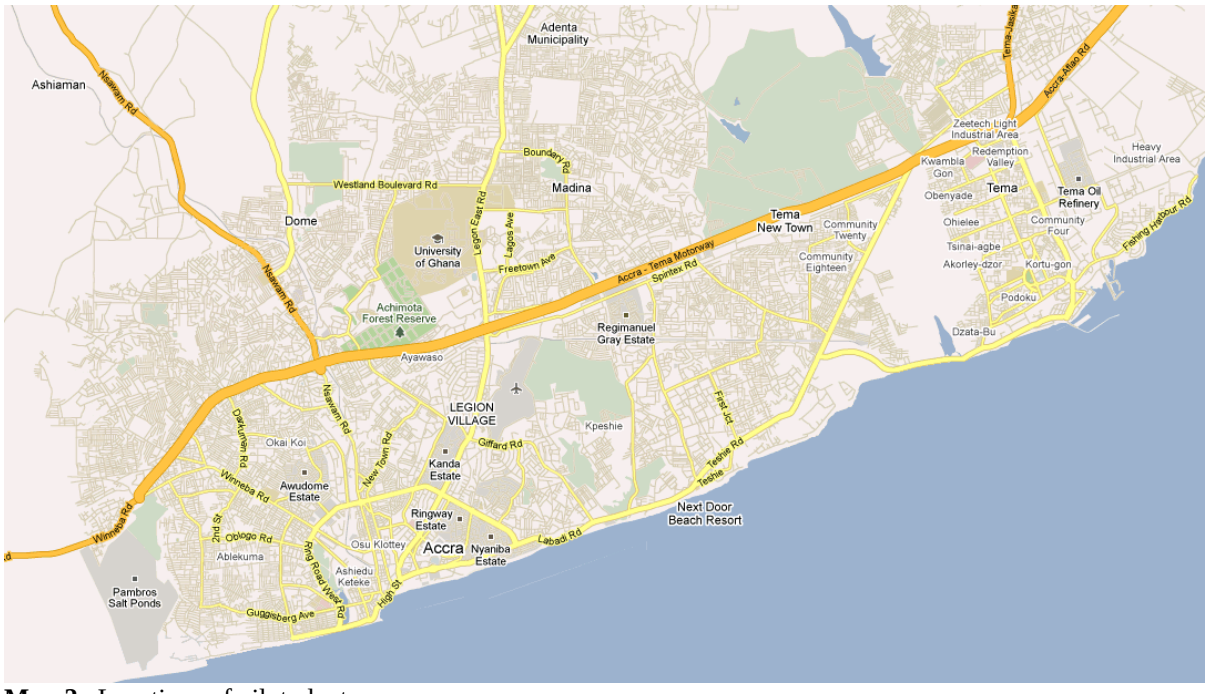
ANNEX 5 – Project Implementation Graph



Schematic of the roles of key stakeholders and the flow of activities that comprise the project. WRC is the project administrator and progress toward the outputs of each module will be overseen by the Steering Committee. As depicted, each project module consists of developing (and in some cases implementing) value chains for reuse-oriented sanitation. IWMI will serve as the managing body for all of the day-to-day activities for each module, and additional partners are designated for each phase. (Value chain schematic adapted from Porter, M. (1985). Competitive Advantage. Free Press: New York.)

ANNEX 6 – Maps

Map 1. Country map of Ghana, West Africa.
Kumasi and Sekondi-Takoradi are locations of pilot plants.
The other pilot plants are in the Greater Accra area shown in the enlarged map below.



Map 2. Locations of pilot plants
Presbyterian Boys Secondary School (Presec) and
Legon Waste Stabilization Ponds are close to the University of Ghana.

ANNEX 7 – References

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ANNEX 8 – Project Procurement Plan

Procurement Plan - Supply of Goods

Country / Organization: GHANA
Project / Programme: DESIGN FOR REUSE
Loan / Grant:
Post Review Threshold:

Period Covered by Plan: 2010 - 2012
Prepared by: WRC
Date: MAY 2010
Approved By:

Revision No.:
Date of Revision:

	Basic Data							Bid Document Procurement by PIU		Preparation and submission of bids by bidders		Bid Evaluation		Contract Finalization				Deliverable/ close-out
Description of Item*	Lot Number	Bid Document Reference Number	Estimated Amount in UAC	Procurement Mode	Pre-or-Post Qualification	Prior or Post Review	Plan Vs Achieved	BD Completed date	Non Objection date	Issues of bids date	Bid Submission and opening deadline	Evaluation Report Completed	Non objection Date	Contract Amt in UAC	Contract Award	Contract Signature Date	Contract Approval in SAP	Contract End
Tools for O&M	G01	AWFG01	3700	Shopping	Post	Post	Plan	01.02.2011		15.02.2011	10.03.2011	24.03.2011			04.04.2011	14.04.2011		30.09.2011
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
Total Cost							Plan											
							Achieved											

* As contained in the list of goods and services (Categories of Expenditure)

Procurement Plan - Supply of Works

Country / Organization: GHANA
Project / Programme: DESIGN FOR REUSE
Loan / Grant:
Post Review Threshold:

Period Covered by Plan: 2010 - 2012
Prepared by: WRC
Date: MAY 2010
Approved By:

Revision No.:
Date of Revision:

	Basic Data							Bid Document Procuremente by PIU		Preparation and submission of bids by bidders		Bid Evaluation		Contract Finalization/administration				Deliverable/ close-out
Description of Item*	**Lot Number**	**Bid Document Reference Number**	**Estimated Amount in UAC**	**Procurement Mode**	**Pre-or-Post Qualification**	**Prior or Post Review**	**Plan Vs Achieved**	**BD Completed date**	**Non Objection date**	**Issues of bids date**	**Bid Submission and opening deadline**	**Evaluation Report Completed**	**Non objection Date**	**Contract Amt in UAC**	**Contract Award**	**Contract Signature Date**	**Contract Approval in SAP**	**Contract End**
Rehabilitation of WWTP	W01	AWFW01	75000	NCB	Post	Prior	Plan	04.08.2010	13.08.2010	19.08.2010	24.09.2010	05.10.2010	11.10.2010		14.10.2010	18.10.2010		30.04.2011
							Achieved											
Land preparation	W02	AWFW02	900	Shopping	Post		Plan	07.04.2011		13.04.2011	05.05.2011	17.05.2011			02.06.2011	09.06.2011		31.07.2012
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
							Plan											
							Achieved											
Total Cost							Plan											
							Achieved											

* As contained in the list of goods and services (Categories of Expenditure)

Procurement Plan - Supply of Services

Country / Organization: GHANA
Project / Programme: DESIGN FOR REUSE
Loan / Grant:
Post Review Threshold:

Period Covered by Plan: 2010 - 2012
Prepared by: WRC
Date: MAY 2010
Approved By:

Revision No.:
Date of Revision:

	Basic Data					Expression of interest		Terms of reference		Shortlist			Request for proposals		Submission of proposals		Submission of proposals			Evaluation of proposals Technical (T) and Financial (F)						Contract finalization/administration				Deliverable/ close-out
Description of Services*	**Mode of Selection**	**Lump-sum or time-bassed contract**	**Estimated Cost in Amount in UAC**	**Prior or Post review**	**Plan Vs Achieved**	**Publication date**	**Deadline date**	**Preparation Date**	**Non Objection Date**	**Prepared date**	**Non objection Date**	**Plan Vs Achieved**	**Prepared**	**Non Objection date**	**Issues of bids date**	**Bid Submission and opening deadline**	**Proposals Issue Date**	**Submission of propossals deadline**	**Opening of T-Proposals deadline**	**Technical evaluation completed**	**Non Objection date**	**Opening of F-Proposals dated**	**Combined evaluation Completed**	**Non Objection combined evaluation**	**Plan Vs Achieved**	**Contract Amount in UA**	**Contract Award Date**	**Contract Signature Date**	**Contract Approval in SAP**	**Contract End**
Design, Supervise Reh. & Const. Of WWTP	S01	QCBS	16200	Post	Plan							Plan											20.10.2010	20.10.2010	Plan		25.10.2010	31.10.2010		31.07.2011
					Achieved							Achieved													Achieved					
Aquaculture Specialist	S02	SSS	2200,17	Post	Plan							Plan													Plan		23.09.2010	29.09.2010		31.01.2011
					Achieved							Achieved													Achieved					
Compost Specialist	S03	SSS	1466,78	Post	Plan							Plan													Plan					
					Achieved							Achieved													Achieved					
Biogas Specialist	S04	SSS	733,39	Post	Plan							Plan													Plan					
					Achieved							Achieved													Achieved					
Development of Training Manual	S05	SSS		Post	Plan							Plan													Plan					
					Achieved							Achieved													Achieved					
Investigator	S06	SSS			Plan							Plan													Plan					
					Achieved							Achieved													Achieved					
					Plan							Plan													Plan					
					Achieved							Achieved													Achieved					
Total Cost					Plan							Plan													Plan					
					Achieved							Achieved													Achieved					

* As contained in the list of goods and services (Categories of Expenditure)