Cocopeat Effluent Water Filtration Systems in the Philippines: A Comparative Evaluation of Alternative Implementation Models

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Executive Summary[1]

Context & Problem Overview

There is a great necessity for improved sanitation practices in the developing world. Forty percent of the world's population practice open defecation or lack adequate sanitation facilities. In urban areas throughout the developing world, where household and community toilets are available, 2.1 billion people use toilets connected to septic tanks that are not safely emptied or use other systems that discharge raw sewage into open drains or surface waters resulting in a greater incidence of waterborne diseases, poor drinking water quality, and contaminated water sources. In the Philippines, poor sanitation infrastructure and disease costs the economy $1.94 billion a year.

Improved sanitation practices and infrastructure are difficult to implement and sustain. Public services, treatment systems, and sanitation practices in the developing world often require sufficient land, capital, and energy resources that are often scarce. Low cost, sustainable improvements and innovations, as well as local acceptance and ownership, are necessary to develop and implement alternative technologies that can help reuse waste, improve water treatment and improve overall quality of sanitation services.

Researchers at Research Triangle Institute (RTI) International have developed and tested a secondary waste water treatment filter that can be appended to existing decentralized waste water treatment systems (DEWATS) and collection facilities. Using a cocopeat filter, the discarded dust and coir generated from coconut processing plants, an effective bio-filter unit can be constructed. This simple device can easily be connected to existing septic tanks or other primary treatment components to filter effluent waste water and meet national discharge standards. This filtration technology has the potential to improve health and positively impact sanitation services for urban poor communities. Although successful pilot programs have been launched through grant funding and self-financing, RTI would like to explore alternative implementation models to deliver this technology to a larger audience in the Philippines.

Policy Question

What implementation models could RTI International consider for scaling up cocopeat bio-filtration systems to improve access to safe water and sanitation in urban poor areas of the Philippines?

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[1] This student paper was prepared in 2014 as a requirement for the Master of Public Policy Program at Duke University's Sanford School of Public Policy. The research, analysis, and recommendations contained in this paper are the work of the student who authored the document, and do not represent the official or unofficial views of the Sanford School of Public Policy, Duke University, or RTI International. Without the specific permission of its author, this paper may not be used or cited for any purpose other than to inform the client organization about the subject matter. The author relied in many instances on data provided by the client and related organizations and makes no independent representations as to the accuracy of the data.

Data and Methodology

To assess and recommend potential implementation model options the following data and methodology was used:

- Sanitation Sector Landscape Analysis – I conducted a literature review of the Philippines sanitation sector to assess the most significant institutional factors related to implementing DEWATS projects.

- Case Study Analysis – I collected and reviewed relevant case studies related to DEWATS projects implemented in urban Philippines locations to determine key lessons learned, potential implementation models, and project financing structures.

- Integrated Financial and Economic Analysis – From the financial and economic data collected in the case studies, I analyzed cocopeat filter technology system costs with comparable secondary treatment systems. Additionally, I analyzed potential cost distributions of a cocopeat filter system using four different implementation models.

Findings

- Cocopeat filter technology is a proven low cost, sustainable, and effective alternative to other secondary waste water treatment technology options with comparable efficiency.

- The Community Participation model shows the most potential for mitigating institutional risks and constraints within the sanitation sector.

- Efficient DEWATS implementation using a cocopeat filter has the potential to improve benefit to cost ratios (BCRs), reduce cost burdens on direct users, and introduce sanitation treatment systems to urban areas where space constraints are a key limiting factor.

Recommendations

RTI could pursue Community Participation models for implementing cocopeat filter DEWATS projects with support from local government units (LGUs) and NGOs. This model shows the most promise for mitigating institutional risks, promoting awareness of sanitation benefits, driving ownership by end users, and enabling technology adoption. Given that technical implementation, social marketing, and sanitation training expertise resides predominantly with NGOs, RTI should also continue to promote the benefits of cocopeat filter technology through these subject matter experts.

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List of Acronyms

ABR	Anaerobic Baffled Reactor
ADB	Asian Development Bank
AUSAID	Australian Agency for International Development
BCR	Benefit to Cost Ratio
BNS	Basic Needs Services
BOD	Biochemical Oxygen Demand
BORDA	Bremen Overseas Research & Development Association
CAPS	Center for Advanced Philippine Studies
CBO	Community Based Organization
COD	Chemical Oxygen Demand
DENR	Department of Environment and Natural Resources
DEWATS	Decentralized Waste Water Treatment Systems
DGIS	Directorate General of International Cooperation
DILG	Department of the Interior and Local Government
DO	Dissolved Oxygen
DOH	Department of Health
DPWH	Department of Public Works and Highways
EASAN	East Asia Sanitation Conference
ECO-Asia	Ecological Sanitation - Asia
ESI	Economics of Sanitation Initiative
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
GTZ	German Technical Corporation
IRC	International Resource Centre on Water Supply, Sanitation and Hygiene
ITB	Institut Teknologi Bandung
JBIC	Japan Bank for International Cooperation
LBP	Land Bank of the Philippines
LDA	Laguna Lake Development Authority
LGU	Local Government Unit
LINAW	Local Initiative for Affordable Waste Water
LWUA	Local Water Utilities Administration
MDG	Millennium Development Goal
MMDA	Metro Manila Development Authority
NAWASA	National Water and Sanitation Association of the Philippines
NEDA	National Economic Development Authority
NH_4^+	Ammonia Content
NO_3^-	Nitrate Content
NPV	Net Present Value
N_{TKN}	Nitrogen Content
NWRB	National Water Resources Board
O&M	Operations and Maintenance
PADCO	Planning and Development Collaborative International, Inc.
PCWS	Philippine Center for Water and Sanitation
pH	Standard Measure of Acidity

PhilHealth	Philippine Health Insurance Corporation
PPP	Public-Private Partnership
RTI	Research Triangle Institute
SBR	Sequencing Batch Reactor
SIDA	Swedish International Development Cooperation Agency
SuSEA	Sustainable Sanitation for East Asia
SWAPP	Solid Waste Management Association of the Philippines
TSS	Total Suspended Solids
UDDT	Urine Diverting Dry Toilet
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WAND	Water, Agroforestry, Nutrition and Development Foundation
WATSAN	Water Sanitation
WASH	Water Supply, Sanitation, and Hygiene
WHO	World Health Organization
WSP	Water and Sanitation Program
WTP	Willingness to Pay

I. INTRODUCTION

POLICY QUESTION

What implementation models could Research Triangle Institute (RTI) International consider for scaling up cocopeat bio-filtration systems to improve access to safe water and sanitation in urban poor areas of the Philippines?

PROBLEM OVERVIEW

There is a great necessity for improved sanitation practices in the developing world. Forty percent of the world's population (2.5 billion people) practice open defecation or lack adequate sanitation facilities.[2] In urban areas throughout the developing world, where household and community toilets are available, 2.1 billion people use toilets connected to septic tanks that are not safely emptied or use other systems that discharge raw sewage into open drains or surface waters.[3] These suboptimal sanitation practices result in a greater incidence of waterborne diseases, poor drinking water quality, and contaminated water sources. 1.8 million deaths are attributed to diarrheal diseases each year with 90% occurring in children under 5 years old in developing countries.[4] It is estimated that marginal improvements in sanitation can improve diarrheal morbidity by 37.5%.[5]

Improved sanitation practices and infrastructure are also difficult to implement and sustain. Public services, treatment systems, and sanitation practices in the developing world often require sufficient land, capital, and energy resources that are often scarce. Low cost, sustainable improvements and innovations, as well as local acceptance and ownership, are necessary to develop and implement alternative technologies that can help reuse waste, improve water treatment and improve overall quality of sanitation services. Sanitation innovation is particularly crucial in urban areas and communities, where billions of people are only capturing and storing their waste in septic tanks and latrine pits, without sustainable ways to process the waste once these storage facilities are full.[6]

RTI International has developed an effective, waste water filter that has the potential to improve health and positively impact sanitation services for urban poor communities. Although successful pilot programs have been launched through grant funding and self-financing, RTI

[2] (Prüss-Üstün, Bos, Gore, & Bartram, 2008)
[3] (Bill & Melinda Gates Foundation, 2013)
[4] (World Health Organization, 2013)
[5] (World Health Organization, 2013)
[6] (Bill & Melinda Gates Foundation, 2013)

would like to explore additional partnerships and implementation models to deliver this technology to a larger audience in the Philippines.

CONTEXT AND BACKGROUND

Sanitation in the Philippines

As part of the Millennium Development Goals, commissioned by the United Nations in September 2000, the Philippines government adopted a resolution in 2004[7] to target "halving by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.[8]" According to official estimates, Southeast Asian developing countries, including the Philippines, are officially on track to meet this goal; however, 29% of this population still lacks access to improved sanitation facilities.[9] Despite progress toward improved sanitation access, these estimates may be misleading since official access data only accounts for waste entering septic tanks or pit latrines. Often, these storage facilities are improperly sealed and poorly serviced resulting in waste water overflows to uncovered drainage systems, thus leaving the majority of the population across the country exposed to raw sewage.[10]

Because of inadequate infrastructure, investment, and services in the Philippines, contaminated drinking water and waterborne diseases continue to be a significant health concern to the public accounting for more than 500,000 morbidity and 4,200 mortality cases a year.[11] Poor sanitation infrastructure and disease in the Philippines costs the economy $1.94 billion a year. 71% of these costs are for healthcare associated with 38 million cases of diarrhea per year and 31 premature deaths per day.[12] The remaining economic losses are due to lost income from major industries such as fisheries and tourism. According to estimates from the World Health Organization, for every $1 financial investment in improved sanitation solutions, the expected return in the Philippines could result in $9 to $11 of economic benefits.[13]

Multiple sanitation strategies and interventions have been tested and implemented with varying degrees of success toward reducing public health costs and other economic losses. These models have included community-based solutions, government funded models, non-governmental aid models, and hybrid partnership models. Often, these strategies are implemented at a high financial cost, lack widespread distribution, and/or lack acceptance and buy-in. Many of these

[7] (National Statistical Coordination Board, 2004)
[8] (United Nations, 2013, p. 46)
[9] (United Nations, 2013, p. 48)
[10] (The World Bank Group, 2005, p. xviii)
[11] (The World Bank Group, 2005, p. xviii)
[12] (Rodriquez, Jamora, & Hutton, 2008)
[13] (Hutton, Haller, & Bartram, 2007)

strategies also only focus on sanitation storage rather than waste water treatment. Future sanitation interventions will require a more sustainable approach with a reliance on low cost, locally available resources.[14]

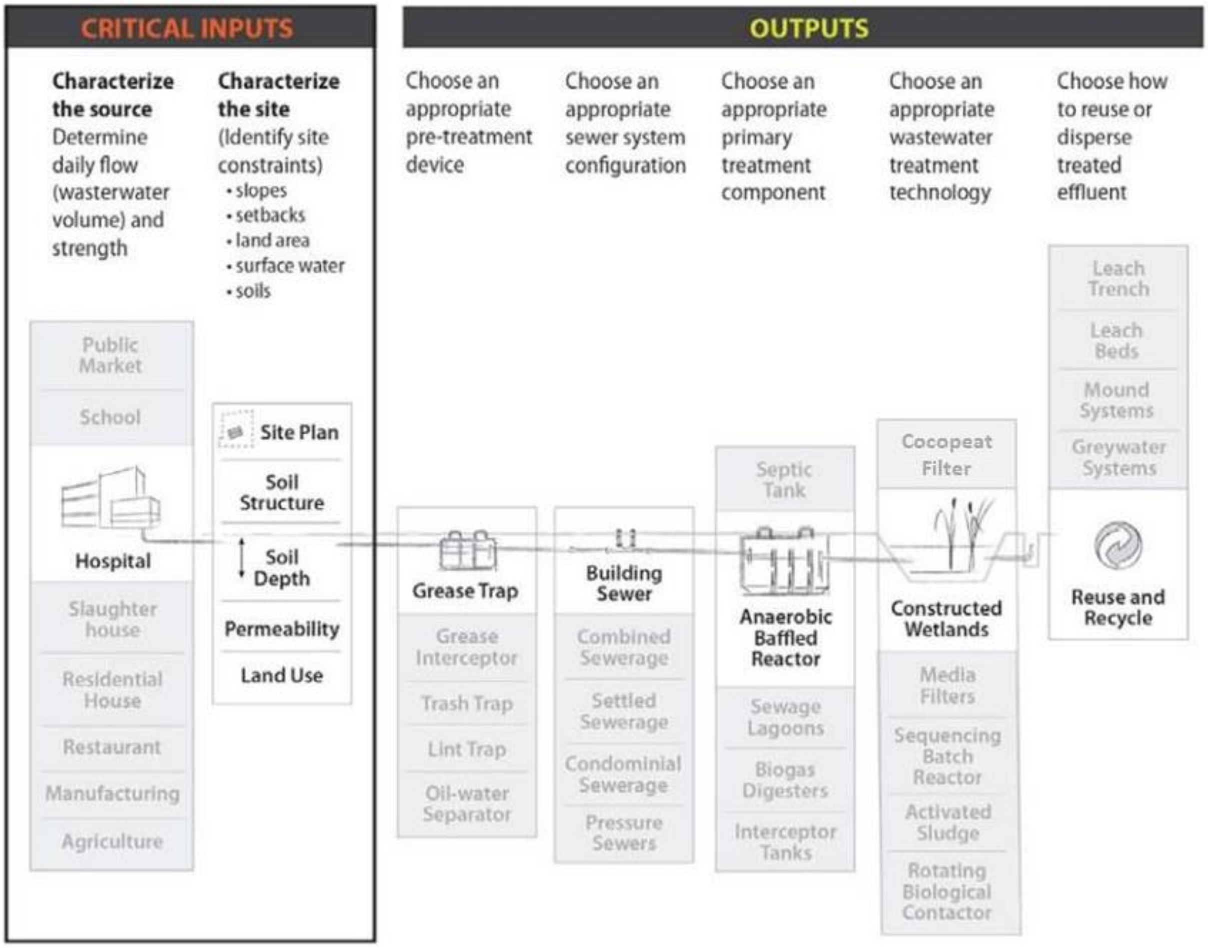
Cocopeat Filter Research

Since 2011, researchers at RTI International have developed and tested a secondary waste water treatment filter that can be appended to existing decentralized sanitation systems and collection facilities. Using a small plastic or wooden box and the proper loading of cocopeat, the discarded dust and coir generated from coconut processing plants, an effective bio-filter unit can be constructed. This simple device can easily be connected to existing septic tanks or other primary treatment components to filter effluent waste water and meet national discharge standards.[15] Depending on the site configurations and soil conditions, the effluent waste water from a cocopeat filter can be directly discharged into a common drainage system or reused for plant irrigation.[16] Each filter unit can be configured to meet the needs of a single household or scaled up for a small community.[17] Appendix A and B show example filters and potential filter configurations for various inputs and site conditions.

Figure 1 details the critical inputs for choosing appropriate DEWATS technology and a range of possible system configurations. With an adaptive approach to waste water treatments, a variety of different configurations could be implemented. Cocopeat filters are considered secondary treatment technology and used following treatment from a primary treatment mechanism (e.g., septic tanks, anaerobic baffled reactors, sewage lagoons, etc.). Due to low cost technology and minimal space constraints cocopeat filters have the potential to be used in lieu of a variety of other comparable secondary treatment mechanisms (e.g., constructed wastelands, alternative media filters, etc.).

[14] (Bill & Melinda Gates Foundation, 2013)
[15] (RTI International, 2012)
[16] (Robbins D. , Interview with Dave Robbins on Using Coco Peat to Develop Low-Cost Waste Water Treatment, 2012)
[17] (Robbins D. , Addressing Site Constraints through Cocopeat System Design, 2012)

Figure 1: Critical Inputs and Outputs of a Decentralized Waste Water Treatment System[18]



Source: Adapted from Developing Guidance Policies for the Management of Decentralized Waste Water Treatment Systems (DEWATS) by Local Governments, D. Robbins 2012.

Current Cocopeat Filter Collaborations

RTI conducted laboratory testing at Can Tho University in Vietnam and Duke University in North Carolina to test various aspects of the filtration technology. Test results of effluent sample filter water showed 90% reductions in organic matter, suspended solids, and pathogenic bacteria[19] and met discharge standards in accordance with the Philippine Clean Water Act of 2004[20] and the Revised Effluent Regulations of 1990[21]. Appendix D compares filter test results with regulatory standards.

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[18] (Robbins D. , Developing Guidance Policies for the Management of Decentralized Wastewater Treatment Systems (DEWATS) by Local Governments, 2011).
[19] (RTI International, Can Tho University, 2012)
[20] (Congress of the Philippines, 2004)
[21] (Government of the Philippines, 1990)

Table 1: RTI Cocopeat Pilot and Testing Programs

Location	Description	Target Users	Partners
Philippines	RTI and Habitat for Humanity collaborated to incorporate cocopeat filters into septic tanks designs for low income residential housing developments in Oriental Mindoro.[22]	Urban Poor Communities	Habitat for Humanity RTI International
Philippines	The cocopeat system installed at Putatan Elementary School serves over 2,000 users. Pour-flush toilets discharge to a septic tank equipped with a small pump that feeds effluent to the cocopeat bio-filter. [23]	Schools	Putatan Elementary School RTI International Gates Foundation
Philippines	The Muntinlupa Public Market waste water project coupled a cocopeat filter with a traditional sewage treatment system to treat from human, animal, and food waste water and meet local discharge standards.[24]	Public Market	RTI International USAID Muntinlupa City LINAW ECO-Asia
Indonesia	Institut Teknologi Bandung is testing cocopeat filter technology to study configurations for single family homes in flood prone areas.[25]	Single Family Households	Institut Teknologi Bandung (ITB) Gates Foundation
USA	Cocopeat filter media was laboratory tested at Duke University under different loading scenarios and compared with sphagnum peat, an effective bio-filtration medium.[26]	Research	RTI International Duke University Gates Foundation
Vietnam	Can Tho University tested cocopeat filters to demonstrate how the technology might be incorporated into waste water systems for rural farmers.[27]	Rural Farmers	Can Tho University RTI International Gates Foundation
Bangladesh	A pilot project was implemented in Kushtia, Bangladesh to treat fecal sludge and solid waste together using a fecal drying bed, compost plant, and a cocopeat filter.[28]	Urban Poor Communities	Kushtia Municipality UNESCAP

[22] (Doczi, 2012)
[23] (Robbins D. , Addressing Site Constraints through Cocopeat System Design, 2012)
[24] (Santos Jr. & Robbins, 2011)
[25] (Robbins & Richkus, 2012)
[26] (Robbins & Richkus, 2012)
[27] (Robbins & Richkus, 2012)
[28] (Enayetullah & Sinha , 2013)

In addition to laboratory testing, pilot programs were established in Indonesia, Philippines, Bangladesh, and Vietnam due to the high production of coconuts in these countries.[29] Pilot filter programs were launched in schools, public markets, communities, and other locations to test usability features of the filter, configurations, and potential partnership options. Thus far, RTI has implemented these pilot programs primarily through self-financing and a grant funded by the Bill & Melinda Gates Foundation. Table 1 provides a summary of these pilot projects and partners.

Benefits of Cocopeat Filter Technology

From both laboratory and pilot testing, cocopeat filter technology has shown the following advantages:

- *Low cost*: On average, each filter costs less than 2 cents per user per day to build and maintain[30], which is considerably less than the 5 cents per day goal set by the Bill & Melinda Gates Foundation's Sanitation and Hygiene initiative.[31] Cocopeat filters, on average, require 70% of the capital and maintenance costs of a constructed wetland.[32]

- *Effectiveness*: Testing showed that these filters have a 90% removal rate of harmful matter and bacteria thus producing effluent water suitable for discharge in accordance with national standards.[33]

- *Sustainability*: Cocopeat is a locally renewable resource in coconut rich countries. When cocopeat media life has been expended, it can safely be used as a nutrient rich fertilizer.[34]

- *Low Land Resource Requirements*: Cocopeat filtration efficiency is comparable to constructed wetlands and sewage lagoons; however, cocopeat filters require 60% less land and are 90% faster to build.[35]

- *Longevity*: Cocopeat filters have a potential life expectancy of up to 8 years with an expected usable life of 3 years before requiring media replacement. [36]

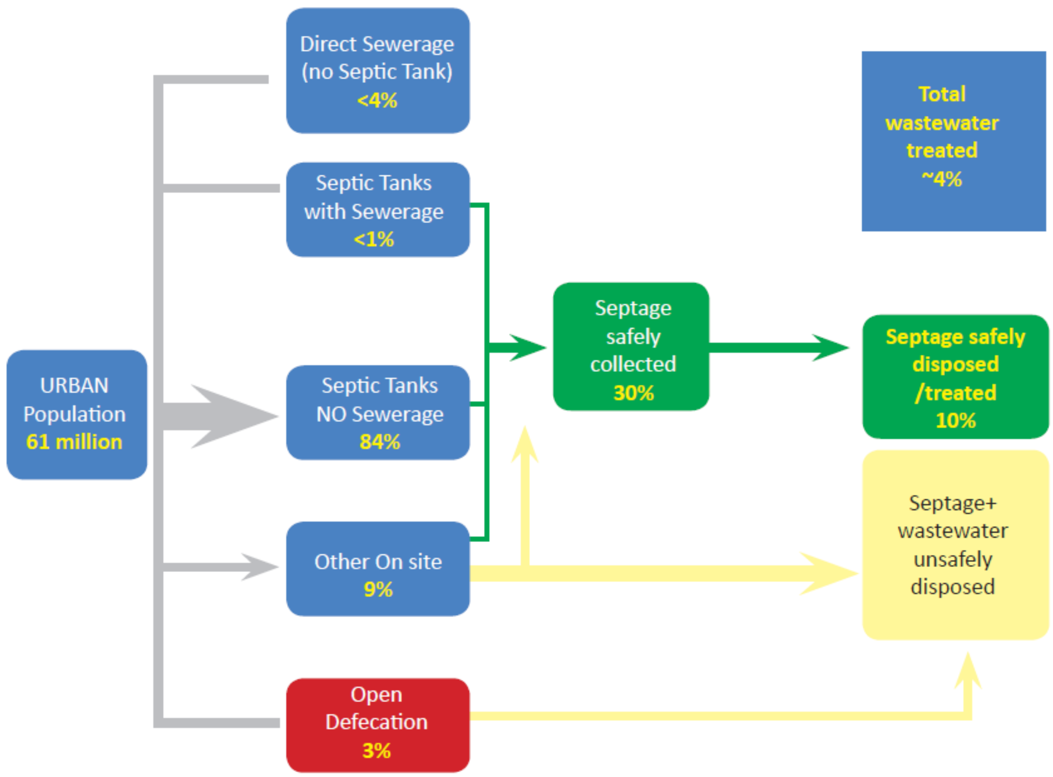
[29] (United Nations Conference on Trade and Development, 2012)
[30] (Robbins & Richkus, 2012, p. 7)
[31] (Bill & Melinda Gates Foundation, 2013)
[32] (RTI International, 2012, p. 25)
[33] (RTI International, Can Tho University, 2012)
[34] (Robbins D. , Interview with Dave Robbins on Using Coco Peat to Develop Low-Cost Waste Water Treatment, 2012)
[35] (RTI International, 2012, p. 25)
[36] (Sherman, 2006)

II. DECENTRALIZED WASTE WATER TREATMENT IN THE PHILIPPINES

SANITATION SECTOR OVERVIEW

In urban areas throughout the Philippines, there is high access to sanitation services but low access to waste water treatment. Over 95% of the urban population has access to sewerage, septic tanks, or other on site collection facilities; however, less than 14% of total urban sewage is being safely treated.[37] Figure 2 details the current state of waste water collection and treatment in the Philippines.

Figure 2: Waste Water and Septage Flow in Urban Philippines[38]



Source: East Asia and the Pacific Region Urban Sanitation Review, World Bank 2012.

Several regulatory, technological, cultural, and economic factors frame the institutional landscape for the sanitation sector in the Philippines. These factors have both enhanced and hindered the implementation of DEWATS projects throughout the Philippines. Through both a literature review of the Philippines sanitation sector and a DEWATS case study analysis, I assessed the most significant institutional factors related to implementing DEWATS projects.

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[37] (Kearton, et al., 2013)
[38] (Kearton, et al., 2013)

Legislation & Policy

The sanitation subsector is guided by several laws and regulations that govern effluent discharge standards, sanitation policies, and agencies responsible for carrying out these laws. As they pertain to DEWATS, these include the following notable legislation:

Provincial Water Utilities Act of 1973[39]	This act established local Water Districts as the prime authorities responsible for providing and maintaining urban water supply and sanitation outside of Metro Manila.
Revised Effluent Regulations of 1990[40]	This law established national effluent discharge standards for sanitation systems.
Local Government Code of 1991[41]	This code divided the local Philippines government into three administrative levels of local government units (LGUs): provinces, municipalities, and barangays[42]. LGUs are charged with the authority to establish local sanitation regulations and enforcement mechanisms to support national standards.
Clean Water Act of 2004[43]	This act established regulations prohibiting the dumping of untreated waste water into the ground and bodies of water. The act calls for all waste water pollution to be discharged via a sewer system or DEWATS. This law also mandates that LGUs share in the management and improvement of water quality standards within their jurisdiction.

Government Agencies

Department of Environment and Natural Resources (DENR)[44]	DENR is responsible for defining and regulating effluent discharge standards for waste water. Regional offices provide assistance and technical support to LGUS, Water Districts, and other stakeholders to develop action plans in support of the Clean Water Act.

[39] (Government of the Philippines, 2012)
[40] (Government of the Philippines, 1990)
[41] (Department of Interior and Local Government, 2010)
[42] The barangay is the lowest level of government administration in the Philippines. The barangay can be considered close to the equivalent of a "village," "district," or "ward."
[43] (Congress of the Philippines, 2004)
[44] (Department of Environmental and Natural Resources, 2014)

Department of Interior and Local Government (DILG)[45]	DILG defines policies, and performance standards for LGU capacity building programs. DILG also assists LGUs in preparing action plans, accessing finance, and facilitating sanitation project plans.
Department of Public Works and Highways (DPWH)[46]	DPWH helps to set long term goals for sanitation spending, program objectives, and provision of septage services. DPWH is the lead authority for developing the National Sewerage & Septage Management Plan (NSSMP) with national targets for pollution reduction, service provision, and access to sanitation by 2020.
Local Government Units (LGUs)[47]	These government units are organized from the city level to the community (barangay) level to administer sanitation management, provide services and enforce policies for residents. LGUs are responsible for financing, planning, and regulating water and sanitation services.
Local Water Utilities Administration (LWUA)[48]	LWUA is a specialized lending institution that provides financial and technical assistance for the development, administration, and regulation of local Water Districts in partnership with LGUS.
National Economic Development Authority (NEDA)[49]	NEDA is the key agency for policy formulation, coordination, and planning for the sanitation sector. Responsibility for monitoring and evaluation of national septage management programs also resides with NEDA.
National Water and Sanitation Association of the Philippines (NAWASA)[50]	NAWASA is an organization of small scale private service sanitation operators with the intent of collaborating on best practices to improve service delivery and promote community involvement.
Philippine Center for Water and Sanitation (PCWS)[51]	PCWS serves as a research organization and provides technical services to local governments for implementing low cost water and sanitation systems within communities.

[45] (Department of Interior and Local Government, 2010)
[46] (Department of Public Works and Highways, 2014)
[47] (Department of Interior and Local Government, 2010)
[48] (Local Water Utilities Administration, 2011)
[49] (Republic of The Philippines National Economic and Development Authority, 2013)
[50] (Philippine Water Partnership, 2010)
[51] (Philippine Center for Water and Sanitation, 2014)

Water Districts[52]	Water Districts serve as a separate legal entity from LGUs with the authority to regulate water supply and sanitation services.

Non-Governmental Organizations

Asian Development Bank (ADB)[53]	ABD provides loan financing, grant financing, and technical assistance for DEWATS projects. ADB also partners with LGUs and other external agencies to provide institutional strengthening to meet sanitation infrastructure needs.
Bremen Overseas Research and Development Association (BORDA)[54]	BORDA assists in developing sustainable sanitation solutions through partnerships with LGUs and other supporting agencies to deliver quality standards, implementation measurement, research, technical assistance, and training for DEWATS projects.
German Technical Cooperation Agency (GTZ)[55]	GTZ provides technical assistance, training, and infrastructure development in areas lacking access to improved sanitation. GTZ aids LGUs to improve policies and governance around sanitation and introduce low cost sanitation options.
Philippine Center for Water and Sanitation (PCWS)[56]	PCWS serves as a research organization and provides technical services to local governments for implementing low cost water and sanitation systems within communities.
USAID[57]	USAID provides technical assistance of DEWATs projects and promotes social marketing programs to educate and train community members in the health benefits of improved sanitation. USAID contributes both loan and grant financing to support LGUs in attaining Millennium Development Goals. USAID partnered with multiple stakeholders, government agencies, and external agencies for a four year project to help implement the Clean Water Act.

[52] (Government of the Philippines, 2012)
[53] (Asian Development Bank, 2013)
[54] (Bremen Overseas Research and Development Association, 2014)
[55] (Asian Development Bank, 2013)
[56] (Philippine Center for Water and Sanitation, 2014)
[57] (AECOM, 2014)

World Bank[58]	World Bank supports localized sanitation infrastructure projects through direct engagement with LGUs community-based organizations, and the private sector. Several DEWATs projects have been implemented with technical assistance support, loan financing, and grant financing from the World Bank.

Technology Factors

The primary storage and treatment technology used is the septic tank. 84% of households in urban areas discharge waste water to a septic tank.[59] Despite this relatively high access to sanitation, the design, construction, and maintenance of these septic tanks remains suboptimal. Septic tanks are often inaccessible and/or improperly maintained resulting in overflows to open drainage systems rather than via a secondary treatment facility (e.g., constructed wetland, media filter, etc.).

Secondary treatment systems have become more prevalent in recent years as health standards and improved low cost technology have emerged. The most common secondary treatment systems include constructed wetlands, reed beds, anaerobic baffled reactors, rotating biological contactors, activated sludge, and other filtration media. These technologies allow for aerobic and anaerobic digestion of harmful waste water components prior to effluent discharge to the ground or surrounding bodies of water.

DEWATS have been successful alternatives to city wide sewerage systems in urban areas due to low cost designs, high efficiency, and adaptable configurations based on individual site requirements. Sanitation technology improvements and DEWATS innovations have been spurred by external organizations such as the Bill & Melinda Gates Foundation's Sanitation and Hygiene initiative campaign with the goal of providing low cost, simple waste water treatment, collection, and reuse technology at the cost of less than 5 cents per user per day.

Social, Cultural & Economic Factors

Significant pressure has been placed on creating sustainable infrastructure due to the rapid population growth and urbanization within the Philippines. Between 2000 and 2010, the population increased by 1.9% per year, on average, with most growth in urban areas.[60] Population in urban areas is projected to grow even more rapidly, by as much as 67%, between 2010 and 2030. Urban expansion and job opportunities have fueled the Philippine economy,

[58] (Asian Development Bank, 2013)
[59] (Asian Development Bank, 2013)
[60] (Asian Development Bank, 2013)

growing 4.64% per year between 2007 and 2011.[61] Despite rapid economic and population growth, there remains a disparity in sanitation services and infrastructure investments between urban poor communities and middle income communities.

Sanitation spending has been a low priority for both local governments and residents in the Philippines. On average, only 3% of total spending allocated to water and sanitation is spent on sanitation improvement. The majority of the total funding is directed toward improving water supply sources and infrastructure. Local governments, therefore, receive relatively few subsidies to improve sanitation infrastructure.

There is poor education about the health benefits associated with improved sanitation infrastructure. Thus, there is a lower consumer willingness to pay for improved sanitation technology. Many stakeholders associate having a septic tank with adequate sanitation and thus are not proactive about paying for desludging services or demanding improved treatment systems. LGUs acknowledge the importance of sanitation education, but given the low fiscal priority attention to sanitation is often limited. When education is led by LGUs, training is generally limited to basic health education about the relationship between clean water, sanitation awareness and proper hygiene practices.[62]

NGOs have been instrumental partners in filling this education gap through sanitation marketing programs. In addition to basic sanitation education, sanitation marketing programs aim to enhance community involvement and demand for improved sanitation systems. These programs include stakeholders throughout the community to determine the specific sanitation requirements, select appropriate DEWATS configurations, meet financial constraints, and encourage social acceptance of new technologies. Through a strategic marketing mix, social campaigns, and key community partnerships, these programs have enhanced DEWATS projects, increased consumer willingness to pay, and reduced project costs through higher community participation.[63]

Key Risks & Constraints

Given the current sanitation sector landscape, there are significant institutional risks and constraints related to implementing successful DEWATS projects. These risks and constraints are detailed in Table 2.

[61] (Asian Development Bank, 2013)
[62] (Water and Santiation Program, 2011)
[63] (Sustainable Sanitation Alliance, 2010)

Table 2: Key Risks & Constraints for DEWATS in the Philippines

Risk/Constraint	Description	Consequence	Mitigation
Site Risks			
Space Constraints	Risk of inability to service demand due to land constraints	Delay and cost	Selection of DEWATS components with small footprint
Design, Construction & Commissioning Risks			
Design	Risk that the design of DEWATS is incapable of providing services at desired cost	Long term increases in investment and operating costs	Implementation leader (typically a subject matter expert from the private sector or an NGO) works in coordination with LGU to approve all plans, construction and subcontracting
Construction	Risk that circumstances will prevent DEWATS from being delivered on time and at budget	Delay and increased cost	Implementation leader and LGU enter into a fixed price guarantee for baseline construction services
Financial Risks			
Access to Financing	Risk that loan/grant funding will not be available	Delays or cancellation of construction and/or cost increases	LGU pursues multiple sources of financing
Follow-on Financing	Risk that follow-on financing will be unavailable should cost overruns occur mid construction	No funding to continue construction, increased costs, and higher cost of capital	LGU secures guarantees for various sources of financing above initial projected costs
Payback Period	Risk that long pay-back period will be unattractive to LGUs	Delays or cancellation of construction	LGU seeks alternative sources of financing and quantifies economic benefits to support DEWATS implementation
Sector Investment	Risk of low private and public investments in DEWATS due to mismatch of cost burden bearers and beneficiaries	Inadequate funding to meet demand requirements	LGU enforces sanitation laws to drive participation and awareness
Economic Risks			
Benefit to Cost Ratio (BCR)	Risk of low benefit to cost ratio for small incremental movements up sanitation ladder	Low return for financial investment	Prioritize selection of projects that maximize BCR
Consumer Willingness to Pay (WTP)	Risk of low WTP for sanitation infrastructure and services is low for direct users	Lower NPV of DEWATS projects and longer payback	Seek low cost DEWATS technology and increase WTP through participatory social marketing engagements

Risk/Constraint	Description	Consequence	Mitigation
Operating Risks			
Inputs	Risk that required inputs and costs will be greater than anticipated	Lower benefit to cost ratio	Source long term supply contracts to manage costs
Demand	Risk that users will not use DEWATS	Lower benefit to cost ratio	LGU and NGOs use marketing and promotional strategies to enhance demand
Operating & Maintenance	Risk that design and construction quality is inadequate resulting in higher than anticipated maintenance and refurbishment cost	Higher maintenance costs	Implementing agency establishes and enforces a routine maintenance plan to maintain system integrity
Environmental Risks			
Sanitation Access & Coverage	Risk that inconsistent DEWATS within a LGU or in adjacent LGU will be suboptimal and not address site and input constraints	Lower benefit to cost ratio, increased construction costs	LGUs and implementing agencies adequately assess sites and inputs to deliver optimal DEWATS
Discharges to Ground & Water Sources	Risk that sanitation system will not properly collect and treat harmful waste water	Lower benefit to cost ratio	LGU and NGOs use marketing and promotional strategies to enhance demand for improved sanitation
Cultural Risks			
Education	Risk that poor education about sanitation benefits will lead to non-use or improper maintenance	Non-use of system and health consequences	LGU and NGOs use marketing and promotional strategies to enhance demand for improved sanitation
Legislative & Government Policy Risks			
Priority for Sanitation Services	Risk that Sanitation Infrastructure investments will be displaced by competing infrastructure needs	Project delays, inadequate coverage	Partner with additional funding agencies to seek additional financing
Policy Enforcement	Risk that Government will not implement fee collection or enforce sanitation regulations	Lower NPV, poor quality control	Partner with external agency for capacity building and project finance structuring
Technical Expertise	Risk that implementing authority does not hold technical expertise and authority for a successful project	Delay and/or low quality implementation	Partner with NGO or supporting agency with domain knowledge
Delineation of Responsibilities	Risk that overlapping responsibilities and weak sector planning fosters delays and inefficiencies in DEWATS implementation	Delays in implementation, poor governance	LGU and other partners need to clearly define roles and responsibilities at project onset.
Policy Changes	Risk that changes in sanitation policies may shift authority for sanitation financing and administration to other governing units	Delays in implementation, financing restrictions	Seek additional sources of financing from external supporting agencies

III. CASE STUDY ANALYSIS OF DEWATS FINANCING MODELS

DATA & METHODOLOGY

Scope of Analysis & Search Criteria

Several sanitation interventions have been implemented throughout the Philippines across multiple demographics and environments. I sought out case studies that specifically focused on DEWATS interventions with outcomes related to improvement of effluent waste water parameters such as Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), and Fecal Coliform levels.

I performed a broad search of multiple economic, sanitation, and international development journals for relevant studies. I also searched through working papers from multiple research institutes, universities, and international governance organizations. My primary aim was to find studies that had well documented costs, well documented results, and implementation lessons learned. From my search, I identified over 100 potentially relevant studies using Boolean searches of the following key terms: *Water Sanitation, Health Impact, Philippines, DEWATS, Waste Treatment System, Water, Sanitation, Sewage, Costs, Impact, and Case Study*.

Studies were rejected if they did not meet the following criteria:

- Project was completed in the last 15 years
- Economic benefit to cost ratio >1
- Project was completed in an urban setting
- Intervention related to a decentralized waste water treatment system
- Project was completed in the Philippines
- Intervention included secondary waste water treatment components
- Project included well documented costs, beneficiaries, and lessons learned

Summary of Studies

A total of 28 case studies met the inclusion criteria and are included in Appendix 4. These case studies were published between 2007 and 2013 with projects completed from 2005 to 2012. Studies focused on DEWATS systems implemented for communities of households, slaughterhouses, schools, universities, public markets, public buildings, and one jail. Each case study is characterized by the chief stakeholder responsible for leading the project implementation; 1) Private Participation, 2) Local Government, 3) NGO and 4) Community Participation. In all of the selected cases, some combination of partnership between the public sector, private sector, and NGOs was employed to implement successful projects. Although the intervention methods vary across all of the studies, the expected overall economic impact is positive for each case. For each case, health and economic impacts are not directly measured. As a proxy for health and economic impacts, improved water quality outputs and the number of direct beneficiaries serve as indicators for successful implementations. A summary of the 28 case studies examined in this analysis is detailed in Table 3.

Table 3: Summary of Case Study Characteristics

Summary Characteristics	**Number of Case Studies**
Model Classification	
Private Participation Model	4
NGO Model	5
Local Government Model	13
Community Participation Model	6
Chief Beneficiary	
Community Buildings, Households	10
Hospital	2
Public Market	7
Slaughterhouse	4
Other	3
Year Project Completed	
2005 – 2010	15
after 2010	13
Capital Investment Cost	
< $100,000	18
$100,000 – 500,000	8
> $500,000	2

COMPARATIVE CASE STUDY ANALYSIS

From the studies that met the inclusion criteria, I selected 4 case studies that were the most representative models of DEWATS implementation and financing approaches. These 4 cases highlight typical financial risk distribution and burden among the key stakeholders for each approach; private participation model, local government model, NGO model, and community participation. These cost distributions are used as base cases to highlight possible financing structures for a cocopeat filter DEWATS project in the next section. Table 4 details the 4 case studies used as base case financing structures.

Table 4: Selected DEWATS Base Case Study Models

Case Study	Location	Approach	Chief Beneficiaries	Chief Risk Partner
Preserving Water Quality for Iloilo City Mission Hospital[64]	Iloilo City	Private Participation	Hospital Staff and Patients	Iloilo Mission Hospital
Implementing a Septage Treatment Plant in Dumaguete City[65]	Dumaguete City	Community Participation	Community Households	Community Residents
Constructed Wetland for a Peri-urban Housing Area[66]	Bayawan City	Local Government	Community Households	City of Bayawan
Decentralized Waste Water Treatment Facility for the Lilo-an Public Market[67]	Lilo-an	NGO	Public Market Vendors and Users	Asian Development Bank

Private Participation Model

In this approach, a private entity such as a school, university, jail, or hospital finances the DEWATS project. The impetus for commencing the project is usually driven by regulatory pressure to meet effluent discharge standards. Among the case studies using this approach, capital investments financed by the private sector ranged from 50% to 90% with the median at 85% for the selected case study. In all case studies, the private sector contributed 100% toward ongoing operations and maintenance costs. While the private entity is the main implementing and financing stakeholder, there is often collaboration with the LGU to assist with meeting regulatory requirements. NGOs are consulted for technical assistance, construction, and implementation of training programs. In some cases, LGUs have partnered with the private sector to drive awareness for improved sanitation and replicate successful private sector projects with other local businesses.

NGO Model

In this approach, a non-governmental organization is the primary financing partner for a particular DEWATS project. Among the case studies using this approach, capital investments financed by NGOs ranged from 60% to 80% with the median at 67% for the selected case study.

64 (PADCO, 2006)
65 (PADCO, 2006)
66 (Sustainable Sanitation Alliance, 2010)
67 (König, 2006)

In most cases, routine maintenance and ongoing costs are passed on to the local government at project completion. Implementation efforts are usually carried out very closely with the LGU to build capacity and conduct system training. An NGO is typically also included in these projects to conduct technical assessments and determine the most appropriate DEWATS design based on input and site configurations.

Local Government Model

In this approach, the LGU or Water District is the primary financing partner for a particular DEWATS project. Among the case studies using this approach, capital investments financed by LGUs ranged from 75% to 100% with the median at 97% for the selected case study. In all case studies, the LGU contributed 100% toward ongoing operations and maintenance costs. In most cases, the LGU either contracted technical assistance and construction from local providers or sought assistance from NGOs for site design and implementation guidance. Initial project costs were most often financed through the LGU coffers, loan financing, and subsidies. Ongoing maintenance costs and loan repayments are often passed onto community residents as a fixed user fee or as a percentage of their water supply fee.

Community Participation Model

In this approach, community residents are the main implementing and financing partners for sanitation projects. NGOs are typically the driving impetus for spurring action within communities by creating forums and social awareness programs about improved sanitation benefits. Among the case studies using this approach, capital investments financed via community participation ranged from 75% to 95% with the median at 91% for the selected case study. Community stakeholders are given training to make informed decisions regarding appropriate DEWATS technology and appropriate financing programs. Community stakeholders are direct participants in the consulting, decision making, financing, construction, and maintenance of DEWATS projects. LGUs are typically responsible for collecting user fees and dispersing funds for capital and operations & maintenance expenses.

Table 5: Cost Allocation for Selected DEWATS Implementation Models

Cost Burden	**Private Participation Model**	**NGO Model**	**Local Government Model**	**Community Participation Model**
Private Sector	**85% (50-90%)**	0% (0%)	0% (0%)	0% (0%)
NGO	14% (5-20%)	**67% (60-80%)**	2% (2-10%)	9% (5-25%)
Local Government	1% (0-40%)	33% (20-40%)	**97% (75-100%)**	0% (0-20%)
Community / Direct Users	0% (0%)	0% (0%)	0% (0-10%)	**91% (75-95%)**

Comparison of Model Risks and Benefits

Each DEWATS model faces risks to implementation within the current Philippines operating environment. Given the risk factors identified in the landscape analysis and a study of lessons learned from the selected cases, a qualitative analysis of each approach is examined in Table 6 to compare the relative strengths and weaknesses of each implementation model.

Table 6: Ability to Address Institutional Risks by Implementation Model

	Implementation Approach			
Risk/Constraint	*Private Part. Model*	*Local Govt. Model*	*NGO Model*	*Community Part. Model*
Site Risks				
• Space Constraints	✅	✅	✅	✅
Design, Construction & Commissioning Risks				
• Design	⊖	❌	✅	❌
• Construction	⊖	❌	✅	❌
Financial Risks				
• Access to Financing	✅	⊖	✅	⊖
• Follow-on Financing	✅	⊖	✅	⊖
• Payback Period	✅	❌	⊖	✅
• Sector Investment	❌	❌	❌	❌
Economic Risks				
• Benefit to Cost Ratio (BCR)	✅	⊖	✅	✅
• Consumer Willingness to Pay (WTP)	❌	⊖	⊖	✅
Operating Risks				
• Inputs	⊖	⊖	⊖	⊖
• Demand	⊖	⊖	⊖	⊖
• Operating & Maintenance	⊖	⊖	⊖	⊖
Environmental Risks				
• Sanitation Access & Coverage	❌	✅	✅	✅
• Discharges to Ground & Water Sources	✅	✅	✅	✅
Cultural Risks				
• Education	❌	⊖	✅	✅
Legislative & Government Policy Risks				
• Priority for Sanitation Services	❌	⊖	✅	⊖
• Policy Enforcement	❌	⊖	❌	⊖
• Technical Expertise	❌	❌	✅	⊖
• Delineation of Responsibilities	✅	⊖	✅	⊖
• Policy Changes	⊖	⊖	⊖	⊖

✅ *Strong Ability to Address Risk*
⊖ *Moderate Ability to Address Risk*
❌ *Weak Ability to Address Risk*

IV. ANALYSIS OF FINANCING MODELS FOR A COCOPEAT FILTER

COCOPEAT FILTER BASE CASE COST MODEL

In 2006, a DEWATS system was implemented for the Muntinlupa Public Market to collect and treat waste water containing organic material, suspended solids, fats, oils, grease, and excreta. Prior to system implementation, untreated waste water flowed directly from the market to rivers and lakes that are primary drinking water supply sources for Metro Manila. While the City of Muntinlupa was the main financing and implementation partner, USAID, the Muntinlupa Market Vendors Association, and other supporting agencies were integral to project success.[68]

This case study is significant because a cocopeat filter was used in the final selected DEWATS design allowing for a detailed breakdown of costs. A constructed wetland was also considered as a secondary waste water treatment option but a cocopeat filter was selected for due to space constraints, lower capital costs, and lower O&M costs.

I selected this case study to serve as a base case to compare a DEWATS implementation using a cocopeat filter and a constructed wetland (a comparable secondary treatment option in terms of waste water treatment efficiency). Additionally, this case is used to evaluate cost distributions under the 4 implementation models. A table of parameters and the base case financial cost analysis are detailed in Appendix 5 and 6.

Economic impacts of improved sanitation are estimated for health costs averted, productivity costs averted, mortality costs averted, water access cost savings, water reuse savings, water treatment cost savings, excreta reuse, and access time. These parameters are estimated based on a recent study by the World Bank assessing the economic benefits from improved sanitation services in urban settings using DEWATS.[69] These key economic benefits are characterized below:

- *Health Cost Savings* – the costs include the pain and burden due to illnesses associated with poor sanitation. On average, these annual costs are estimated to be $34.90 per direct beneficiary.

- *Productivity Cost Savings* – these costs include individual or household income losses from illnesses attributable to poor sanitation. On average, these annual costs are estimated to be $24.62 per direct beneficiary.

[68] (Sacendoncillo & de Pano, 2007)
[69] (Water and Santiation Program, 2011)

- *Water Access Cost Savings* – these costs include the time required for individuals to seek out and transport clean water supply sources. On average, these annual costs are estimated to be $8.06 per direct beneficiary.

- *Water Reuse Savings* – these costs include the water savings due to repurposing treated effluent water rather than discharging to ground sources. The annual costs vary depending on the treatment system.

- *Water Treatment Cost Savings* – these costs include the time and resources required for individuals to treat polluted water and make it safe for consumption. On average, these annual costs are estimated to be $1.70 per direct beneficiary.

- *Excreta Reuse* – this includes the benefits associated with using urine and human excreta as fertilizer following treatment. On average, these annual benefits are estimated to be $11.02 per direct beneficiary.

- *Access Time Savings* – these costs include the travel and waiting time necessary for individuals to defecate in communities without toilets or improved sanitation systems. On average, these annual costs are estimated to be $34.00 per direct beneficiary.

COCOPEAT FILTER VS A CONSTRUCTED WETLAND

A cocopeat filter is able to filter waste water with the same efficiency as a constructed wetland at a fraction of the cost and space requirements. Using data from the Muntinlupa Market case study, I conducted a quantitative net present value (NPV) analysis to assess the financial cost difference and value for each technology.

Assumptions

The Muntinlupa Market case study details many of the financial parameters necessary for a comprehensive NPV model; however, some assumptions were required to complete this analysis. Specifically, the following assumptions are built into this model:

- The construction cost of a cocopeat filter is approximately 70% of cost of a constructed wetland[70].
- A cocopeat filter occupies one tenth of the land required for a constructed wetland[71].

[70] (Robbins D. , Addressing Site Constraints through Cocopeat System Design, 2012)

- No additional land costs are required using the cocopeat filter configuration.
- Economic benefits are approximately the same for a system using either a cocopeat filter or a constructed wetland with the exception of additional water reuse savings associated with cocopeat filter.
- Economic benefits are based on the number of direct users (1448 market stall users).
- Stall user fees are maintained constant at $0.11 per stall per month in each model.

Analysis

A financial and economic analysis of the benefits and costs of the DEWATS project for both a cocopeat filter and a constructed wetland is detailed in Table 7. These figures are based on 2006 pro-forma financial projections detailed in the Muntinlupa Market case study and an economic study conducted by the World Bank. From these initial figures, reasonable assumptions are included to project the financial and economic impact over a 20 year lifespan.

The financial analysis reveals a positive net present value (including stall user fees) of $216K for the constructed wetland system and $293K for the cocopeat filter system. The additional economic benefits also support a positive overall impact on the local economy with a NPV of $1,887K for the constructed wetland and $1,925K for the cocopeat filter. Appendices 7 and 8 give a detailed year by analysis for each scenario.

Using a cocopeat filter in lieu of a constructed wetland is supported in terms of time savings, economic return, space constraints, and construction time. Table 8 details a comparison of a constructed wetland vs. a cocopeat filter.

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[71] (Sacendoncillo & de Pano, 2007)

Table 7: Cost Comparison of a Constructed Wetland vs. a Cocopeat Filter

Financial Analysis	**Constructed Wetland**	**Cocopeat Filter**
Revenue	**NPV**	**NPV**
Stall User Fees	616,464	616,464
Total Revenue	**616,464**	**616,464**
		-
Expenses		-
Technical assistance	25,000	25,000
System Construction Costs	87,000	87,000
Estimated Cocopeat Filter Cost	-	43,000
Estimated Constructed Wetland Cost	61,428	-
Estimated Land Costs	58,572	-
Social Marketing Plan	12,936	12,936
Operations and Maintenance	78,891	78,891
Electrical Costs	34,122	34,122
Water Consumption	42,648	42,648
Total Expenses	**400,597**	**323,597**
Net Revenue	**215,866**	**292,866**
Economic Analysis		
Economic Impact Benefits		
Health Care Costs Averted	535,855	535,855
Productivity Costs Averted	378,016	378,016
Mortality Costs Averted	132,045	132,045
Water Access Cost Savings	123,753	123,753
Water Reuse Electricity Savings	-	38,173
Water Treatment Cost Savings	26,102	26,102
Access Time	522,036	522,036
Excreta Reuse	169,201	169,201
Total Benefits	**1,887,008**	**1,925,181**

Table 8: Comparison of Secondary Treatment Options for Muntinlupa Market

	Cocopeat Filter	**Constructed Wetland**
Construction Costs	$43,000	$61,000
Incremental Land Cost	-	$59,000
Operation & Maintenance Costs	$175	$175
Land Requirement	150 m^3	1,500 m^3
Benefit to Cost Ratio (BCR)	5.8	4.7
Time to Recoup Investment Costs	3.5 years	6 years
User Fee Required to Recoup Investment Costs in 3.5 Years	$0.11 per stall per month	$0.17 per stall per month
Estimated Economic Benefits (NPV)	$1,887,000	$1,887,000
Estimated Time to Build	2-4 weeks	8-12 weeks

COCOPEAT FILTER FINANCED UNDER DIFFERENT MODELS

Using the base case financial costs from the base case Muntinlupa Market case study, I created cost distribution models to analyze the costs under the various implementation models.

Assumptions

To ensure comparability among the 4 implementation models, I made the additional following assumptions:

- Total economic benefits to the end users are held constant ($1.9M) for each model with constant distribution of externalities across key stakeholder. Table 9 details these economic benefit allocations.
- Total financial costs are held constant ($324K)

Table 9: Allocation of Externalities to Key Stakeholders for a Cocopeat Filter

		Allocation of Externalities			
	Externalities	Stall Owners	Market Users	City Residents	Local Gov
Benefits					
Health Care Costs Averted	535,855	-	-	535,855	-
Productivity Costs Averted	378,016	-	378,016		-
Mortality Costs Averted	132,045	-	-	132,045	-
Water Access Cost Savings	123,753	123,753	-	-	-
Water Reuse Electricity Savings	38,173	38,173	-	-	-
Water Treatment Cost Savings	26,102	-	26,102	-	-
Access Time	522,036	-	522,036	-	-
Excreta Reuse	169,201	-	-	-	169,201
Total Benefits	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**

Analysis

Using the Private Participation Model, the private sector bears 88% of the financial costs. Given the structure of Muntinlupa Market, these costs would likely be borne by the vendors association. This structure is detailed in Table 10.

Table 10: Cost Allocation Using the Private Participation Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)
Costs						
Technical Assistance Costs	25,000	-	25,000	-	-	-
System Construction Costs	87,000	87,000	-	-	-	-
Estimated Cocopeat Filter Costs	43,000	43,000	-	-	-	-
Social Marketing Plan	12,936	-	9,055	3,881	-	-
Operations and Maintenance	78,891	78,891	-	-	-	-
Electrical Costs	34,122	34,122	-	-	-	-
Water Consumption	42,648	42,648	-	-	-	-
Total Costs	**323,597**	**285,661**	**34,055**	**3,881**	**-**	**-**

Using the NGO Model, the implementing NGO bears 52% of the overall cost. After the construction phase, the LGU would assume remaining maintenance and operation costs as detailed in Table 11.

Table 11: Cost Allocation Using the NGO Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)
Costs						
Technical Assistance Costs	25,000	-	25,000	-	-	-
System Construction Costs	87,000	-	87,000	-	-	-
Estimated Cocopeat Filter Costs	43,000	-	43,000	-	-	-
Social Marketing Plan	12,936	-	12,936	-	-	-
Operations and Maintenance	78,891	-	-	78,891	-	-
Electrical Costs	34,122	-	-	34,122	-	-
Water Consumption	42,648	-	-	42,648	-	-
Total Costs	**323,597**	**-**	**167,936**	**155,661**	**-**	**-**

Using the Local Government Model, the LGU bears 89% of the costs including construction and O&M. The remaining 11% is borne by a partner NGO related to financing technical assistance and social marketing support. This cost distribution is detailed in Table 12.

Table 12: Cost Allocation Using the Local Government Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)
Costs						
Technical Assistance Costs	25,000	-	25,000	-	-	-
System Construction Costs	87,000	-	-	87,000	-	-
Estimated Cocopeat Filter Costs	43,000	-	-	43,000	-	-
Social Marketing Plan	12,936	-	9,055	3,881	-	-
Operations and Maintenance	78,891	-	-	78,891	-	-
Electrical Costs	34,122	-	-	34,122	-	-
Water Consumption	42,648	-	-	42,648	-	-
Total Costs	**323,597**	**-**	**34,055**	**289,542**	**-**	**-**

Using the Community Participation Model, the resident market stall owners bear 88% of the costs with the remaining costs absorbed by the LGU and partner NGO. This cost distribution is detailed in Table 13.

Table 13: Cost Allocation Using the Community Participation Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)
Costs						
Technical Assistance Costs	25,000	-	25,000	-	-	-
System Construction Costs	87,000	-	-	-	87,000	-
Estimated Cocopeat Filter Costs	43,000	-	-	-	43,000	-
Social Marketing Plan	12,936	-	9,055	3,881	-	-
Operations and Maintenance	78,891	-	-	-	78,891	-
Electrical Costs	34,122	-	-	-	34,122	-
Water Consumption	42,648	-	-	-	42,648	-
Total Costs	**323,597**	**-**	**34,055**	**3,881**	**285,661**	**-**

V. DISCUSSION & CONCLUSION

Four implementation models were analyzed for RTI to consider; the private participation model, the NGO model, the local government model, and the community participation model.

The Community Participation Model shows great promise for delivering suitable technology to end users with technical assistance from NGOs. This model helps drive ownership by community stakeholders, increases consumer willingness to pay, and best aligns cost bearers and direct beneficiaries. Additionally, since many DEWATS are maintained through user fees, there is limited involvement with the LGU.

The Local Government Model is slow to implement due to multiple overlapping bureaucratic institutions with an unclear delineation of responsibilities. This often results in inefficient collection and disbursement of funds necessary for project construction. Given that LGUs do not possess requisite technical expertise, additional external support is often required to implement successful DEWATS projects.

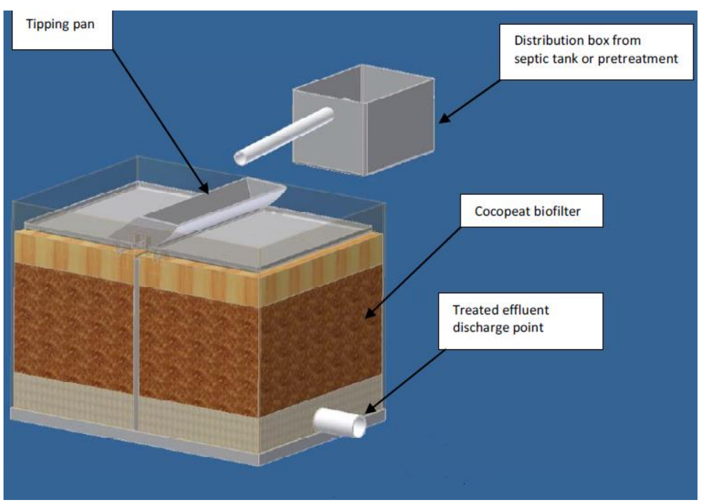
The Private Participation Model is relatively quick to implement due to limited involvement with the LGU. This model shows great promise for streamlining financing and quick implementation. NGO assistance is often still necessary for a successful technical integration. Space constraints for private institutions also drive the need for alternative secondary waste water treatment technologies such as cocopeat filters.

The NGO Model has been successful in driving DEWATS projects since funding, implementation, and technical guidance all reside with the NGO. This may result in limited ownership responsibility or uptake from community members upon project hand off. Typically, following construction, NGOs provide operations and maintenance training to community members and the LGU.

In each model analyzed, a key driver for success is employing a sanitation social marketing program in conjunction with a DEWATS project. These programs are important for community engagement, project cost reduction, and increasing consumer willingness to pay. The expertise for these programs typically resides with NGOs. Generally, LGUs and private sector participants lack funding and the requisite knowledge to be primary implementation agents for these campaigns. In particular, USAID, BORDA, GTZ, and PCWS have been key NGOs for incorporating social marketing campaigns across the Philippines. Support from these NGOs across multiple projects has been a key factor to ensuring replicable and sustainable DEWATS projects.

RTI could pursue Community Participation models for implementing cocopeat filter DEWATS projects with support from local government units (LGUs) and NGOs. This model shows the most promise for mitigating institutional risks, promoting awareness of sanitation benefits, driving ownership by end users, and enabling technology adoption. Given that technical implementation, social marketing, and sanitation training expertise resides predominantly with NGOs, RTI should also continue to promote the benefits of cocopeat filter technology through these subject matter experts.

Appendix 1: Example Cocopeat Filter System[lxxii]



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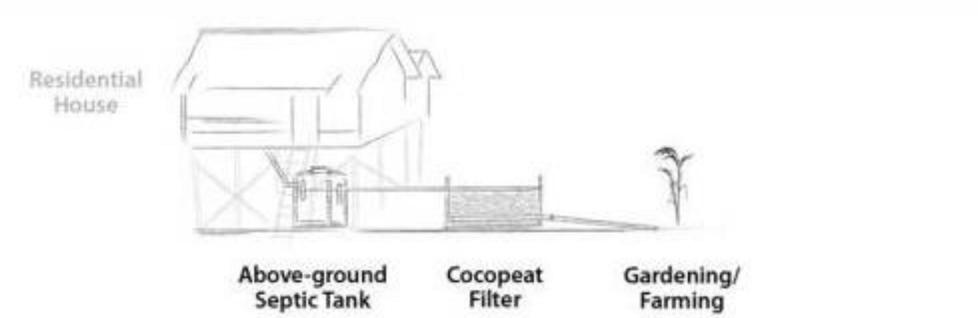
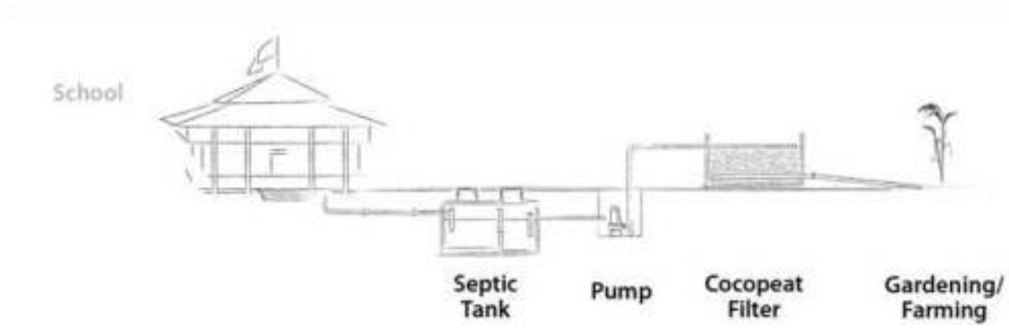
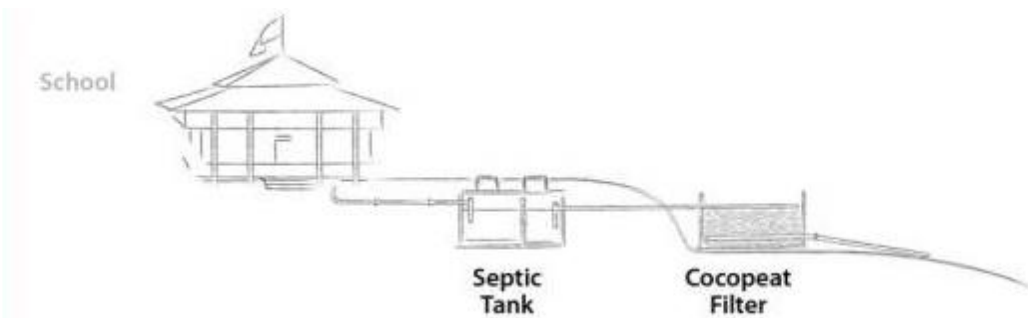
lxxii (Robbins D. , Addressing Site Constraints through Cocopeat System Design, 2012)

Appendix 2: Sample Cocopeat Filter Configurations[lxxiii]







[lxxiii] (Robbins D. , Addressing Site Constraints through Cocopeat System Design, 2012)

Appendix 3: Significant Parameters Compared with Water Effluent Standards

Parameters	Unit	Cocopeat Filter Sample Results[74]		Philippines Water Standards[75]	
		Influent Range	Effluent Range	Class C	Class D
pH	-	6.32-6.38	7.47-7.70	**6.0-9.5**	**5.5-9.5**
DO	mgO_2/L	1.15-3.20	3.3-5.0	**No Standard**	**No Standard**
TSS	mg/L	74-122	4-24	**150**	**250**
COD	mg/L	428.57-600	115.2-190	**175**	**350**
BOD	mg/L	146-250	20.0-29.6	**80**	**200**
N_{TKN}	mg/L	25.2-60.2	5.24-12.6	**No Standard**	**No Standard**
NH_4^+	mg/L	16.24-22.4	1.96-4.48	**0.9**	**13.0**
NO_3^-	mg/L	0.22-17.46	0.21-3.69	**24**	**50**
Total Phosphates	mg/L	0.03-14.28	0.02-3.36	**2**	**15**
Total Coliform	MPN/100mL	$4.6*10^5$-$4.6*10^7$	$3.9*10^2$-$9.3*10^2$	**15,000**	**25,000**
Fecal Coliform	MPN/100mL	$4.6*10^4$-$1.1*10^7$	30-40	**400**	**800**

Class C Standards
1. Fishery Water for the propagation and growth of fish and other aquatic resources
2. Recreational Water Class II (for boating, fishing, etc.)
3. Agriculture, irrigation, and livestock watering

Class D Standards
1. Industrial Water Supply (for manufacturing processes after treatment, cooling, etc.)
2. Navigation and other similar uses

[74] (RTI International, Can Tho University, 2012)
[75] (Government of the Philippines, 1990)

Appendix 4: Summary of Selected DEWATS Case Studies

Name of Study	Location	Project Summary	Model Type	Implementation & Financing Partners	Chief Risk Partner	Estimated Individuals Impacted	Unit Type	Year Completed	Capital Investment Cost
Ecosan Projects in San Fernando City, Province of La Union[76]	San Fernando City	UDDT toilets in 3 villages to deter open defecation practices	Community Participation	Center for Advanced Philippine Studies (CAPS) Solid Waste Management of the Philippines (SWAPP) Foundation for a Sustainable Society, Inc. (FSSI) Institute for the Development of Educational and Ecological Alternatives, Inc. (IDEAS) WASTE City Government of San Fernando Dutch Government	Communities of San Fernando City, Province of La Union	2650	Households, Schools	2006	$22,000
Local Initiatives for Affordable Waste Water Treatment (LINAW): Dumaguete City Public Market[77]	Dumaguete City	Low cost septage treatment plant for a public market	Community Participation	Dumaguete City United States Agency for International Development (USAID) Philippine Sanitation Alliance (PSA) Basic Needs Services (BNS) Philippines - BORDA	USAID City of Dumaguete	1255 Stalls	Public Market	2007	$80,000
Local Initiatives for Affordable Waste Water Treatment (LINAW): Dumaguete City Septage Treatment Plant[78]	Dumaguete City	Low cost septage treatment plant and social marketing campaign	Community Participation	Dumaguete City United States Agency for International Development (USAID) Philippine Sanitation Alliance (PSA) Basic Needs Services (BNS) Philippines - BORDA	USAID City of Dumaguete	116,392	Households	2010	$575,000
Compliance to Environmental Standards to Abate Further Violation: Abattoir of Zamboangita, Negros Oriental[79]	Zamboangita	Establishment of a waste water treatment plant including a biogas digester for a local slaughterhouse	Community Participation	Local Community Groups Basic Needs Philippines (BNS BORDA) German Technical Cooperation (GTZ) Department of the Interior and Local Government (DILG)	Local Community Groups	Unknown	Slaughterhouse	2012	$113,637

[76] (Center for Advanced Philippine Studies (CAPS), 2007)
[77] (PADCO, 2006)
[78] (PADCO, 2006)
[79] (Sustainable Sanitation Alliance, 2010)

Name of Study	Location	Project Summary	Model Type	Implementation & Financing Partners	Chief Risk Partner	Estimated Individuals Impacted	Unit Type	Year Completed	Capital Investment Cost
Laguna de Bay Institutional Strengthening and Community Participation Project II: Nagcarian Slaughterhouse[80]	Sta. Cruz, Lugana and Nagcarian, Laguna	Institution and instrument strengthening, waste sanitation and management, natural resources management	Community Participation	Municipal governments of Nagcarian, Laguna BORDA Laguna Lake Development Authority (LDA) World Bank	Municipal Governments of Laguna	Unknown	Slaughterhouse	2010	$38,637
Laguna de Bay Institutional Strengthening and Community Participation Project I: Sta Cruz Community[81]	Sta. Cruz, Lugana and Nagcarian, Laguna	Institution and instrument strengthening, waste sanitation and management, natural resources management	Community Participation	Municipal governments of Sta. Cruz, Laguna BORDA Laguna Lake Development Authority (LDA) World Bank	Municipal Governments of Laguna	145,000	Households	2010	$40,909
Muntinlupa City Market Sanitation[82]	Muntinlupa City	Implementation of a DEWATS system with collection, filtration, and waste water reuse options to reduce unsanitary conditions	Local Government	Muntinlupa City Government USAID LINAW Department of Environment and Natural Resources (DENR) Market Vendors Association	Muntinlupa City Government	1445 Stalls	Public Market	2006	$130,000
Integrated Waste Management Scheme for Small and Medium Scale Slaughterhouses[83]	Valenzuela City	Waste management scheme devised to collect, separate, and treat waste while minimizing waste water	Local Government	Bureau of Animal Industry Department of Agriculture Basic Needs Services (BNS) Philippines - Bremen Overseas Research and Development Association (BORDA) German Technical Cooperation (GTZ) Food and Agriculture Organization of the United Nations (FAO)	Bureau of Animal Industry	30 hogs / 10 cattle per day	Slaughterhouse	2006	$11,364
Constructed Wetland for a Peri-urban Housing Area[84]	Bayawan City	Peri-urban upgrading of a settlement; domestic waste water treatment with constructed wetland	Local Government	City of Bayawan Department of the Interior and Local Government (DILG) GTZ	City of Bayawan	3380	Households	2006	$225,000

[80] (The World Bank Group in the Philippines)
[81] (The World Bank Group in the Philippines)
[82] (Sacendoncillo & de Pano, 2007)
[83] (Animal Products Development Center – Bureau of Animal Industry, 2010)
[84] (Sustainable Sanitation Alliance, 2010)

Name of Study	Location	Project Summary	Model Type	Implementation & Financing Partners	Chief Risk Partner	Estimated Individuals Impacted	Unit Type	Year Completed	Capital Investment Cost
San Fernando City Market DEWATS[85]	San Fernando City	Implementation of a DEWATS system consisting of collection, filtration, and waste water reuse options to reduce unsanitary conditions and foul smells from the market area	Local Government	San Fernando City Government USAID Philippine Sanitation Alliance Department of Environment and Natural Resources (DENR) Market Vendors Association	City Government of San Fernando	700 Stalls	Public Market	2005	$116,000
UDD toilets with reuse in allotment gardens[86]	Cagayan de Oro	Constructing UDD toilets with agriculture reuse	Local Government	Local Government Units of Cagayan de Oro City Government of Cagayan de Oro (Philippines), German Embassy, Manila, Philippines , Center for International Migration	City of Cagayan de Oro	500	Households, Schools	2005	$6,000
Compliance to Environmental Standards to Abate Further Violation: Public Market of Manjuyod, Negros Oriental[87]	Manjuyod	Establishment of a waste water treatment plant for a local public market	Local Government	Local Government Unit (LGU) and community Basic Needs Philippines (BNS BORDA) German Technical Cooperation (GTZ) Department of the Interior and Local Government (DILG)	LGU	Unknown	Public Market	2010	$38,367
Integrated Waste Management System for Bayawan City[88]	Bayawan City	Urban renewal and community upgrading by adding a waste water treatment facility and adding 40 UDDTs, constructed wetland	Local Government	Bayawan City Government German Technical Cooperation (GTZ) Department of the Interior and Local Government (DILG)	City of Bayawan	3250	Households, Schools	2006	$2,700,000

85 (Kearton, et al., 2013)
86 (Sustainable Sanitation Alliance, 2010)
87 (Sustainable Sanitation Alliance, 2010)
88 (Sustainable Sanitation Alliance, 2010)

Name of Study	Location	Project Summary	Model Type	Implementation & Financing Partners	Chief Risk Partner	Estimated Individuals Impacted	Unit Type	Year Completed	Capital Investment Cost
Preserving Water Quality of Iloilo City Slaughterhouse[89]	Iloilo City	Construction of DEWATS for a Public Abattoir	Local Government	City Government of Iloilo Iloilo River Development Council USAID (LINAW)	City of Iloilo	Unknown	Slaughterhouse	2007	$79,546
Urine-diversion Dehydration toilets in rural areas[90]	Bayawan City	Constructing UDD toilets in villages and schools	Local Government	City of Bayawan Department of the Interior and Local Government (DILG)	City of Bayawan	500	Households, Public Buildings	2008	$50,000
Sta. Ana Public Market Sewage Treatment Rehabilitation[91]	Manila City	Implementation of a DEWATS system consisting of collection, filtration, and waste water reuse options to reduce unsanitary conditions and foul smells from the market area	Local Government	Manila City Government USAID (LINAW) Department of Environment and Natural Resources (DENR) Metro Manila Development Agency (MMDA)	USAID Manila City Government	220 Stalls	Public Market	2010	Unknown
Decentralized Waste Water Treatment "Eco Tanks" for the Riverside Communities of Barangays Catbangen & Poro, and the Seaside Community of Barangay San Francisco[92]	San Fernando City	Project assessed sanitation conditions, installed collection facilities, filtration devices, and enhanced community participation and awareness for sanitation	Local Government	CITYNET (NGO) Prince Albert II of Manco Foundation USAID City Government of San Fernando City	San Fernando City CITYNET USAID	470	Households	2012	$87,000
Compliance to Environmental Standards to Abate Further Violation: Provincial Capital of Bohol[93]	Bohol	City developed and implemented a secondary waste water treatment plant to service public building and meet discharge standards	Local Government	Provincial Government of Bohol Basic Needs Philippines (BNS BORDA) German Technical Cooperation (GTZ) Department of the Interior and Local Government (DILG)	Provincial Government of Bohol	Unknown	Public Buildings	2010	$61,364

[89] (PADCO, 2006)
[90] (Sustainable Sanitation Alliance, 2010)
[91] (Gambrill, 2013)
[92] (Sustainable Sanitation Alliance, 2010)
[93] (Sustainable Sanitation Alliance, 2010)

Name of Study	Location	Project Summary	Model Type	Implementation & Financing Partners	Chief Risk Partner	Estimated Individuals Impacted	Unit Type	Year Completed	Capital Investment Cost
Compliance to Environmental Standards to Abate Further Violation: Sorsogon City, Sorsogon[94]	Sorsogon City	Establishment of a waste water treatment plant for a local public market	Local Government	City Government of Sorogon Basic Needs Philippines (BNS BORDA) German Technical Cooperation (GTZ) Department of the Interior and Local Government (DILG)	City of Sorsogon	Unknown	Public Market	2010	$131,818
Biogas for the Cagayan de Oro City Jail[95]	Cagayan de Oro	Installation of a biogas reactor to supplement existing waste water treatment facilities	NGO	International Committee of the Red Cross (ICRC) Cagayan City Jail	ICRC	1000	Jail	2010	$27,700
Community and School UDD Toilets[96]	Misamis Oriental, Libertad, Initao and Manticao	23 UDD community toilets at schools and in community centers	NGO	Water, Agroforestry, Nutrition and Development Foundation (WAND) German Doctors for Developing Countries	WAND	1000	Households, Schools	2007	$15,000
Building Communities…Em powering Communities[97]	Quezon City	Multi household collection facilities using anaerobic baffled reactors (ABRs)	NGO	Gaward Kalinga (NGO) Multiple City LGUs Local Community Members	Gaward Kalinga	150	Households	2008	Unknown
Decentralized Waste Water Treatment Facility for the Lilo-an Public Market: A Pilot and Demonstration Activity of the Asian Development Bank[98]	Lilo-an	Construction of a waste water treatment facility to treat public market waste water, construction of public toilets in the market	NGO	Lilo-an Community Multi-purpose Market Vendors Cooperative Asian Development Bank Municipality of Lilo-an	Asian Development Bank	120 Stalls	Public Market	2006	$50,000

94 (Sustainable Sanitation Alliance, 2010)
95 (International Committee of the Red Cross, 2011)
96 (Sustainable Sanitation Alliance, 2010)
97 (Sustainable Sanitation Alliance, 2010)
98 (König, 2006)

Name of Study	Location	Project Summary	Model Type	Implementation & Financing Partners	Chief Risk Partner	Estimated Individuals Impacted	Unit Type	Year Completed	Capital Investment Cost
Decentralized Waste Water Treatment Systems for the San Fernando City Slaughterhouse[99]	San Fernando City	Installation of a DEWATS system including a septic tank, secondary treatment, and a biogas digester	NGO	BORDA City Government of San Fernando City Congressional Development Fund of Congressman Victor F. Ortega	Victor F. Ortega	80 pigs / 6 cattle / 2 water buffalo / 10 goats per day	Slaughterhouse	2011	$46,500
Decentralized Waste Water Treatment System for LORMA Medical Center[100]	San Fernando City	Construction of a new DEWATS to upgrade from existing septic tanks	Private Participation	LORMA Medical Center Biosafe Inc. (Private Contractor) City Government of San Fernando City USAID	LORMA Medical Center	586	Hospital	2008	$46,000
Preserving Water Quality of Iloilo City Hospital[101]	Iloilo City	Construction of DEWATS for a Mission Hospital	Private Participation	City Government of Iloilo Iloilo River Development Council Iloilo Mission Hospital USAID (LINAW)	Mission Hospital	Unknown	Hospital	2009	$147,727
Compliance to Environmental Standards to Abate Further Violation: VR Abattoir of Antipolo City[102]	Antipolo City	Establishment of a waste water treatment plant including a biogas digester for a local slaughterhouse	Private Participation	VR Abattoir Management Laguna Lake Development Authority Antipolo City Government Basic Needs Philippines (BNS BORDA) German Technical Cooperation (GTZ) Department of the Interior and Local Government (DILG)	VR Abattoir	Unknown	Slaughterhouse	2010	$54,546
Compliance to Environmental Standards to Abate Further Violation: Ateneo de Manila University[103]	Manila	University constructed and implemented a DEWATS secondary waste water treatment plant to meet effluent discharge standards	Private Participation	Municipal governments of Sta. Cruz, Laguna and Nagcarian, Laguna BORDA Laguna Lake Development Authority (LDA) World Bank	Ateneo de Manila University	Unknown	University	2012	$136,136

[99] (Sustainable Sanitation Alliance, 2010)
[100] (Philippine Sanitation Alliance, 2011)
[101] (Sustainable Sanitation Alliance, 2010)
[102] (Sustainable Sanitation Alliance, 2010)
[103] (Evangelista, 2013)

Appendix 5. Table of Parameters for NPV Analysis

Financial Parameters	
System Life (years)	20
Expendable Component Life (years)	10
Discount Rate	8%
Total Beneficiaries (daily)	10,748
Stall Owners (direct users)	1,448
Vendors	4,800
Customers	4,500
Daily flow of treated water (m3/day)	210
Max effluent BOD from septic (g/ml)	600
Max effluent BOD from secondary (g/ml)	30
Stall User fee per day (USD)	0.11
Economic Parameters	
Health Care Costs Averted (USD per direct beneficiary ideal)	34.90
Productivity Costs Averted (USD per household ideal)	24.62
Mortality Costs Averted (USD per household ideal)	8.60
Water Access Cost Savings (USD per household ideal)	8.06
Water Treatment Cost Savings (USD per household ideal)	1.70
Access Time (USD per household ideal)	34.00
Excreta Reuse (USD per household ideal)	11.02
Ideal Multiplier	1.0

Appendix 6. NPV Analysis of Muntinlupa Market Using a Cocopeat Filter

Financial Analysis		**Year**																			
Revenue	**NPV**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Stall User Fees	616,464	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137
Water Reuse Electricity Savings	38,173	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Total Revenue	**654,637**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**	**61,737**
Expenses																					
Technical assistance (USAID)	25,000	25,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
System Construction Costs	87,000	87,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Cocopeat Filter Costs	43,000	43,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Constructed Wetland Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Land Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Social Marketing Plan	12,936	3,000	3,000	3,000	3,000	3,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Operations and Maintenance	78,891	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440
Electrical Costs	34,122	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218
Water Consumption	42,648	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022
Total Expenses	**323,597**	**172,680**	**17,680**	**17,680**	**17,680**	**17,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**
Economic Analysis																					
Economic Impact Benefits																					
Health Care Costs Averted	535,855	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535
Productivity Costs Averted	378,016	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650
Mortality Costs Averted	132,045	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453
Water Access Cost Savings	123,753	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671
Water Treatment Cost Savings	26,102	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462
Access Time	522,036	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232
Excreta Reuse	169,201	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957
Total Benefits	**1,887,008**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**

Appendix 7. NPV Analysis of Muntinlupa Market DEWATS Using a Constructed Wetland

Financial Analysis		Year																			
Revenue	**NPV**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Stall User Fees	616,464	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137	58,137
Water Reuse Electricity Savings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Revenue	**616,464**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**	**58,137**
Expenses																					
Technical assistance (USAID)	25,000	25,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
System Construction Costs	87,000	87,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Cocopeat Filter Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Constructed Wetland Cost	61,428	61,428	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Land Costs	58,572	58,572	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Social Marketing Plan	12,936	3,000	3,000	3,000	3,000	3,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Operations and Maintenance	78,891	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440	7,440
Electrical Costs	34,122	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218	3,218
Water Consumption	42,648	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022	4,022
Total Expenses	**400,597**	**249,680**	**17,680**	**17,680**	**17,680**	**17,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**	**14,680**
Economic Impact Benefits																					
Health Care Costs Averted	535,855	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535	50,535
Productivity Costs Averted	378,016	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650	35,650
Mortality Costs Averted	132,045	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453	12,453
Water Access Cost Savings	123,753	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671	11,671
Water Treatment Cost Savings	26,102	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462	2,462
Access Time	522,036	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232	49,232
Excreta Reuse	169,201	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957	15,957
Total Benefits	**1,887,008**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**	**177,959**

Appendix 8. Integrated Economic and Financial Analysis of a Cocopeat Filter Using a Private Participation Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)	Allocation of Externalities: Stall Owners	Market Users	City Residents	Local Gov
Benefits										
Health Care Costs Averted	535,855	-	-	-	-	535,855	-	-	535,855	-
Productivity Costs Averted	378,016	-	-	-	-	378,016	-	378,016		-
Mortality Costs Averted	132,045	-	-	-	-	132,045	-	-	132,045	-
Water Access Cost Savings	123,753	-	-	-	-	123,753	123,753	-	-	-
Water Reuse Electricity Savings	38,173	-	-	-	-	38,173	38,173	-	-	-
Water Treatment Cost Savings	26,102	-	-	-	-	26,102	-	26,102	-	-
Access Time	522,036	-	-	-	-	522,036	-	522,036	-	-
Excreta Reuse	169,201	-	-	-	-	169,201	-	-	-	169,201
Total Benefits	**1,925,181**	**-**	**-**	**-**	**-**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**
Costs										
Technical Assistance Costs	25,000	-	25,000	-	-	-	-	-	-	-
System Construction Costs	87,000	87,000	-	-	-	-	-	-	-	-
Estimated Cocopeat Filter Costs	43,000	43,000	-	-	-	-	-	-	-	-
Social Marketing Plan	12,936	-	9,055	3,881	-	-	-	-	-	-
Operations and Maintenance	78,891	78,891	-	-	-	-	-	-	-	-
Electrical Costs	34,122	34,122	-	-	-	-	-	-	-	-
Water Consumption	42,648	42,648	-	-	-	-	-	-	-	-
Total Costs	**323,597**	**285,661**	**34,055**	**3,881**	**-**	**-**	**-**	**-**	**-**	**-**
Net Resource Flow	**1,601,584**	**(285,661)**	**(34,055)**	**(3,881)**	**-**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**

Appendix 9. Integrated Economic and Financial Analysis of a Cocopeat Filter Using a NGO Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)	Allocation of Externalities			
							Stall Owners	Market Users	City Residents	Local Gov
Benefits										
Health Care Costs Averted	535,855	-	-	-	-	535,855	-	-	535,855	-
Productivity Costs Averted	378,016	-	-	-	-	378,016	-	378,016		-
Mortality Costs Averted	132,045	-	-	-	-	132,045	-	-	132,045	-
Water Access Cost Savings	123,753	-	-	-	-	123,753	123,753	-	-	-
Water Reuse Electricity Savings	38,173	-	-	-	-	38,173	38,173	-	-	-
Water Treatment Cost Savings	26,102	-	-	-	-	26,102	-	26,102	-	-
Access Time	522,036	-	-	-	-	522,036	-	522,036	-	-
Excreta Reuse	169,201	-	-	-	-	169,201	-	-	-	169,201
Total Benefits	**1,925,181**	**-**	**-**	**-**	**-**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**
Costs										
Technical Assistance Costs	25,000	-	25,000	-	-	-	-	-	-	-
System Construction Costs	87,000	-	87,000	-	-	-	-	-	-	-
Estimated Cocopeat Filter Costs	43,000	-	43,000	-	-	-	-	-	-	-
Social Marketing Plan	12,936	-	12,936	-	-	-	-	-	-	-
Operations and Maintenance	78,891	-	-	78,891	-	-	-	-	-	-
Electrical Costs	34,122	-	-	34,122	-	-	-	-	-	-
Water Consumption	42,648	-	-	42,648	-	-	-	-	-	-
Total Costs	**323,597**	**-**	**167,936**	**155,661**	**-**	**-**	**-**	**-**	**-**	**-**
Net Resource Flow	**1,601,584**	**-**	**(167,936)**	**(155,661)**	**-**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**

Appendix 10. Integrated Economic and Financial Analysis of a Cocopeat Filter Using a Local Government Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)	Allocation of Externalities			
							Stall Owners	Market Users	City Residents	Local Gov
Benefits										
Health Care Costs Averted	535,855	-	-	-	-	535,855	-	-	535,855	-
Productivity Costs Averted	378,016	-	-	-	-	378,016	-	378,016		-
Mortality Costs Averted	132,045	-	-	-	-	132,045	-	-	132,045	-
Water Access Cost Savings	123,753	-	-	-	-	123,753	123,753	-	-	-
Water Reuse Electricity Savings	38,173	-	-	-	-	38,173	38,173	-	-	-
Water Treatment Cost Savings	26,102	-	-	-	-	26,102	-	26,102	-	-
Access Time	522,036	-	-	-	-	522,036	-	522,036	-	-
Excreta Reuse	169,201	-	-	-	-	169,201	-	-	-	169,201
Total Benefits	**1,925,181**	**-**	**-**	**-**	**-**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**
Costs										
Technical Assistance Costs	25,000	-	25,000	-	-	-	-	-	-	-
System Construction Costs	87,000	-	-	87,000	-	-	-	-	-	-
Estimated Cocopeat Filter Costs	43,000	-	-	43,000	-	-	-	-	-	-
Social Marketing Plan	12,936	-	9,055	3,881	-	-	-	-	-	-
Operations and Maintenance	78,891	-	-	78,891	-	-	-	-	-	-
Electrical Costs	34,122	-	-	34,122	-	-	-	-	-	-
Water Consumption	42,648	-	-	42,648	-	-	-	-	-	-
Total Costs	**323,597**	**-**	**34,055**	**289,542**	**-**	**-**	**-**	**-**	**-**	**-**
Net Resource Flow	**1,601,584**	**-**	**(34,055)**	**(289,542)**	**-**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**

Appendix 11. Integrated Economic and Financial Analysis of a Cocopeat Filter Using a Community Participation Model

	Economic PV	Financial PV (Private Sector)	Financial PV (NGO)	Financial PV (Local Gov)	Financial PV (Stall Owners)	EV - FV (Externalities)	Allocation of Externalities			
							Stall Owners	Market Users	City Residents	Local Gov
Benefits										
Health Care Costs Averted	535,855	-	-	-	-	535,855	-	-	535,855	-
Productivity Costs Averted	378,016	-	-	-	-	378,016	-	378,016		-
Mortality Costs Averted	132,045	-	-	-	-	132,045	-	-	132,045	-
Water Access Cost Savings	123,753	-	-	-	-	123,753	123,753	-	-	-
Water Reuse Electricity Savings	38,173	-	-	-	-	38,173	38,173	-	-	-
Water Treatment Cost Savings	26,102	-	-	-	-	26,102	-	26,102	-	-
Access Time	522,036	-	-	-	-	522,036	-	522,036	-	-
Excreta Reuse	169,201	-	-	-	-	169,201	-	-	-	169,201
Total Benefits	**1,925,181**	**-**	**-**	**-**	**-**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**
Costs										
Technical Assistance Costs	25,000	-	25,000	-	-	-	-	-	-	-
System Construction Costs	87,000	-	-	-	87,000	-	-	-	-	-
Estimated Cocopeat Filter Costs	43,000	-	-	-	43,000	-	-	-	-	-
Social Marketing Plan	12,936	-	9,055	3,881	-	-	-	-	-	-
Operations and Maintenance	78,891	-	-	-	78,891	-	-	-	-	-
Electrical Costs	34,122	-	-	-	34,122	-	-	-	-	-
Water Consumption	42,648	-	-	-	42,648	-	-	-	-	-
Total Costs	**323,597**	**-**	**34,055**	**3,881**	**285,661**	**-**	**-**	**-**	**-**	**-**
Net Resource Flow	**1,601,584**	**-**	**(34,055)**	**(3,881)**	**(285,661)**	**1,925,181**	**161,926**	**926,154**	**667,900**	**169,201**

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