Final Report

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Applicability of DEWATS in Urban Neighborhoods of the Port-au-Prince Metropolitan Area (PPMA)



International Federation
of Red Cross and Red Crescent Societies

RÉPUBLIQUE D'HAÏTI
DINEPA
Direction Nationale
de l'Eau Potable
et de l'Assainissement

BORDA

Bremen Overseas Research and Development Association

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Introduction to BORDA

BORDA e.V. (Bremen Overseas Research & Development Association) is a specialist organization actively involved in the fields of poverty alleviation, sustainable protection of natural resources and the strengthening of social structures. As a German Association, BORDA has been providing Basic Needs Services like water supply and sanitation since 1976.

One of the significant instruments to provide basic sanitation is DEWATS ("Decentralized Wastewater Treatment Systems"), a technical approach, developed in the 1990s in collaboration with an International network of organizations and experts. It is a demand-based solution to reduce water pollution by small and medium enterprises and settlements in densely populated areas. Dissemination of the DEWATS based sanitation solutions represents a focal activity of BORDA's interventions.

DEWATS is an effective, efficient, affordable and proven wastewater treatment solution. For (sub-) tropical regions and low-income groups in underdeveloped and developing countries, DEWATS is often the only realistic option. DEWATS Service Packages include not only the design and construction of hardware but also a complete set of integrated measures, like participatory planning and health and hygiene education, which are combined to create a 'tailor-made' project suited to demand.

To date, over 1000 DEWATS have been implemented directly by the BORDA-partner networks for public stakeholders and private clients in the following sectors:

- Low- and middle-income settlements (densely populated communities).
- Agro-Industries (livestock incl. slaughterhouses, soya bean processing, alcohol & noodle production, etc.).
- Public Institutions (hospitals, schools, prisons, etc.).
- Labour intensive SMEs with mainly domestic wastewater.

A worldwide community of DEWATS promoters and implementors has been capacitated through BORDA's training programs.

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Glossary

ABR	Anaerobic Baffled Reactor
ARC	American Red Cross
BOD_5	Biochemical Oxygen Demand
CASEC	Conseils d'Administration des Sections Communales
CBO	Community Based Organisation
CBS	Community Based Sanitation
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CTE	Centre Technique d'Expolitation
DEWATS	Decentralized Wastewater Treatment Systems
DINEPA	Direction Nationale de l'Eau Potable et l'Assainissement
FRC	French Red Cross
GHG	Greenhouse Gases
GoH	Government of Haïti
IDP	Internally Displaced Person
IFRC	Internation Federation of the Red Cross and Red Crescent Societies
INA	Integrated Neighbourhood Approach
IO	International Organisation
MDG	Millenium Development Goal
MSPP	Ministère de la Santé Publique et de la Population
NGO	Non-governmental Organisation
O&M	Operation & Maintenance
PD	Planted Drain
PPMA	Port-au-Prince Metropolitan Area
RB	Rock Band
RC	Red Cross
SMEs	Small and Medium Sized Enterprises
SS	Suspended Solids
SSS	Simplified Sewerage System

1. Executive Summary

This Report documents the findings of a study on the application of DEWATS in urban neighborhoods of the Port-au-Prince Metropolitan Area (PPMA). The study by BORDA was commissioned by the IFRC and DINEPA and undertaken in December 2012. It assessed the applicability of DEWATS in the PPMA in general and more specifically at 4 Red Cross sites. Appropriate DEWATS options were developed for the 4 sites in order to demontrate actual potential projects.

DEWATS ('Decentralized Wastewater Treatment Systems') is introduced in the Report as a technical approach which addresses the problems and limitations of on-site sanitation solutions (e.g. latrines) and conventional wastewater treatment systems (e.g. large sewerage networks, pumping stations and aerobic wastewater treatment requiring appreciable energy inputs). The DEWATS approach is designed to be affordable and reliable requiring relatively less operation and maintenance.

The introduction to the Report explains the objectives and describes briefly the background to sanitation in the PPMA, the legal and institutional framework for sanitation and the activities of the IFRC in sanitation in the PPMA. Poor sanitation in the area has a direct negative impact on the environment and on the public health of its inhabitants.

The study methodology details the activities undertaken by the consultant over the 20-day consultancy period, limitations of the study and the assumptions made by the consultant. An important parameter for the DEWATS design is wastewater quantity and composition which was assumed for the purposes of the study.

A general section on "Applicability of DEWATS in the PPMA" enlists the criteria that were used to assess the feasibility of 19 different DEWATS treatment options. These criteria fall under 4 headings: Institutional and Legal Criteria, Environmental and Sustainability Criteria, Socio-economic criteria, and Technical Criteria. The criteria are used to rank the 19 options in a table called 'DEWATS Feasibility Matrix'. The matrix shows that the addition of an Anearobic Baffled Reactor (ABR) greatly improves the institutional, legal and environmental feasibility of the intervention, but increases the initial investment cost.

The 4 RC sites are described in 4 separate sections and possible DEWATS options are proposed for all 4 sites. These are based on assessments of the sites by the BORDA consultants using criteria relevant to site conditions to determine which DEWATS option has most potential in each area. The options are selected from the DEWATS feasibility matrix and specific capital and O&M costs are presented according to the size of the catchments connected to the proposed DEWATS. DEWATS are considered feasible at all 4 sites with a combination of a Settler and an Anaerobic Baffled Reactor (ABR) being the suggested primary and secondary treatment option.

The Report concludes with a section providing a general statement that DEWATS is feasible in the PPMA and makes recommendations for DEWATS implementation. The recommendations specify the parameters for DEWATS to succeed as a key technology in the wastewater treatment strategy in the PPMA. They stress on capacity building through learning projects, site specific annalysis of physical parameters, cost benefit analysis, public consultation, participatory methodologies, wastewater composition, engagement of DINEPA and the establishment of a DEWATS network in Haiti.

Annexes to the report provide a more detailed description of feasibility study criteria, indicative costs for the suggested options, a description of a possible pubic toilet option using DEWATS, the Consultant's Terms of Reference and a list of meetings and site visits.

2. Background, Objectives and Methodology of the Study

2.1. Background

On 12th January 2010, an earthquake measuring 7.0 on the Richter's Scale struck Haiti. The earthquake's epicentre was about 15 km south-west of the Country's capital Port-au-Prince, in the vicinty of the city of Léogane. The International Federation of the Red Cross (IFRC) worked during 2010 and 2011 as an emergency response aiming at providing basic water, sanitation and hygiene services for the Haitian people. In early 2011, the IFRC began formulating a long term recovery strategy, the Integrated Neighborhood Approach (INA). INA aims at reconstructing and developing targeted communities across the sectors of water and sanitation, health, settlements, violence prevention and disaster risk reduction.

As part of INA, IFRC will implement water and sanitation activities in support of settlement activities. The specific urban context of PPMA, where there is no municipal sewage system, requires innovative sanitation solutions.

In coordination with the government body, DINEPA (Direction Nationale de l'Eau Potable et l'Assainissement), IFRC envisaged undertaking an evaluation of the applicability of DEWATS solutions in the urban settings of the PPMA (Port-au-Prince Metropolitan Area). These semi-centralized systems are part of the new sanitation strategy of DINEPA, who would like to develop some pilot projects.

2.2. Report Objectives

The main object of the Report is to evaluate the applicability of Decentralized Wastewater Treatment Systems (DEWATS) in the PPMA and to provide recommendations as to the most appropriate and technically feasible systems to be implemented in the 4 Red Cross working areas assessed during the study. The specific objectives can be seen in the Terms of Reference in Annex D.

2.3. Study Methodology

A BORDA team of 2 consultants undertook the following activities over a 20-day consultancy assignment during December 2012 in Port-au-Prince:

Desk Study and Literature Review

The Red Cross provided the following documentation and data:

- Plans showing topography, building location and water courses.
- Plans showing location of water points.
- Data on type of toilet.
- Report by the private company, LGL SA., on the development of infrastructure at the FRC INA site, Delmas 9,11.

Additional relevant literature was accessed from the internet and can be seen in the references section at the end of the Report.

Meetings with Sanitation Stakeholders

Meetings were held with various stakeholders during the consultancy period: DINEPA, CASEC, Red Cross Representatives, INA community members, NGOs and private sector sanitation agencies.

Visits to INA sites

The schedule of the site visits undertaken by the consultant is shown in Annex E. For each site visit, a site reconnaissance helped the consultants to observe the RC INA project activities, the specific urban contexts in each neighborhood and the sanitation technologies and practices adopted. The following were also observed:

- topography of the site.
- housing types.
- location and service of some water points.
- type of existing sanitation infrastructure; toilets; rainwater and grey water drainage; and solid waste management.
- location and condition of the water courses on, and bordering, the site.
- type of institutions (e.g. schools and hospitals) and SMEs in the vicinity of the site.
- The residents and their socio-economic background.

Informal interviews with community members (6 interviews per site visit) were conducted during visits to households and water points.

Limitations of the Study

- **Community Acceptance of DEWATS**
  A brief assessment was made of community acceptance of the DEWATS approach based on informal interviews with community members during the site visits and a community meeting at Delmas 9,11,13. However, due to time constraints, a comprehensive assessment of community acceptance could not be made.
- **Local Authorities Acceptance of DEWATS**
  Meetings were held with DINEPA and CASEC, though the concerned Mayors of the 4 case study sites could not be consulted during the study. A comprehensive assessment was not made of local authority acceptance of DEWATS.
- **Water Consumption**
  Water consumption is difficult to determine in Port-au-Prince without assessing actual usage in individual households. Reliable water consumption data for specific sites in the PPMA was not available from the concerned sources including the RC, DINEPA and the CTE.
- **Wastewater Composition**
  Wastewater composition in terms of pollution load must be known in order to design the DEWATS units. However, no information on wastewater composition was available during the consultancy period.

Consultant's Assumptions

The following assumptions were made:

- Water Consumption = 60 liters per person per day (60 l/cap./day).[1]
- Wastewater Effluent Discharge Standards used in the study are:

Chemical oxygen demand (COD):	< 150 mg/l
Biological oxygen demand (BOD):	< 50 mg/l
Total suspended solids (TSS):	< 50 mg/l
pH:	6,8 – 7,2

The introduction of discharge standards in the PPMA could benefit from a phased approach. If a phased approach is adopted, the above values could represent the first phase.

[1]DINEPA's minimum standard of 20l/person/day is too low as water consumption to consider for DEWATS.

3. DEWATS Approach and Assessment Criteria

3.1. DEWATS Approach

3.1.1. Introduction

DEWATS is the acronym for "Decentralized Wastewater Treatment Systems". It is better described as a technical approach rather than a technology package. As a decentralized, low maintenance and sustainable solution, DEWATS fills the "gap" between on-site sanitation systems (e.g. pit latrines) and conventional centralized sewerage collection and treatment system, as demonstrated in the figure below.

The demand for reliable, efficient and affordable wastewater treatment systems is increasing worldwide especially in densely populated urban regions where adequate wastewater treatment systems do not exist and uncontrolled discharge of wastewater endangers environmental health and water resources. Many governments passing new environmental laws stipulate that discharges of wastewater from households must not pollute the environment. Therefore, wastewater treatment before discharge into the environment becomes a statutory requirement for households, as well as institutions, and industrial installations.

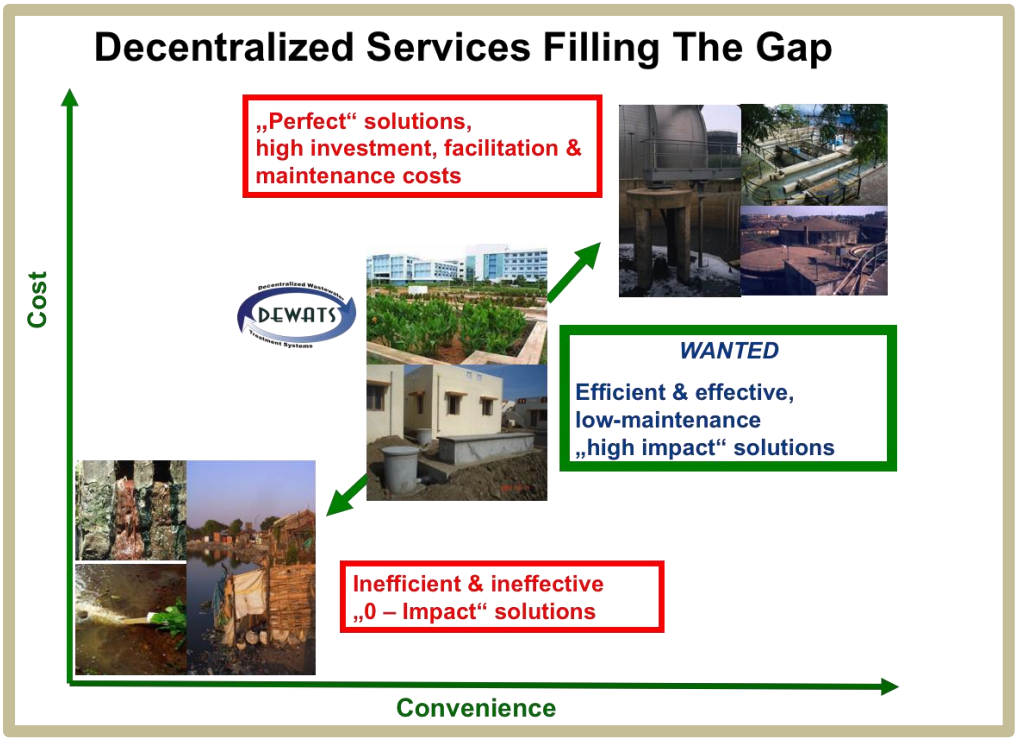


Figure 1: DEWATS fills the technological gap between inconvenient low cost onsite sanitation solutions and expensive sophisticated conventional centralized treatment systems.

3.1.2. DEWATS Principles

DEWATS designs are customized for specific local conditions but follow basic principles.

a) Principle of Decentralization: smaller catchment areas are easier to manage and the overall investment is less than for large catchment areas (like a whole city).

b) Principle of Simplification: most of the areas lacking basic sanitation are unable to operate and maintain complex systems.

c) Principle of Resource Conservation: Treated products are valuable resources (water, organic matter, nitrogen, phosphorus and energy): Re-use should be considered.

DEWATS are characterized by the following features:

- Treatment for mainly organic pollution from both domestic and industrial sources.
- Treatment for wastewater flows from 1-1000 m³ per day.
- Reliable, durable and tolerant towards inflow fluctuation.
- Low operation and maintenance requirements; no electro-mechanical components.
- Can be an integral part of comprehensive wastewater treatment strategies.
- Modular design of all components can be adapted to changing flows and discharge standards.
- Cost efficiency.
- Uses only locally available construction materials.
- Renewable energy source and nutrient recycling (biogas, water for irrigation, sludge compost).

The modules are designed and constructed using civil engineering methods. Above-ground modules can be aesthetically designed and integrated in the landscape requirement.

Figure 2: Left - DEWATS baffled reactor under construction; Right -DEWATS polishing pond

3.1.3. DEWATS Modules

DEWATS are modular treatment systems, configured from several possible treatment modules according to the wastewater characteristics, treatment requirements and local conditions. The treatment modules (shown in Figure 3) use one of 4 different treatment steps:

- Pre-treatment/Primary treatment – Sedimentation in ponds, settlers, septic tanks or bio-digesters.
- Secondary anaerobic treatment - Anaerobic digestion in baffled reactors or anaerobic filters.
- Secondary/tertiary aerobic/anaerobic treatment - Anaerobic and facultative decomposition in sub-surface flow horizontal gravel filters and aerobic ponds.
- Post-treatment - aerobic treatment in polishing ponds.

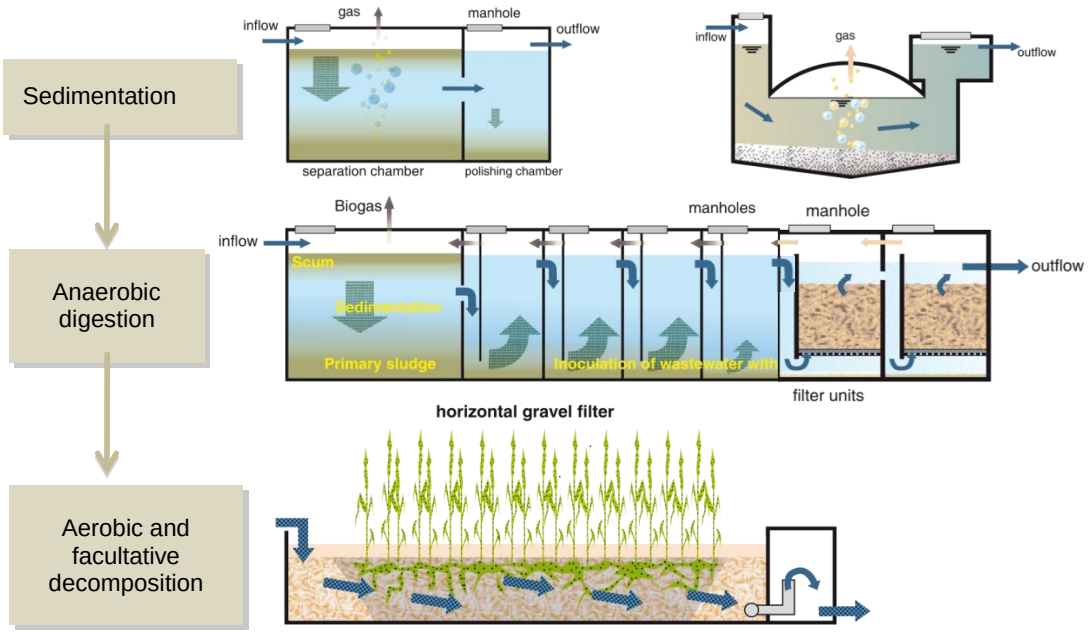


Figure 3: Frequently used DEWATS modules

The text below gives a brief description of frequently used DEWATS modules, while table 1 below presents advantages and disadvantages of each:

a) Septic Tank

- Consists of a minimum of 2 to 3 compartments,
- Settling / sedimentation tanks for retaining particles with large retention times,
- Outlet is free from settleable solids,
- Most dissolved and suspended matter pass untreated to next stage of treatment,
- Efficiency is 25% to 40%,
- Desludging period is 1 to 3 years depending on sludge storage

b) Settler

- Consists of 2 compartments,
- Settling /sedimentation tanks for retaining settleable solids with short retention times (2h),
- Outlet is largely free from settleable solids,
- Dissolved and suspended matter passes untreated to next stage of treatment,
- Efficiency is 25% to 30%,
- Desludging period is 1 to 3 years depending on sludge storage

c) Biogas Settler

- Sedimentation tank for retaining particles
- Biogas is formed as a result of digestion of settled organic matter under anaerobic conditions
- Outlet is free from settleable solids
- Most dissolved and suspended matter passes untreated to next stage of treatment
- Efficiency is 25% - 40%
- Desludging period is 1 to 3 years depending on sludge storage
- Biogas produced for which gas storage is needed (gas tight)

d) Anaerobic Baffled Reactor (ABR)

- Treatment occurs in the absence of oxygen (anaerobic),
- Wastewater passes through a series of chambers in an up-flow form,
- Sludge (activated) lies at the bottom of each chamber,
- Further treatment (degradation) of suspended and dissolved solids by available bacteria,
- Efficiency is 75% to 85%,
- Desludging is needed only if excess sludge (activated) is generated,
- Upflow velocity is best below 1m/hr

e) Anaerobic Filter (AF)

- Treatment occurs in the absence of oxygen (anaerobic),
- Wastewater passes through a series of chambers through the filter material (bacteria carrier) in an up-flow form,
- The filter material is gravel, slag or plastic elements with large surfaces,
- Desludging is needed only if excess sludge (activated) is generated,
- Often added to the ABR to increase its efficiency in critical locations.

f) Horizontal Planted Gravel Filter (PGF)

- Treatment occurs in the presence of oxygen (aerobic),
- Treatment concentrates more on removal of smell and color,
- Planted Gravel Filter (PGF) consist of plants (reeds) and filter material (graded gravels, river pebbles),
- The filter is permanently soaked (up to 50 cm from bottom) in water,
- The flow is mainly lateral,
- Suitable for pre-treated wastewater

Other Modules Applied instead of PGF

The space required for a PGF and anaerobic ponds as tertiary treatment modules is often not available in the urban context of Port au Prince. In order to provide minimal oxygenation and treatment to the secondary effluent, the following options are also considered:

Rock-Band (RB): A covered canal with passive aeration, provides oxygen to the effluent, reducing odor and changing the conditions from anaerobic to aerobic. Stones (rocks) in the canal provide the required turbulence. Rock-band modules are robust but have reduced treatment efficiency.

Planted Drain (PD): a ditch with filter material that allows for fast effluent flow and is planted with helophytes. Depending on the length, it can provide good post treatment of anaerobic effluents.

Divider-weir / spillway

Where the maximum inflow volume cannot be guaranteed, DEWATS units have a divider-weir or spillway. This allows for bypassing of wastewater in case of heavy inflows (e. g. caused by heavy rains or flooding) that exceed the designed inflow capacity.

3.1.4. Community Based Sanitation (CBS)

The CBS framework is tailored to improve sanitation conditions in densely populated urban areas. Project implementation depends on the active cooperation of communities, governments, NGOs and the private sector. Implementation of smart and proven technical options are synthesized with

capacity-building measures and technical expertise; thus CBS is mainstreamed as a viable technical option in areas, where neither individual on-site systems nor centralized sewerage systems can fulfill the stakeholders' need of basic sanitation.

CBS projects are based on a holistic and demand-responsive approach. Instead of merely providing sanitation “hardware”. CBS projects aim to improve hygiene behavior and sanitation infrastructure in a more integrated and sustainable manner. CBS projects generally focus on poor and densely populated areas and closely reflect the preferences of the target communities.

Table 1: Advantages and Disadvantages of main DEWATS modules

DEWATS module	Treatment process	Used for type of wastewater	Advantages	Disadvantages
settler	sedimentation, sludge stabilization	wastewater with settleable solids, especially domestic	simple, durable, less space as it is under- ground	only treatment of solids, effluent not odorless
septic tank	sedimentation, sludge stabilization	wastewater with settleable solids, especially domestic	simple, durable, requiring less space (more than settler as it is under ground	low treatment efficiency, effluent not odorless
biogas Settler	sedimentation, sludge stabilization	wastewater with settleable solids, especially domestic	access to renewable source of energy (biogas); closed system	more complex than settler; special skills needed for gas-tight dome construction
Imhoff tank	sedimentation, sludge stabilization	wastewater with settleable solids, especially domestic	durable, requiring less space as it is under ground; odorless effluent	more complex than septic tank; needs regular desludging
anaerobic baffled reactor	anaerobic degradation of suspended and dissolved solids	pre-settled domestic and industrial wastewater with narrow COD/BOD ratio, suitable for high organic load ww	Simple. durable, high treatment efficiency, less space required; negligible blockage; cheap compared to anaerobic filter	less efficient when treating wastewater with low organic concentration; longer start-up phase than anaerobic filter
anaerobic filter	anaerobic degradation of suspended and dissolved solids	pre-settled domestic and industrial wastewater with narrow COD/BOD ratio	Simple, durable if well constructed and ww properly pre-treated; high treatment efficiency, less space required as it is underground	Costlier than ABR because of special filter material; blockage of filter possible; slight effluent odor despite high treatment efficiency
Horizontal planted gravel filter	aerobic-facultative-anaerobic degradation of dissolved and fine suspended solids, pathogen removal	suitable for domestic and weak industrial wastewater where settleable solids and most suspended solids are already removed	high treatment efficiency when properly constructed; link with landscaping possible; no wastewater above ground; can be cheap if filter material is available at site; no odor	Appreciable space requirement; high skills level and care required during construction; special maintenance and supervision during first 1-2 years
anaerobic pond	sedimentation, anaerobic degradation sludge stabilization	strong and medium industrial wastewater	simple in construction, flexible in respect to degree of treatment, little maintenance	wastewater pond occupies open land; some odor; mosquitoes difficult to control
aerobic pond	aerobic degradation, pathogen removal	weak, mostly pre-treated wastewater from domestic and industrial sources	simple construction, good performance if well dimensioned; high pathogen removal rate; can be used to create a natural environment; fish farming option if large in size and low loaded	appreciable space requirement; proliferation of mosquitoes and odor could be a nuisance if undersized near residential areas; algae can raise effluent BOD

3.2. Assessment Criteria for DEWATS Solutions

The criteria used to study the applicability of DEWATS in the PPMA are as shown in the 'DEWATS Applicability Matrix' in Table 2 and are described below. The rankings used in the matrix are explained in the notes following it.

Table 2 uses the assessment criteria to compare 19 different DEWATS treatment options - 2 for individual households, 11 for neighborhoods (a neighborhood is here defined as 20 to 1000 households) and 6 for public toilet options. The different treatment options are made up from DEWATS modules presented in chapter 3.1.

3.2.1. Institutional and Legal Criteria

Compliance with national discharge standards (1a)

The National Discharge Standards in the PPMA are currently being developed by DINEPA. Hence, assumptions regarding effluent discharge standards have been made in order to compare the treatment capacity of the presented DEWATS options. These assumptions are presented in section 2.

Compliance with national strategy of DINEPA (1b)

The following 4 elements from DINEPA's National Strategy (see next section) have been used:

1. Black water (from toilets) should not be discharged onto the ground. (DINEPA, 2012)
2. Grey water (from sinks and showers) may be transported by open conduits. (CIAT, 2012)
3. Drainage conduits are to be laid at a minimum gradient of 0.5%. (CIAT, 2012)
4. To guarantee the continuing water services and sanitation services, users will be obliged to pay a tariff (DINEPA, 2011)

For additional institutional and legal considerations, refer also to Annex A.

3.2.2. Environmental and Sustainability Criteria

Addresses the entire sanitation chain (2a)

DEWATS, by definition, concerns wastewater conveyance, treatment, safe discharge of effluent and potentially re-use. User Interface (toilets) is assumed to be or to become a flush toilet.

Effluent treatment efficiency (2b)

DEWATS modules have treatment efficiencies as presented in Chapter 3.1. This criterion rates the DEWATS treatment options according to their ability to remove BOD and COD and consequently reduce the risk of water contamination.

Reduction of CO2 emissions (2c)

The potential contribution of the different DEWATS options for the reduction of CO_2 (or CO_2 equivalent) emissions is considered. This comprises: (1) potential substitution of chemical fertilizer with recycled nutrients in the treated effluent; (2) reduction of methane emissions through combustion of biogas; and (3) potential substitution of fossil fuels (charcoal) with methane (biogas).

For additional environmental and sustainability considerations, refer also to Annex A.

3.2.3. Socio-economic criteria

Estimated cost of initial investment per person (3a)

Capital investment costs are based only on construction of the DEWATS plant. This is based on previous experience in other countries and on indicative local costs of the main construction materials. These costs are presented in the matrix as 'Indicative cost initial investment per capita' in USD and 'Indicative monthly O+M cost per household' in HTG.

For convenience, a neighborhood of 100 households generating a wastewater flow of 50m^3 per day (including uncontrolled entries like infiltration and illegal connections) has been assumed to arrive at the size of the treatment options in the matrix. It is important to note that the following costs are not included in the cost estimation.

- Cost for purchase or rental for the land.
- New construction of household connection and/or closure of existing septic tanks.
- Reconditioning of existing sewerage lines (opening of sewer to some extent, removal of solid waste, repair of bottom plate and walls depending on demand, reconnecting of existing connections).
- Laying of simplified sewer system (SSS): On average, a SSS is about 20% the capital cost of a conventional centralized sewer system. The very heterogenic conditions of the sites at Port-au-Prince will make this cost vary considerably from site to site.
- Demolition of former buildings or basements.
- Temporary or permanent replacement of existing and crossing pipelines or channels.
- Erection of divider weir depending on existing mixed water channels or amount of wastewater to be discharged.
- Temporary discharge of groundwater or incoming wastewater into existing channels within area of construction

The public toilet options have been developed assuming a 12 seater toilet block. The cost shown in table 2 is for the DEWATS treatment only; toilet block and related services are not included.

Estimated annual O&M cost per household (3b)

Operation and Maintenance (O&M) costs include simple equipment for DEWATS operation, labor costs, maintenance of SSS, and periodical maintenance including desludging every 2 years and filter bed maintenance every 5 years. A neighborhood of 100 households has been assumed to determine the O&M costs for the different treatment options in the matrix.

See also annex B for a description of O&M costs.

Interest of local authorities for DEWATS (3c)

After specific consultation with DINEPA, the CASEC for Turgeot and other sanitation actors with local authority contacts, there are indications of a basic interest in DEWATS, especially if: DEWATS can be financed externally, DEWATS comply with minimum discharge standards and DEWATS can be integrated into wider neighborhood infrastructure projects. Comparative ranking of the treatment options in the matrix can only be undertaken after presentation of the specific options to the concerned local authorities.

Interest of communities for DEWATS (3d)

After one community meeting and approximately 6 individual interviews per study site, as well as meetings with other sanitation actors with community contact, there are indications of a basic interest in DEWATS by the targeted communities. This interest focuses on the improvements brought about by wastewater conveyance (i.e. the sanitary benefits in the immediate vicinity of households) and also consideration of the re-use opportunities associated with some of the DEWATS process modules. Less interest was evinced for the environmental state of the public ravines than

for the private spaces in front of the households. Comparative ranking of the treatment options in the matrix can only be undertaken after presentation of the specific options to the concerned communities.

The poorer the settlement, the lower appears to be sanitation on the priority list of individual households. It may therefore be incumbent on the local authorities to facilitate provision of basic sanitation services for the general public health. Linking decentralized sanitation projects with other household requirements or settlement improvements may be often required if a relevant community involvement beyond an initial period is to be expected.

For additional socio-economic considerations, refer also to Annex A.

3.2.4. Technical Criteria

Local availability of construction material (4a)

It is an integral strategy of the DEWATS technical approach to use local materials. Therefore all of the presented options use locally available materials.

Appropriate construction techniques (4b)

The construction techniques required for DEWATS are standard civil engineering construction methods common in Haiti: bricklaying, reinforced concrete, normal plumbing and control of hydraulic levels, and safe excavation. Therefore, all the presented DEWATS options use appropriate construction techniques. Whilst these construction techniques are common in Haiti, they are often not applied at the required quality level. Hence, training of construction teams is of crucial importance.

DEWATS being a water retaining structure requires very close control of hydraulic aspects; skilled labor must be used with an experienced and capable construction supervisor.

Appropriate O&M activities (4c)

Considering appropriate O&M activities for sanitation systems as requiring neither skilled labor nor electrical power, DEWATS satisfies these requirements and obviates the need for labor or energy inputs as part of its technical approach.

Disaster-friendly sanitation solution (4d)

The specific disaster-related risks threatening DEWATS in Haiti are floods and earthquakes. DEWATS construction can be tailored to mitigate these risks and therefore can be integrated as an appropriate WASH component in a DRR (Disaster Risk Reduction) program. In the case of earthquakes, smaller, modular units are able to mitigate risk better than larger units and below-groundwater retaining structures (DEWATS are below-ground structures) are more earthquake resistant than above-ground water retaining structures. In the case of floods, DEWATS reduces contamination caused by overflowing latrines, and may be used as part of a ravine rehabilitation project.

Estimated Lifespan (4e)

The design life of a DEWATS unit is determined by the materials used and the quality of construction. Assuming good quality materials and good construction supervision, a minimum of 25-year lifespan can be expected.

One of the benefits of DEWATS is that a plant can be designed for future expansion (to suit change in wastewater composition or in effluent discharge standards) by adding modules at later phases. This would, of course, require making provision of land required for the expansion.

For additional technical considerations, refer also to Annex A.

Table 2: DEWATS Applicability Matrix

	DEWATS Treatment Option	Institutional &legal criteria		Environmental /Sustainability Criteria			Socio-economic criteria			
		Compliance with national discharge standards	*Compliance with national strategy of DINEPA*	*Addresses the entire sanitation chain*	*Effluent treatment efficiency*	*Reduction of CO2 Emissions*	*Indicative cost initial investment /capita [USD]*	*Indicative monthly O+M cost/ household [HTG]*	*Interest of local authorities for DEWATS*	*interest of communities for DEWATS*
	Criteria ref.:	**1-a**	**1-b**	**2-a**	**2-b**	**2-c**	**3-a**	**3-b**	**3-c**	**3-d**
1	Individual house: SPT+ DD	3	2	3	3	3	3,400	375.00		
2	Individual house: ST + ABR + DR	1	1	2	1	2	5,300	430.00		
3	NH : SPT+ DD	3	2	3	3	3	600	75.00		
4	NH: ST + DR	3	1	2	3	3	300	70.00		
5	NH ST+ DD	3	2	3	3	3	300	70.00		
6	NH: ST + ABR + DR	1	1	1	1	2	870	120.00		
7	NH: BST + ABR + DR	1	1	1	1	1	1,200	120.00		
8	NH: ST + ABR + AF + DR	1	1	1	1	2	1,200	75.00		
9	NH: BST + ABR + AF + DR	1	1	1	1	1	1,500	75.00		
10	NH: ST + ABR (+ AF) + PGF + DR	1	1	1	1	2	1,900	130.00		
11	NH: BST + ABR (+ AF) + PGF + DR	1	1	1	1	1	2,200	140.00		
12	NH: ST + ABR (+ AF) + [PGF] + DR	1	1	1	1	2	1,200	75.00		
13	NH: BST + ABR (+ AF) + [PGF] + DR	1	1	1	1	1	1,500	75.00		
14	Public Toilet: ST+ DD	3	2	3	3	3	50	50.00		
15	Public Toilet: ST + DR	3	1	2	3	3	50	50.00		
16	Public Toilet: ST + ABR (+ AF) + DR	1	1	1	1	2	220	50.00		
17	Public Toilet: BST + ABR (+ AF) + DR	1	1	1	1	1	280	50.00		
18	Public Toilet: ST + ABR (+ AF) + [PGF] + DR	1	1	1	1	2	220	50.00		
19	Public Toilet: BST + ABR (+ AF) + [PGF] +DR	1	1	1	1	1	280	50.00		

Table 2 (continued): DEWATS Applicability Matrix

	DEWATS Treatment Option	Technical criteria				
		Local availability of construction material	*Appropriate construction techniques*	*Appropriate O & M activities*	*Disaster friendly sanitation solutions*	*Estimated life Span*
	Criteria ref.:	4-a	4-b	4-c	4-d	4-e
1	Individual household :SPT+ DD	1	1	1	1	25
2	Individual household: ST + ABR + DR	1	1	1	1	25
3	NH: SPT+ DD	1	1	1	1	25
4	NH: ST + DR	1	1	1	1	25
5	NH ST+ DD	1	1	1	1	25
6	NH: ST + ABR + DR	1	1	1	1	25
7	NH: BST + ABR + DR	1	1	1	1	25
8	NH: ST + ABR + AF + DR	1	1	1	1	25
9	NH: BST + ABR + AF + DR	1	1	1	1	25
10	NH: ST + ABR (+ AF) + PGF + DR	1	1	2	1	25
11	NH: BST + ABR (+ AF) + PGF + DR	1	1	2	1	25
12	NH: ST + ABR (+ AF) + [PGF] + DR	1	1	2	1	25
13	NH: BST + ABR (+ AF) + [PGF] + DR	1	1	2	1	25
14	Public Toilet : ST+ DD	1	1	1	1	25
15	Public Toilet : ST + DR	1	1	1	1	25
16	Public Toilet : ST + ABR (+AF) + DR	1	1	1	1	25
17	Public Toilet : BST + ABR (+AF) + DR	1	1	1	1	25
18	Public Toilet : ST + ABR (+AF) + [PGF] + DR	1	1	2	1	25
19	Public Toilet :BST + ABR (+AF) + [PGF] +DR	1	1	2	1	25

Legend to Table 2: DEWATS Feasibility Matrix:

SPT: Septic Tank ST: Settler BST: Biogas Settler
ABR: Anaerobic Baffled Reactor AF: Anaerobic fixed bed Filter (+AF): Anaerobic fixed bed Filter optionally planed in for future stricter discharge standards
PGF: Planted Gravel Filter [PGF]: Planted Gravel Filter planned for but build in a second phase
DR: Discharge to Ravine: directly if DEWATS is adjacent to Ravine or indirect via main street canal or via subsidiary street canal and main street canal.
DD: Discharge to existing drainage, or to open area. NH = Neighborhood = 20 to 1000 household
Public Toilet: Sanitation complex with demand based services (toilets, shower, washing place, water kiosk) with DEWATS.

Rating

1) Institutional and legal Criteria

1-a: Yes: 1; Partially: 2 No: 3

1-b: 1= Yes (all DINEPA strategic elements complied with) 2= Partially (1 DINEPA strategic elements not complied with; 3=No (more than 1 DINEPA strategic elements not complied with)

2) Environmental Sustainability Criteria

2-a: 1=conveyance, treatment, safe discharged and reuse potential considered; 2= conveyance, treatment, safe discharged; 3=conveyance, treatment,

2-b: 1= COD/BOD <100/30mg/l; 2=COD/BOD<150/50mg/l; 3=COD/BOD>150/50mg/l

2-c: 1=potential effluent reuse for agriculture+ Biogas combustion + fossil fuel substitution; 2=potential effluent reuse; 3= no potential reuse]

3) Socio-Economic Criteria

3-a: cost in USD (refer also to annex B).

3-b: cost in HTG for operation and maintenance of SSS and treatment system for 50 m3 daily wastewater flow. For Public toilets, operating costs have been developed using a 12 seater toilet with 35 users/day/ seat. The tertiary treatment has been assumed as PGF (planted gravel filter). Rock-band and planted drain options have not been considered in this table. For estimation purposes, 20USD per capita could be added to the investment cost of the primary/secondary treatment option selected when RB or PD are selected (50 m3 daily wastewater) flow)

3-c: No ranking done. The result of the study is required to collect indications of interest of government departments towards the most promising DEWATS options (see section 3.4)

3-d: No ranking done. The result of the study is required to collect indications of interest of communities towards the specific DEWATS options (see section 3.4).

4) Technical criteria

4-a: Yes: 1; Partially: 2 No: 3

4-b: Yes: 1; Partially: 2 No: 3

4-c: Yes: 1; Partially: 2 No: 3 Note: Partially = PGF maintenance, compared to ST,BST, ABR , AF, higher cost but appropriate

4-d: Yes: 1; Partially: 2 No: 3

4. Sanitation Considerations for the PPMA

4.1. Introduction and General Consideration

The sanitation considerations presented here provide a general overview of the PPMA urban environment and indicate some of the challenges posed when implementing sanitation projects. The considerations are grouped into subjects that are relevant to the applicability of DEWATS in the PPMA.

A general consideration for urban planners and sanitation professionals alike is that Port-au-Prince may be defined according to a rapid and unplanned urbanization which commenced in the 1980s. This rapid urbanization left the majority of the population without access to basic needs services.

4.2. Administrative Division

The Port-au-Prince Metropolitan Area (PPMA) is inhabited by about 2.8 million inhabitants (CIAT, 2010). The PPMA is divided administratively into 7 *communes*: Port-au-Prince, Delmas, Cite Soleil, Tabarre, Petion Ville, Carrefour and Croix-des-Bouquets. Each commune is represented by an elected Mayor and is sub-divided into *section communals*, represented by CASECs (Conseils d'Administration des Sections Communales). Some parts of these communes could be classified as 'peri-urban', although the majority of the PPMA is classified as urban.

4.3. Topography and Watershed Drainage Areas ('basin versants')

The PPMA is located mainly in the large drainage area (watershed) known as the 'plein de cul-de-sac', one of the 30 major watersheds in Haiti. The cul-de-sac drains an area of 1598KM^2 (USAID, 2007). The western side of the PPMA, where the commune of Carrefour is located, in another watershed known as 'Zone du Leogane'.

Figure 4: Two main watersheds of the PPMA: Cul-de-Sac to the East and Leogane to the West.

The watersheds define the general topography of the PPMA sloping from the hills of Petion Ville down to the sea. Within these two large watersheds, it should also be possible to delineate sub-watersheds defined by ravines and rivulets that run throughout the PPMA. Defining these sub-watersheds would facilitate sanitation planners to identify opportunities for integrated

decentralized solutions within the drainage master plan and could also facilitate preparation of the general drainage master plan to consider existing DEWATS projects.

4.4. Land Use

The PPMA is largely an urban zone with some peri-urban and rural zones. Within the urban zone there is a mixture of residential areas of varied socio-economic groupings, a central commercial district, a port area and a market area. The inhabitants of these areas are diverse; it is beyond the scope of this Report to attempt a precise categorization of land-use according to the PPMA population. However, a simplified categorization by land-use typologies in the PPMA has been attempted in the list and the figures are shown below.

It is important to note that the following land-use typologies may exist in isolation but it is more likely that geographic areas will contain several of these land-use typologies together:

- *High-income residential neighborhoods ('haut standing'):*

  Housing plots are planned and defined with large building areas greater than 300 m^2 having two storey or more. The urban area less dense and there is space for construction.

- *Middle-income residential neighborhoods ('moyenne standing'):*

  Housing plots are planned and defined with building area of 100-300m^2, single or two-storeyed. The urban area is of medium density and there is limited space for construction.

- *Low-income residential neighborhoods ('bas standing'):*

  Semi-finished and improvised housing plots with a building area of less than 100m^2. Houses are usually unplanned with open spaces being taken up by smaller buildings. The urban area is dense and finding space for construction is difficult.

- *Slum neighborhoods ('bidonvilles')*

  Slum neighborhoods in the PPMA are usually 'low-lying' (near the sea) or 'sloped' (on the hills around the edge of the urban area). Slum dwellings are usually small with 20-30m^2 per household. The urban area is very dense and finding space for construction is difficult and may involve relocation of existing structures.

- *IDP camps*

  There are still over 300,000 IDPs, mostly living in camps in the PPMA (OCHA, 2012). The camps are characterized by their light, temporary structures and deficiency in public sanitation services.

- *Market area*

  The large market area near the Port comprises of several different markets (Marche Croix-de-Bossalles, Marche du Port, Marche Cabrit etc.) each with its own management structures in place. The markets are characterized by a high density of people and market buildings, a large quantity of organic solid waste, poor access to toilets, poor sanitation and flooding.

- *Agricultural land*

  In the North and North-East of the PPMA (in Croix-de-Bouquets) there are some low density, agricultural activities managed by the rural population.

- *Industrial area*

  A large industrial area, 'SONAPI', exists between the airport and the commune of Citey Soley. There are also other industrial areas situated within residential areas of the city.

- *Commercial area*

There is a large commercial area between Champ de Mars and the sea. There are also other commercial areas situated within residential areas of the city.

- *Port area*

  The Port area is located next to the market area.

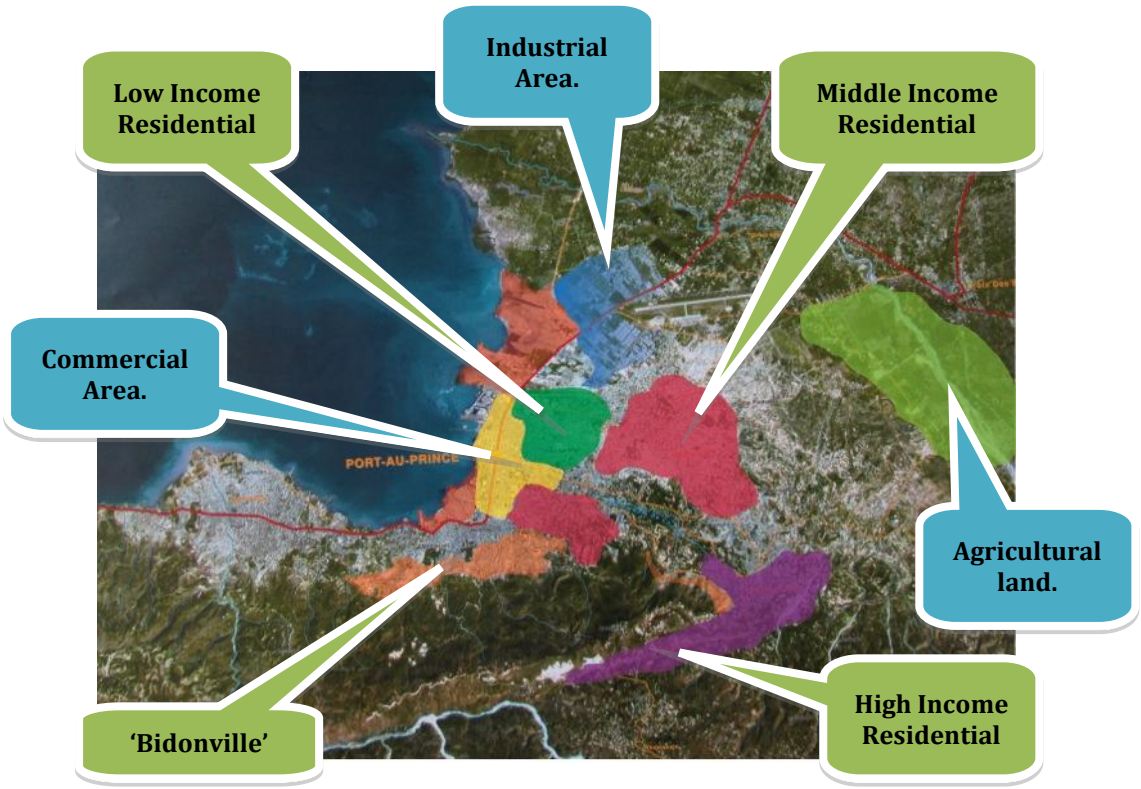


Figure 5: Indicative Land-use typologies in PPMA.

4.5. Access to Water

According to Haitian census data, 68% of the population in the PPMA have access to a protected water source (UNFPA, 2012). The WHO/UNICEF JMP put this figure slightly higher at 70%, of which 15% is through a household pipe connection (WHO/UNICEF, 2012). However, for the vulnerable population, water access is not always convenient, safe or reliable. A diagnostic study undertaken of 242 DINEPA water kiosks in 46 vulnerable neighborhoods of the PPMA (GRET, 2011) highlights some of the issues:

- 50% of water kiosks in neighborhoods did not provide a minimum of 15l/capita/day.
- 50% of neighborhoods were supplied with water for less than 10 hours per week.
- Only 20% of water supplied was chlorinated.

Exact water consumption is difficult to determine in Port-au-Prince without measuring usage in individual households. Reliable water consumption data for the 4 RC sites in the PPMA was not available from any of the sources including the RC, DINEPA, and the CTE.

4.6. Existing Sanitation Infrastructure

Improved sanitation coverage in urban Haiti was at 24% just before the 2010 earthquake (UNICEF & WHO, 2012). It is interesting to note that in 1990, improved sanitation coverage was higher at 44% (UNICEF & WHO, 2012). Exactly how the figure is broken down between the various sanitation

options cannot be generalised for the PPMA and must be determined on a house-by-house basis to arrive at reliable figures. Some considerations are presented below:

- *Toilet types:* Flush toilets leading to septic tanks, simple pit latrines, VIP latrines, bucket toilets, plastic bags and open defecation. Some ecological sanitation options have been piloted in the PPMA since the earthquake (SOIL, 2012).
- *Wastewater segregation*: Where black water and grey water are separated, they are managed differently – grey water is discharged above ground to the street or to street level drainage channels. Black water discharge is usually below ground and not seen.
- *Wastewater drainage*: The PPMA has some examples of decentralized sewer systems from the 1980s (e.g. Ti Plas Cazo). However, the PPMA is largely without a wastewater collection system and individual buildings usually manage their own wastewater. The most commonly used drains for wastewater disposal are storm water drains, canals, ravines and roads. A drainage master plan is being developed by DINEPA.
- *Wastewater treatment*: In December 2011, the first National wastewater treatment site in Morne a Cabrit was commissioned. In May 2012, another site in Titanyen was commissioned. Morne a Cabritand Titanyen are designated for latrine sludge and liquid waste from septic tanks respectively. It should be noted that due to financial constraints, most septic tanks in the PPMA are not desludged and their operational requirements are not provided.
- *Desludging:* Desludging of latrines and septic tanks is undertaken manually (Bayakou) or mechanically (e.g. JEDCO, SANCO). Private sector sanitation actors in the PPMA offer these services. There is also a large fleet of desludging vehicles managed by DINEPA for desludging emergency toilets in IDP camps.
- *Re-use:* Re-use is an innovation to be considered by sanitation projects in Haiti according to DINEPA strategy no. 8 of the Operational Plan for 2012 - 2014 (DINEPA/AECID, 2012). Organic waste is re-used by practitioners of animal husbandry in the ravines and in the market areas and also by certain NGOs in the PPMA (SOIL, 2012).
- *Standards and monitoring*: At the time of reporting, DINEPA was developing the standards for sanitation in the PPMA.

4.7. The Legal and Institutional Framework for Sanitation in Haiti

The government body responsible for water and sanitation in Haiti is DINEPA (Direction National de l'Eau Potable et d'Assainissement). It was created in March 2009 as part of the reform of the water and sanitation sector in Haiti (Corps Legislatif, 2009). This reform and the planned actions to follow after 2009, were set-back by the tragic events of 2010. Decentralization of water and sanitation services is one of the principal objectives of the reform of the water and sanitation sector in Haiti (DINEPA/AECID, 2012).

At the time of writing, Haiti's official technical standards and guidelines for sanitation were being prepared. Some of the existing rules are listed below:

- It is the responsibility of each household to provide a sanitation facility: household toilets should not be subsidised by NGOs. (DINEPA, 2012)
- Public toilet construction may be subsidised completely or partially only if operational costs are also subsidised for an initial period of 6 months to 1 year and that these costs are managed by the local organisation after this start-up period. (DINEPA, 2012)
- To guarentee continuation of water and sanitation services, users will be obliged to pay a tariff (DINEPA, 2011)
- Blackwater (from toilets) should not be discharged to the ground. (DINEPA, 2012)
- Greywater (from sinks and showers) may be transported by open conduits. (CIAT, 2012)
- Drainage conduits are to be laid at a minimum gradient of 0.5%. (CIAT, 2012)

- “any action which pollutes the environment is punishable.” (CIAT, 2012)
- Solid waste disposal is prohibited unless designated metal containers are used. (CIAT, 2012).

If a household decides to install a flush toilet, then logically, and according to the above rules, the household should also provide waste treatment for the sewage if no public sewer is available. However, it is normally infeasible for toilet owners to provide their own treatment and therefore a collective approach is needed.

4.8. Solid Waste Management (SWM)

There is a single landfill site for the treatment of solid waste at Troutier in the commune of Citey Soley. The site is managed by SMCRS, who also manage the solid waste collection in the PPMA. However, the collection service does not reach a majority of the population; over 87% of vulnerable households in the PPMA dispose their solid waste directly into the ravines and canals (UNOPS, 2011).

The scale of the SWM problem is similar to the human waste management problem and the two are closely linked. Hence, sustainable improvement in sanitation must be complemented with sustainable improvement in SWM.

4.9. Location of Effluent Discharge.

DEWATS treats effluent to standards determined by local legislation. Whether the treated wastewater is discharged into the environment or re-used, the effluent discharge location is a determinant in deciding on the level of treatment required.

Effluent receiving watercourses in the PPMA are either (1) natural ravines with stone or gravel beds or (2) man-made, concrete-lined canals. Where technically feasible, treated effluent should be discharged directly from the DEWATS into the watercourse. Where this is not technically feasible, an indirect discharge route may be selected. 3 kinds of discharge options are presented in the figure 6 below:

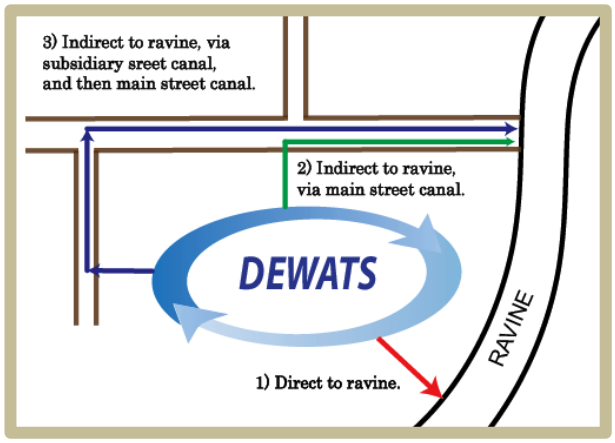


Figure 6: DEWATS discharge options in the PPMA.

Effluent discharge standards may be stringent in the PPMA because of the use of ravines for bathing and clothes washing by the riparian population and the fact that the ravines are often dry or in low-flow and there is little dilution of the discharged effluent. However, effluent discharge standards must also be realistic and reflect the general poor quality of the PPMA environment.

4.10. Interest of Community

The community in the PPMA may have different priorities than the other sanitation actors wishing to implement wastewater treatment projects. Through DEWATS projects, the development support actors and the government may target reduction of illnesses transmitted by excreta, reduction of contamination of water sources, reduction of green house gases and so on. On the other hand, the community and the individual household may wish for improvement of access to toilets, safer neighborhood environment for their children, an increase of dignity through use of sanitation facilities, reduction of expenditure to maintain good health and so on.

The community must be "brought on board" of a project by understanding the benefits it would bring. Beside the benefits of DEWATS, costs related to DEWATS should be also explained to communities, mainly if connected households are expected to make a financial contributions (e.g. monthly tariff). The potential for re-use treatment products (biogas, composted sludge, and treated effluent) and their specific benefits need to be elaborated:

- Biogas from domestic wastewater will help only marginally to reduce the environmental burden due to Haiti's dependency on charcoal as the main cooking fuel (USAID, 2007). Nevertheless, biogas use could help subsidise O&M costs for DEWATS.
- Composted sludge and treated effluent could boost agricultural productivity in Haiti's nutrient-depleted soil (Republic of Haiti, 2004).

Sanitation will never be valued the way water is and therefore, sanitation projects that need contributions of the community require either prolonged community involvement processes or need to be linked with other services for which users have a higher willingness to pay. This may also be the case in Haiti.

4.11. Interest from Local Authorities

Decentralization of water and sanitation services is one of the principal objectives of the water and sanitation sector reform in Haiti (DINEPA/AECID, 2012). As the decentralization occurs, DINEPA will become the leading regulatory body in the country. This decentralization will be from DINEPA to the regional OREPAs, in the short-term and medium-term and from the OREPAs to the communes, in long-term.

Given the fact that decentralization is the key to the reform that is currently taking place, DEWATS could be considered as an appropriate technical approach and one which would generate interest from local authorities. Impact-relevant pilot DEWATS projects will be required to prove to the PPMA authorities that DEWATS can be integrated in the city development plans and can play a substantial role in the city sanitation plan for PPMA. These projects are also required to convince both the local urban bodies responsible to secure basic need services as well as the communities.

5. Four Case Study Sites

5.1. DEWATS Study Site: Delmas 30

5.1.1. Characterization of Site

The site plan for the IFRC INA Site Delmas 30 is shown in figure D30_1 at the end of this section. The site plan shows the key physical features of the site as well as some suggested locations where DEWATS may be applicable. See also the table below.

Ref.	Site Name: Delmas 30	
1	Site area (sq meters)	53,070
2	GPS coordinates	18.5486150°, -072.3110218°
3	Site elevation (meters)	From 100m to 85m (15m difference)
4	Description of receiving watercourses	The site is bordered by a natural ravine and a concrete canal to the North and South respectively.
5	Land use	Dense residential area with a variety of housing types from middle income houses to 'slum' dwellings. Very few open green spaces, mostly impermeable concrete surface or compacted 'hard' gravel surfaces.
6	Number of houses	519
7	Population	2,595
8	Water supply	6 private water kiosks and 3 DINEPA water kiosks. Additionally, there are private household reservoirs that sell water by the bucket.
9	Sanitation	54% of households have latrines, 7% have flush toilets and the remaining 39% have unspecified or no sanitation [Source: IFRC)

Table D30_1: Site characteristics of Delmas 30

5.1.2. Site-specific Considerations for DEWATS

Enlisted below are the site-specific considerations which are crucial for DEWATS implementation at Delmas 30.

Topography and Drainage

- There is a slope throughout the site from the high point near the ravine, down to Delmas 30 and the concrete canal. The slope is quite steep on Impasse La Fois road and more gentle on Rue Damas road.
- The ravine is one of the PPMA's main storm channels and the low-lying area near the ravine is at risk of flooding.
- The ravine itself is at further risk of erosion with each storm event. According to site interviews, the area called Hollywood is regularly flooded after storm events. The flood level in the ravine is approximately 2.5m (as per the LGL report, 2012).
- Both the ravine and the concrete canal could be used as effluent discharge locations.
- The site slopes away from the ravine meander on the east, towards the west and the southwest.

Land use

- The area called 'Holywood' can be defined as low-income or slum.
- The houses are dense with little open space and only 2 main roads, Impasse la Fois and Rue Damas. There is no throughway for vehicles on the site and few vehicles were parked inside the site during the site visits. Vehicle access to a majority of houses is not possible.
- Most road and path surfaces are concrete or compacted gravel. There is a variety of drainage pipes running through these roads and paths (see photo D30_2)
- There is little available free space on the site. The only obvious clear space is the high point of the site near the ravine.
- Households have encroached upto the ravine walls and near "Hollywood"; some houses are actually in the ravine.

Access to Water and Existing Sanitation Infrastructure

- Some middle-income houses have reservoirs which water is sold as private vendors. The extent of the DINEPA network was not mapped but some households visited in "Hollywood" had DINEPA connections.
- A few spot checks during the site visit revealed flush toilets as well as some very poor sanitation practices. These included a septic tank that had been left open in the middle of Rue Damas (owner was waiting to get it fixed (see photo D30_1) as well as a flush toilet with a direct piped connection from the toilet seat to the concrete canal.

Solid Waste Management

- The ravine was used as a solid waste dumpsite by the residents of Delmas 30 and by the large industry ACCRA, who disposed off solid waste further upstream (East).
- Pigs kept as livestock, consume some of the organic waste in the ravine. There are a number of pig stys on the ACCRA factory side of the ravine which are managed by the residents of "Hollywood".

Interest of Community and Local Authorities

- The community may be interested in improving the immediate household environment i.e. covering open storm water channels and releasing stagnant water that causes nuisance and risk for children.
- The community may be interested in improvements to house connections and repairing external plumbing.
- Sanitation may not be a priority for the community, depending on the location of the household and socio-economic group
- A community 'platform' has been set up to interact with the activities of the Red Cross. The Mayor of Delmas has been engaged in significant road building since 2012.

Photos: Delmas 30

Photo D30_1: Collapsed septic tank

Photo D30_2: Drainage channels in walkway

Photo D30_3: Ravine and Sogebank

Photo D30_4: Concrete canal

5.1.3. Opportunities for DEWATS Intervention

Based on the above site-specific considerations, general suggestions can be made on the options for DEWATS intervention at the site. Where possible, suggestions are presented in terms of technical and socio-economic components. Indicative costs for the suggested options are presented in Annex B.

Option 1: Single DEWATS for entire INA site

This option can be excluded as the topography as well as the varied levels of regularization of the neighborhoods would not favor a single DEWATS plant to serve the entire neighborhood.

Option 2: DEWATS for clusters of houses at Impasse Damas (see figure D30_2)

Partitioning the Delmas 30 site into smaller areas determined by their ability to drain by gravity, facilitates consideration of the DEWATS option. A DEWATS option has been identified at Impasse Damas.

There are existing open wastewater channels on both sides of Impasse Damas collecting flows from other smaller wastewater sub drains. Off Rue Damas, is an INA project to connect household rainwater drainage into a rehabilitated shallow canal with recycled-rubble cover slabs. Connected to the top of this new drain are more traditional wastewater channels running above-ground or at a shallow level below ground.

A DEWATS plant could be sited at the lower point of the catchment area near the man-made canal so as to drain into it. A potential site is in the car park near the community meeting hall and water kiosk in the southern part of the site.

A SSS of about 60m with connecting branch sewers is required to connect houses to reach the DEWATS. The SSS design would be integrated in the existing drainage channels.

The DEWATS treatment options suggested would include a settling device and a secondary treatment with an ABR. The settler could be designed as a biogas settler this would depend on the finally decided house connections and the expected quantity of black water. The generated biogas as cooking carburant could be an incentive for the operator. Further, tertiary treatment seems to be infeasible due to constraints of land availability.

With approximately 60 households to be connected, the system would be designed for a $30m^3$ per day wastewater flow. The table below presents the components of this option.

Table D30_2: Delmas 30 option 2

	Technical Components for DEWATS
Toilet	Low flush toilets
House connections	Individual house or house-group connection to SSS
SSS	SSS for black water and grey water in the existing storm water drainage
Storm water drainage	Storm water drainage improvement where necessary
WWT: Settling device	Settler or Biogas Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	None
Discharge point	Storm water channel
Sludge disposal	Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by residents association
O+M	Private Service Provider/Resident Association Tariffs to recover O+M costs; tariff linked to water supply or other local service
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently by local authority (e.g. DINEPA).

Option 3: DEWATS for clusters of houses at Ruelle Fraternite (see figure D30_3)

The Eastern end of Ruelle Fraternite comprises a cluster of around 20 houses which could be connected to a DEWATS plant built beneath the pavement.

The DEWATS treatment options suggested would include a settling device and a secondary treatment with an ABR. The settler could be a biogas settler depending on the finally decided house connections and the expected quantity of black water. The generated biogas as cooking carburant could be an incentive for the operator. Further tertiary treatment does not seem to be feasible due to constraints of land availability.

Discharge to the nearest channel towards south-west would require a discharge pipe running along the main road Delmas 30 (rue Archille). The Table below presents the components of this option.

Table D30_3: Delmas 30 option 3

	Technical Components for DEWATS
Toilet	Low flush toilets
House connections	Individual house or house-group connection to SSS
SSS	SSS for black water and grey water in the existing storm water drainage
Storm water drainage	Storm water drainage improvement where necessary
WWT: Settling device	Settler or Biogas Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	None
Discharge point	Storm water channel
Sludge disposal	Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by Residents Association
O+M	Private Service Provider/Residents Association Tariffs to recover O+M costs; tariff linked to water supply or other local service
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently by local authority (e.g. DINEPA).

Option 4: Public toilets using DEWATS (see figure D30_4)

The absence of public toilets and the fact that 39% of households have undefined sanitation infrastructure should facilitate consideration of public sanitation complexes specially in the low income and slum-like areas.

These complexes should provide different services to be decided with the respective neighborhoods through public consultations. The main considerations should be toilets, showers and clothes washing places. Laundry places should be designed according to requirement and local habits to ensure their utilization. Willingness to pay for these services and related user fees also need to be further elaborated through a detailed study.

The benefits of bundling water supply and wastewater treatment services would also apply to public toilets and water kiosks. Where existing water kiosks are located next to open space (e.g. Ruelle La Paix), these opportunities should be explored.

During the site visit, 3 potential locations were identified:

- Rue La Paix.
- At the high point of Delmas 30
- In the slum area 'Hollywood' (see figure D30_4), although this depends on plans to develop the site especially the ravine.

Other services like showers and laundry places need to be explored through public consultations. The Table below presents the components of this option.

Table D30_4: Delmas 30 option 4

	Technical Components DEWATS Public Toilet Block
Sanitation Facilities	As per demand (toilets, showers, laundry place etc.)
WWT: Settling device	Settler or Biogas Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	Rockband linked with reinforcement of embankment
Discharge point	Ravine
Sludge disposal	a) Sludge drying bed attached b) Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by Residents Association
O+M	Localized service provider (water kiosk, other) Recover O+M costs: through agreed user fees and the balance through cross subsidy from other basic services in the area (e.g. water from water kiosks,)
Ownership	Municipality (Commune)
Monitoring	2 years by donor and then handover to local authority (e.g. DINEPA).

5.1.4. Opportunities to link DEWATS with other neighborhood development activities

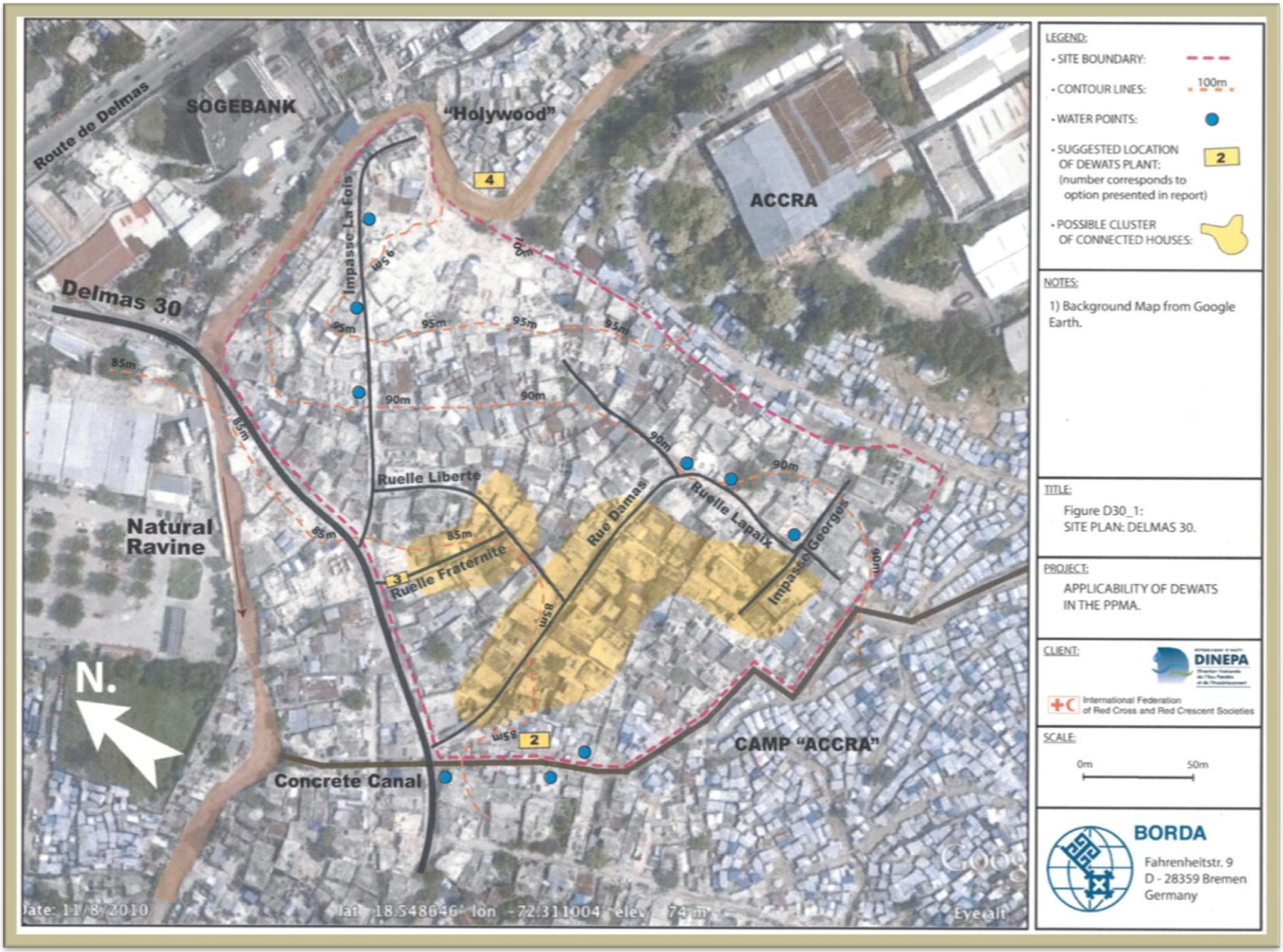
Where possible, decentralized sanitation interventions should be linked to other settlement improvement activities.

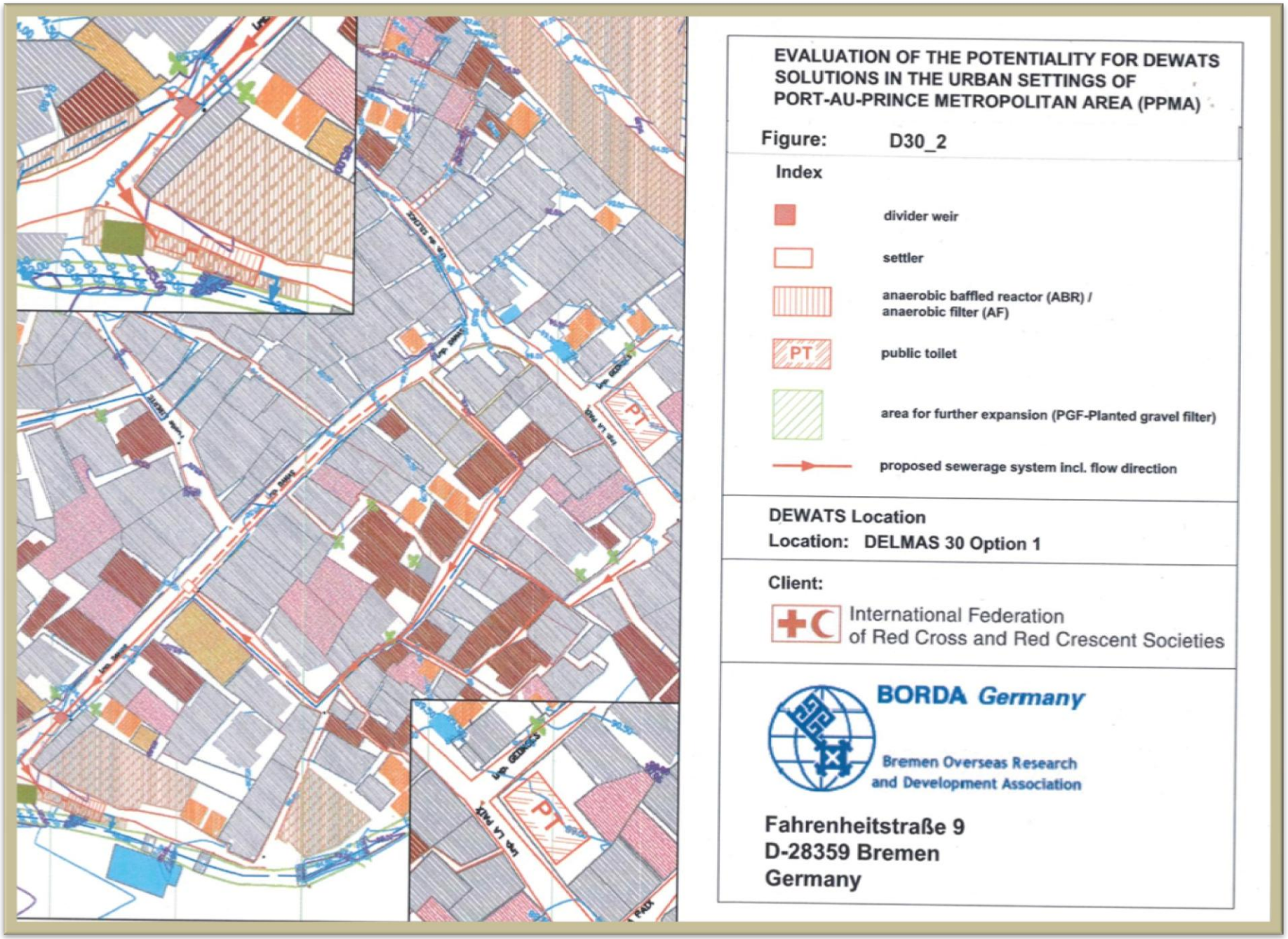
It would be advisable to integrate some of the above described DEWATS opportunities to the planned rehabilitation of the ravine. This would allow for synergies and chances to reduce the investment cost.

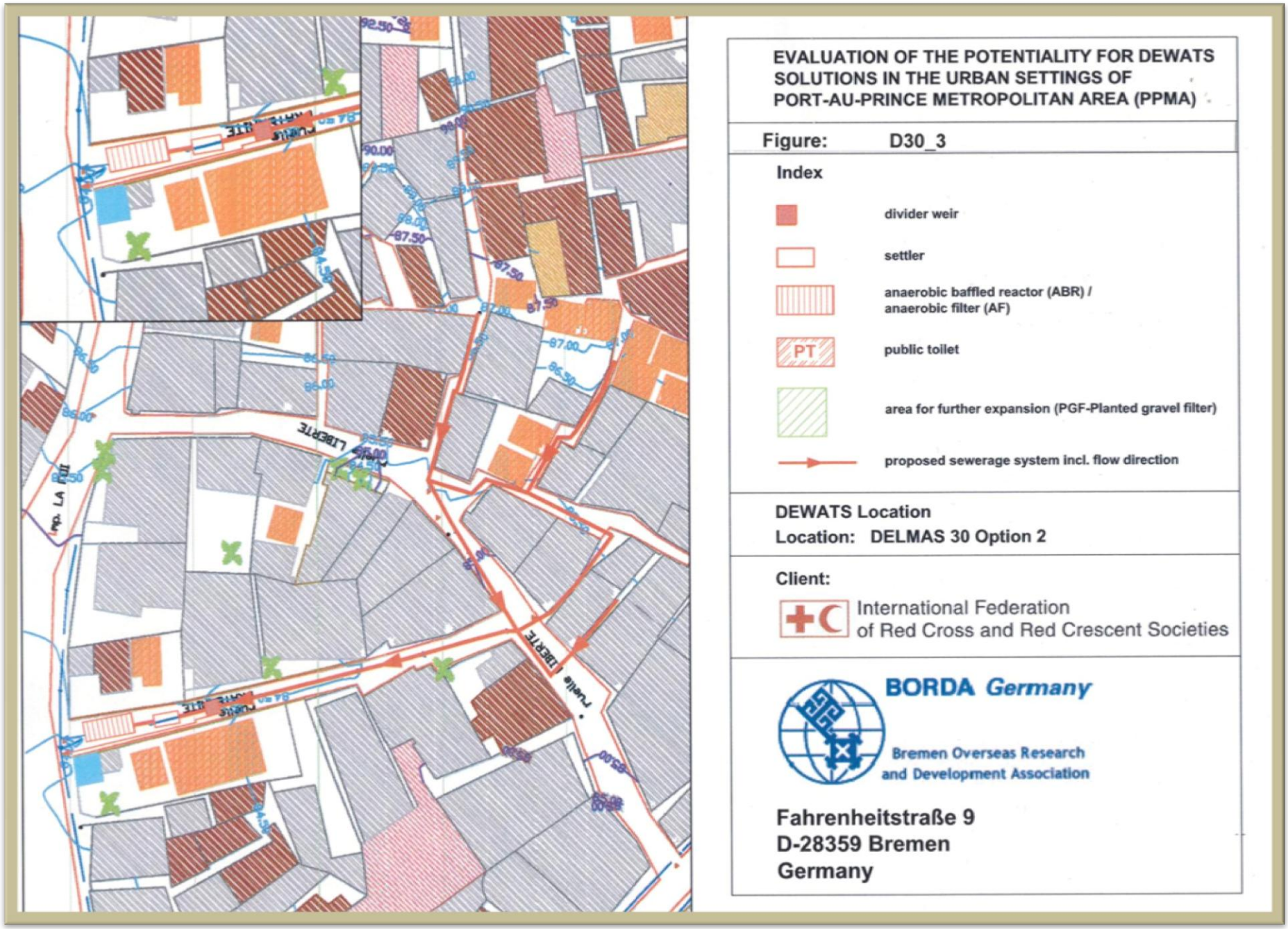
- The DEWATS modules could be designed and constructed as part of the ravine retention wall.
- The DEWATS effluent could provide irrigation for new green recreational spaces along the ravine.
- The top of the DEWATS plant could be a road or pavement for any new transportation or walkway planned for the ravine.

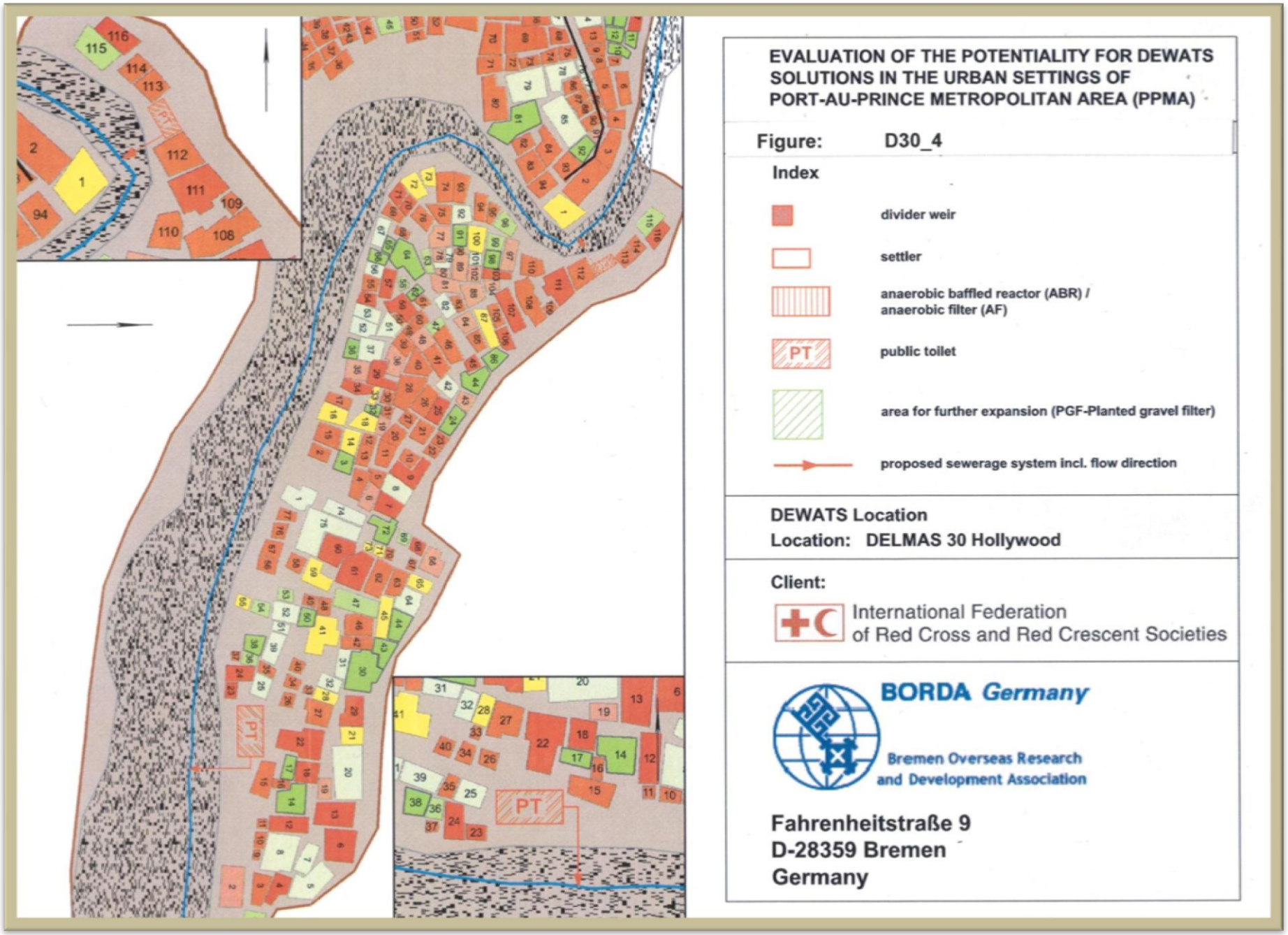
The public sanitation complexes could be linked to other initiatives targeting information services, health and hygiene campaigns, distribution and sales of hygiene and reproductive health articles and so on.

Opportunities to integrate construction of SSS and the effluent discharge line with road building may be available in collaboration with the Mayor's office.


Route de Delmas
SOGEBANK
"Holywood"
ACCRA
Impasse La Fois
Delmas 30
Natural Ravine
Ruelle Liberte
Ruelle Fraternite
Rue Damas
Ruelle Lapaix
Impasse Georges
CAMP "ACCRA"
Concrete Canal
N.
4
3
2
95m
90m
85m
LEGEND:
- SITE BOUNDARY:
- CONTOUR LINES: 100m
- WATER POINTS:
- SUGGESTED LOCATION OF DEWATS PLANT: (number corresponds to option presented in report) 2
- POSSIBLE CLUSTER OF CONNECTED HOUSES:
NOTES:
1) Background Map from Google Earth.
TITLE:
Figure D30_1:
SITE PLAN: DELMAS 30.
PROJECT:
APPLICABILITY OF DEWATS IN THE PPMA.
CLIENT:
DINEPA
International Federation of Red Cross and Red Crescent Societies
SCALE:
0m
50m
BORDA
Fahrenheitstr. 9
D - 28359 Bremen
Germany


EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D30_2
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS 30 Option 1
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany


EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D30_3
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS 30 Option 2
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany


EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D30_4
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS 30 Hollywood
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany

5.2. DEWATS Study Site: Carrefour Feuilles 'CFF'

5.2.1. Characterization of Site

The site plan for the IFRC INA Site CFF is presented in figure CFF_1 at the end of this section. The site plan shows key physical features of the site as well as some suggested locations where DEWATS may be applicable. See also the table below.

Table CFF_1: Site characteristics of CFF

Ref.	Site Name: CFF	
1	Site area (sq. meters)	166,590
2	GPS coordinates	18.5261703°, -072.3423875°
3	Site elevation (meters)	From 110m to 70m (40m difference)
4	Description of receiving watercourses	The site is crossed by a ravine in its North-East corner. A man-made canal in the eastern half of the site drains into this ravine.
5	Land use	Steeply sloping residential area with several middle income houses and T-shelters. Wide streets with trees on either side. 'Hopital Sanitorium' to the West of the site.
6	Number of Houses	539
7	Population	2,695
8	Water Supply	DINEPA water connections Informal water vendor
9	Sanitation	51% of households have latrines, 18% have flush toilets and the balance 31% have unspecified or no sanitation (Source IFRC)

5.2.2. Site-specific Considerations for DEWATS

The following site-specific considerations are important for the possible implementation of DEWATS at CFF:

Topography and Drainage

- There are several construction activities in the area including house construction, walkway improvements and ravine rehabilitation.
- Main roads are asphalted, 6-8 meter wide and have stormwater channels on both sides. Culverts running beneath the road seem to get blocked frequently. They dispose untreated wastewater and solid waste directly into the ravines.

Land Use

- There are several middle-income and some low-income houses in the North-East part of the site.
- There are several Temporary Shelters in the area.
- There is an IDP camp in the North-West part of the site.

Access to Water and Existing Sanitation Infrastructure

- During the site visit, a large quantity of water flowed along the streets. The site appears well served with DINEPA water supply and there are many informal water businesses selling water from house tap connections.

- Most houses seem to have toilets despite the fact that 30% have undefined sanitation access according to IFRC data. The new bathroom plumbing on the first floors seem to be connected to ground floor latrines. It was observed that wastewater discharges directly into ravines as well as into septic tanks .
- No public toilets were seen.

Solid Waste Management

- Solid waste management seems to exist at household level in several areas, whereas the ravines, canals and backyards are used for dumping wastes as in the rest of the city.

Interest of Community and Local Authorities

- The CASEC for Deuxième Morne Hospital, to the North of the CFF site, favors interventions that reduce the exposure to wastewater as he considers "sanitation infrastructure the beginning of health". Public toilets are considered necessary but only for visitors. "Individual toilets is what people are aspiring for".
- Community Associations from the area evinced interest in participating in project activities related to sanitation.

Photos: CFF

Photo CFF_1: Wastewater drain on Rue D'Eau

Photo CFF_2: Canal crossing Impasse Salem

Photo CFF_3: Private water business

Photo CFF_4: Toilet discharge to canal

Photo CFF_5: View up Rue d'Eau

Photo CFF_6: Footpath improvement work

5.2.3. Opportunities for DEWATS Intervention

Based on the above site-specific considerations, general suggestions can be made for DEWATS intervention at the site. Where possible, suggestions are presented in terms of technical and socio-economic components. Indicative costs for the suggested options are presented in Annex B.

Option 1: Single DEWATS for entire INA site

This option may be excluded as the topography as well as the different levels of regularization of neighborhoods would not favor a single DEWATS plant to serve the entire neighborhood. This is re-enforced by the steep slope of CFF that would make the construction of SSS for the entire area difficult; SSS along contours would not be feasible in most places.

Option 2: DEWATS for clusters of houses at Impasse Salem (see figure CFF_2)

The middle income neighborhood of about 20 houses at the junction of Ruelle Admiral and Impasse Salem, could be provided with a SSS. Its wastewater could be treated at a DEWATS constructed beneath Impasse Salem road before it crosses the canal. The land available would allow for a system to serve up to 25 houses. The effluent could be delivered into the canal. A tertiary treatment integrated with a public green area e.g. near the community meeting place further down Impasse Salem, would need to be evaluated when proceeding with the detailed design.

It may be possible to link other existing wastewater house connections to the SSS as well as several other inner houses above Ruelle Admiral but these would require further detailed study as well as identification of additional space for DEWATS.

The existing Community Association should be approached to seek their involvement in planning and operation of the infrastructure to be established.

The DEWATS treatment options suggested would include a settling device and a secondary treatment by an ABR. Both units would be constructed under the road and the discharge would be to the canal. If reuse is considered (see above), an alternative discharge point will need to be located. The Table below presents the components of this option.

Table CFF_2: CFF option 2

	Technical Components for DEWATS
Toilet	Low flush toilets
House connections	Individual house or house-group connection to SSS
SSS	SSS for black water and grey water
Storm water drainage	Storm water drainage improvement where necessary
WWT: Settling device	Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	1) None 2) Planted drain for public greenery
Discharge point	Canal
Sludge disposal	Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by Residents Association
O+M	Private Service Provider/Resident Association Tariffs to recover O+M costs; tariff linked to water provision or other local service
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently by local authority (e.g. DINEPA).

Other Options

Space for other potential DEWATS interventions may be identified at several other locations (bottom of Ruelle Admiral and Impasse Salem road, etc.). A further study would facilitate the identification of further clusters to be served with a DEWATS. Construction will be difficult because of the limited availability of land for either DEWATS or sewerage lines.

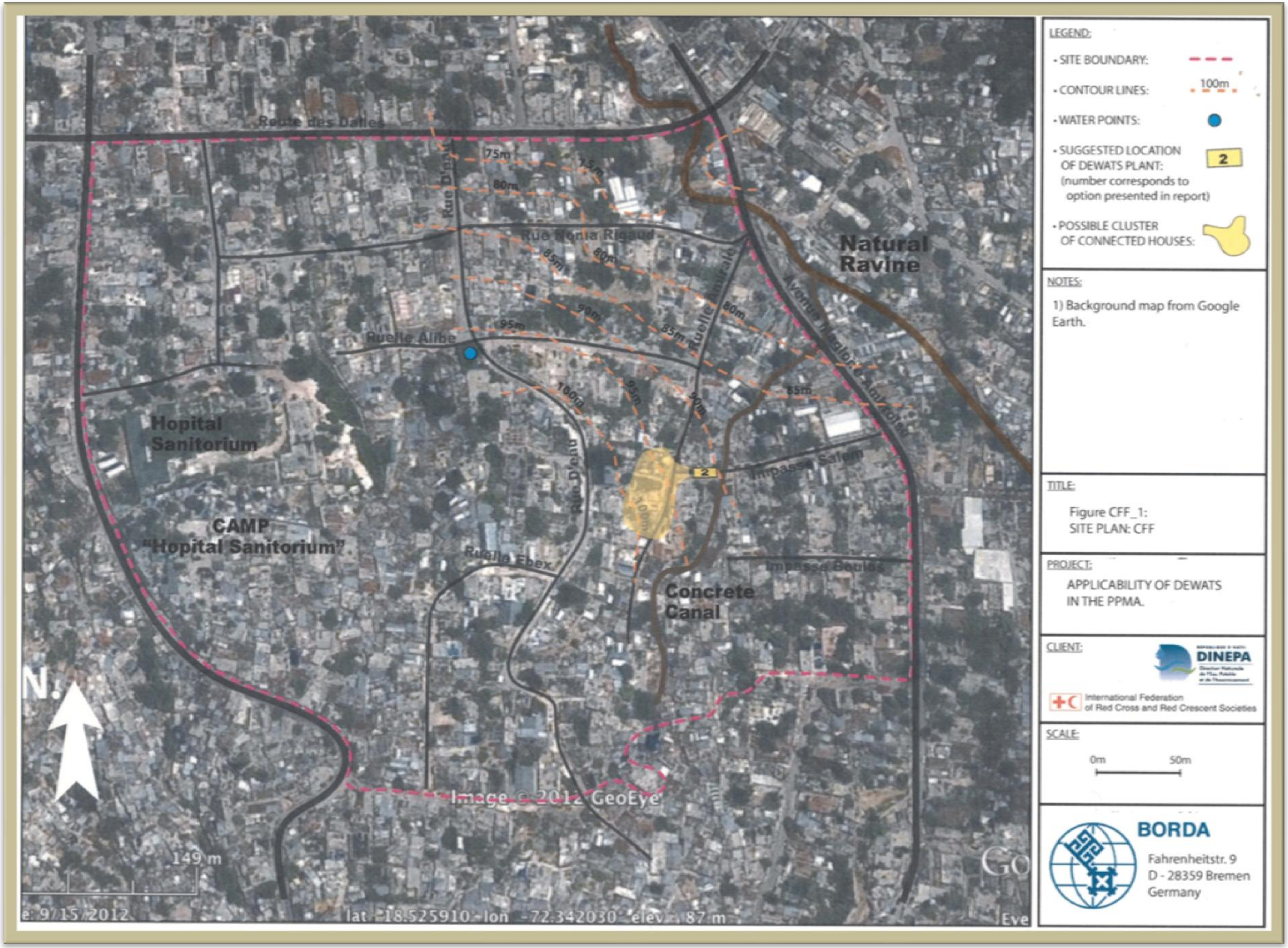
Public toilets, with DEWATS, would probably not be required as most of the houses in CFF have private toilets.

5.2.4. Opportunities to link DEWATS with other neighborhood development activities

Where possible, decentralized sanitation interventions should be integrated with other settlement improvement activities. Ongoing work for reinforcement of ravine embankments with gabions was observed at the site. It would be advisable to coordinate this kind of intervention with DEWATS:

- In the steep parts of CFF and where pedestrian access is not required, the ravine reinforcement work would allow new locations to establish DEWATS which could be integrated with the gabion wall structure.
- In the steep parts of CFF and where pedestrian access would be desirable, other than the above, the footpath could be integrated with some of the tertiary treatment modules.
- In the lower part of CFF, the ravine recovery work could also include the creation of green recreation area (irrigated by treated wastewater) as well as footpaths.
- The observed improvement work of the footpaths among the narrow houses should be combined with laying SSS. This would allow connection of houses otherwise difficult to connect.

Solid waste management (SWM) practices need to be incorporated wherever possible into DEWATS projects in Port au Prince. This could facilitate bundling of tariffs for wastewater treatment services with SWM services until full water supply coverage is attained and water and wastewater charges may be bundled together.


Route des Dalles
Rue D'eau
Rue Nonia Rigaud
Ruelle Alibe
Ruelle Amiral
Natural Ravine
Hopital Sanitorium
CAMP "Hopital Sanitorium"
Rue D'eau
Impasse Salem
Ruelle Ebex
Impasse Boulet
Concrete Canal
Image © 2012 GeoEye
149 m
75m
80m
85m
90m
95m
100m
LEGEND:
• SITE BOUNDARY:
• CONTOUR LINES:
100m
• WATER POINTS:
• SUGGESTED LOCATION OF DEWATS PLANT: (number corresponds to option presented in report)
2
• POSSIBLE CLUSTER OF CONNECTED HOUSES:
NOTES:
1) Background map from Google Earth.
TITLE:
Figure CFF_1:
SITE PLAN: CFF
PROJECT:
APPLICABILITY OF DEWATS IN THE PPMA.
CLIENT:
DINEPA
International Federation of Red Cross and Red Crescent Societies
SCALE:
0m
50m
BORDA
Fahrenheitstr. 9
D - 28359 Bremen
Germany

EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)

Figure: CFF_2

Index

- divider weir
- settler
- anaerobic baffled reactor (ABR) / anaerobic filter (AF)
- PT — public toilet
- area for further expansion (PGF-Planted gravel filter)
- proposed sewerage system incl. flow direction

DEWATS Location

Location: CFF Impasse Salem

Client:

International Federation of Red Cross and Red Crescent Societies

BORDA *Germany*

Bremen Overseas Research and Development Association

Fahrenheitstraße 9
D-28359 Bremen
Germany

5.3. DEWATS Study Site: Delmas 9, 11, 13

5.3.1. Characterization of Site

The site plan for the FRC INA Site 'Delmas 9, 11, 13' is presented in figure D911_1 at the end of this section. It should be noted that the FRC/LGL report on Delmas 9 and 11 (*Delmas 13excluded*) was widely referred to when studying this site. The site plan shows the key physical features of the site as well as some suggested locations where DEWATS may be applicable. See also the table below for site characteristics.

Table D911_1: Site characteristics of Delmas9, 11, 13.

Ref.	Site Name:	Delmas 9, 11, 13
1	Site area (sq. meters.)	127,156
2	GPS coordinates	18.5555065°, -072.3174256°
3	Site elevation (m)	From 46m to 21m (25m difference)
4	Description of receiving watercourses	The Northern border of the site is a natural ravine.
5	Land use	Dense residential area with a variety of housing types, from middle-income houses to low-income houses near the ravine. There is a school "Imacullée Conception" in the centre of the site.
6	Number of Houses	475 (LGL/CRF, 2012)
7	Population	2,375 (LGL/CRF, 2012)
8	Water Supply	A DINEPA water network serves most of the site daily, with 172 household water connections; there are also 2 private kiosks and over 2 dozen private water reservoirs. (LGL/CRF, 2012)
9	Sanitation	"Approximately *50% of households have latrines, and 50% have flush toilets*…. Information on desludging of latrines and septic tanks showed that 30% were accessible to sludge trucks, leaving the majority (70%) to be desludged manually (bayakou)." (LGL/CRF, 2012)

5.3.2. Site-specific Considerations for DEWATS

The following list of site-specific considerations are important for the possible implementation of DEWATS at Delmas 9,11,13:

Topography and Drainage

- There is a suitable gradient for a SSS, allowing wastewater to flow by gravity and reduced need for deep excavation. The gradient runs through the residential area commencing at Route de Delmas and ending at the ravine.
- The ravine is the suitable effluent discharge location.
- The ravine is not fortified on the residential side and erosion is occurring.
- The ravine is one of PPMA's main storm drains and the area near the ravine is at risk of flooding.
- The ravine itself is at further risk of erosion with each storm.

Land Use

- Houses are a mix of middle-income houses and low-income houses. Middle-income households may afford to pay connection fees. Most houses are planned and accessed by around 7 principal roads that run from Route de Delmas down to the ravine. These principal roads are between 5 and 8 meters wide and smaller passages connect these.
- At the bottom of each of the 7 principal roads where they meet the ravine, there is space for construction.
- Households are encroaching on the ravine and available space is diminishing.
- The width of the roads allows for DEWATS construction below the roads.

Access to Water and Existing Sanitation Infrastructure

- Access to water is relatively good with 36% of households having DINEPA house connections.
- All households have their own sanitation infrastructure, either flush toilets or latrines.
- Some households have experience in desludging their latrines or septic tanks.
- Existing drains are exposed being either unfinished or partially damaged.

Solid Waste Management

- The ravine is used as a solid waste dumpsite.
- Pigs kept as livestock consume organic residues in the ravine.

Interest of Community and Local Authorities

- A number of community groups were observed during the site visit. The community appears to be well represented by local management committees.
- The community may be interested in improving immediate house environs i.e. covering open storm water channels as well as disposing stagnant water causing nuisance and risk to children.
- A DEWATS solution would reduce work and cost of maintenance of individual latrines and septic tanks.
- Improvement of solid waste collection could be of interest and benefit.
- The community may be interested in improvements to house connections and renovating external plumbing.
- Sanitation may not be a priority for the community depending on the location of the house and socio-economic status.

Photos: Delmas 9,11,13

Photo D911_1: Water pipes inside drainage

Photo D911_2: Ravine at Delmas 9

Photo D911_3: Potential DEWATS site at D9

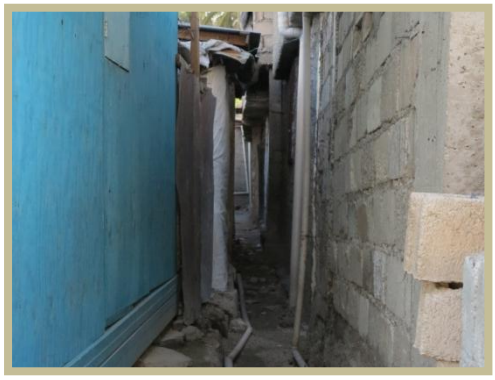


Photo D911_4: Arbitrary plumbing

Photo D911_5: Discharge into Ravine

Photo D911_6: Animal husbandry at ravine

Photo D911_7: Ravine encroachment

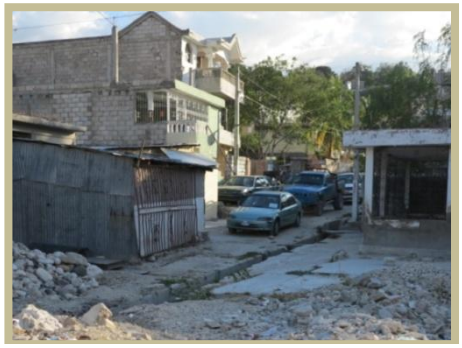


Photo D911_8: Delmas lanes end at ravine

5.3.3. Opportunities for DEWATS Intervention

Based on the above site-specific considerations, general suggestions may be made on the options for DEWATS intervention at the site. Where possible, suggestions are presented in terms of technical and socio-economic components. Indicative costs for the suggested options are presented in Annex B.

Option 1: Single DEWATS for Entire INA Site

The favorable topography of the site, the homogeneous land use across the area and the discharge of all lanes to one ravine front are factors in favor of a single catchment area. Nevertheless, a single catchment area with a single DEWATS treatment plant would require a lateral sewer along the southern bank of the site. This may be difficult as it may involve relocation of existing houses. On the other hand, the size of a single DEWATS for the total wastewater generated at Delmas 9,11,13 would exceed the space available. The integration of one large DEWATS plant into a ravine recovery plan would probably be more difficult than that of several smaller units. Therefore, option 1 is not a preferred option at this stage.

On the other hand, it is advisable to implement all the individual DEWATS units presented below as one integrated project, instead of implementing each of them as individual, disconnected interventions. See also chapter "Opportunities to link DEWATS with other neighborhood development activities" below.

Option 2 to 7: DEWATS-solutions for clusters of houses on lanes (see figures D911_2 to D911_7)

6 potential DEWATS sites adjacent to the ravine have been identified. Each site has an upstream catchment area defined by the roads that run from Route de Delmas down to the ravine. A collecting sewer laid in the road can drain each of these catchments by gravity, to its own DEWATS plant. The 6 sites are shown in figure D911_1 at the end of this section.

Assuming the discharge standards presented in section 2, all 6 sites offer sufficient land to construct the required DEWATS units with the potential for modular expansion of the DEWATS in the future.

The exact positioning of the DEWATS units would depend on: ravine rehabilitation works, the alignment of connecting sewers and the identification of connecting houses.

The proposed options for individual neighborhoods within Delmas 9,11,13 may be executed individually or as one. Implemented together they could have a more beneficial role when integrating these DEWATS interventions in integrated neighborhood development projects, e.g. improvement of the ravine, creation of open urban recreation areas or space for agriculture along the ravine.

The neighborhood must be involved from the initial stage through the existing community associations. It is essential to present the benefits of such interventions to each individual household. This should be addressed when proceeding with the detailed design.

For each of the 6 sites in Delmas 9,11,13, the following DEWATS options are suggested:

Table D911_2: Delmas9,11,13 options 2 to 7.

	Technical Components for DEWATS
Toilet	Low flush toilets
House connections	Individual house or house-group connection to SSS
SSS	SSS for black water and grey water integrated into the existing storm water drainage.
Storm water drainage	Storm water drainage improvement where necessary
WWT: Settling device	Settler or Biogas Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	Possible as second phase: a)PGF or b) Rock band
Discharge point	Ravine
Sludge disposal	Sludge drying bed attached Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by Residents Association
O+M	Private Service Provider/Residents Association Tariffs as to recover O+M costs; tariff linked to water provision or other local service
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently by local authority (e.g. DINEPA).

The 6 DEWATS plants will have a similar treatment process though need for some variations may emerge when proceeding with the detailed design. The following Table indicates the number of households which could be connected and their related wastewater volumes.

Table D911_3: Summary of potential household connections at Delmas9,11,13.

DEWATS location	Connected Households	Design wastewater volume (m3/day)
Option 2: Rue Delmas 7	20	10
Option 3: Rue Ducosquier	30	15
Option 4: Rue Delmas 9	20	10
Option 5: Delmas 11	25	12.5
Option 6: Rue Barreau	70	35
Option 7: Delams 13	50	25

Option 3: Public Toilets Using DEWATS

Most of the houses in Delmas 9,11,13 have private toilets and there is no urgent need for public toilets in the residential area. However, institutional sanitation facilities for the school 'Imaculee Conception' and the marketplace 'Place Dame' on Ave. Haile Selassie should be considered. Poor sanitation conditions at these 2 sites were observed.

5.3.4. Opportunities to link DEWATS with other Neighborhood Development Activities

Based on the varied perspectives on such aspects as technical design and implementation, homogeneity of the neighborhood and the potential for linking DEWATS with other neighborhood development activities, Delmas 9,11,13 appears to be the "simplest" of the 4 RC sites visited.

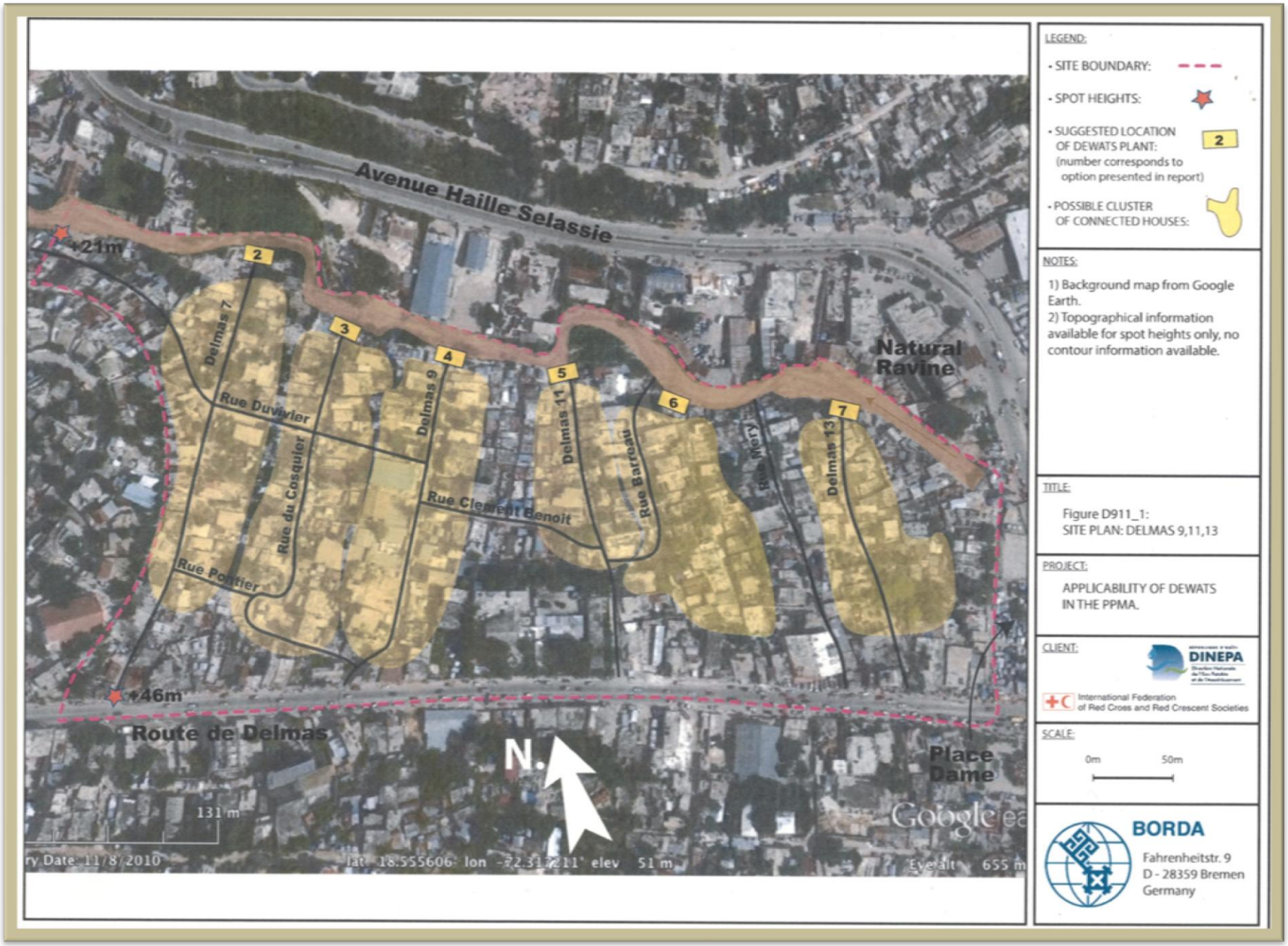
Therefore, it is recommended that the 6 DEWATS solutions presented above be considered as an integral project linked to other important settlement-development measures. These measures need to be discussed in detail with the community, respective authorities and other relevant stakeholders. The preferences need to be evaluated in depth and a joint plan evolved as mutually agreed upon.

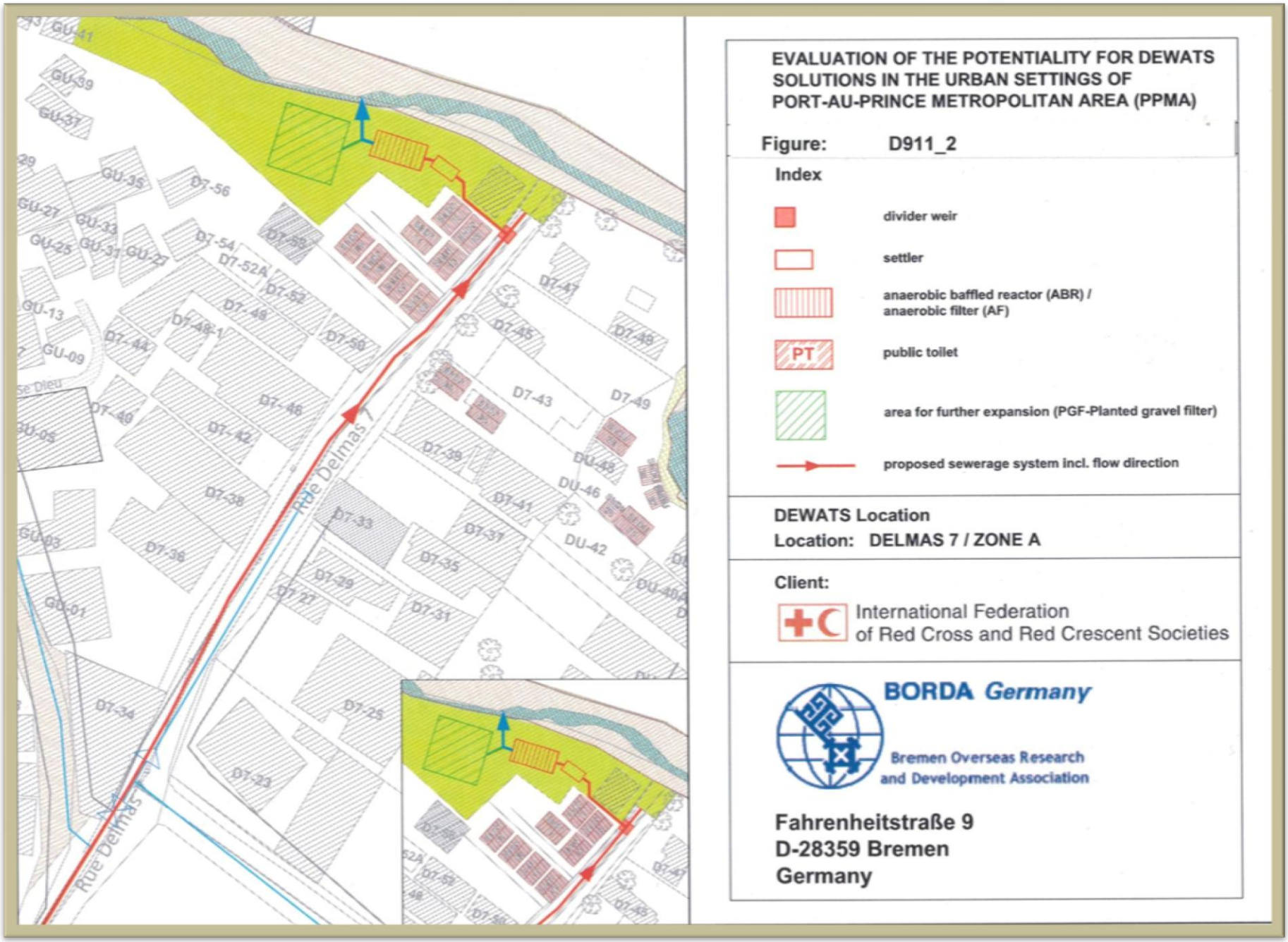
One of the significant points of the site is the common ravine. Hence, integration of DEWATS into a ravine-front recovery and development project could present a win-win approach.

Some of the components of an integrated project that should be evaluated are:

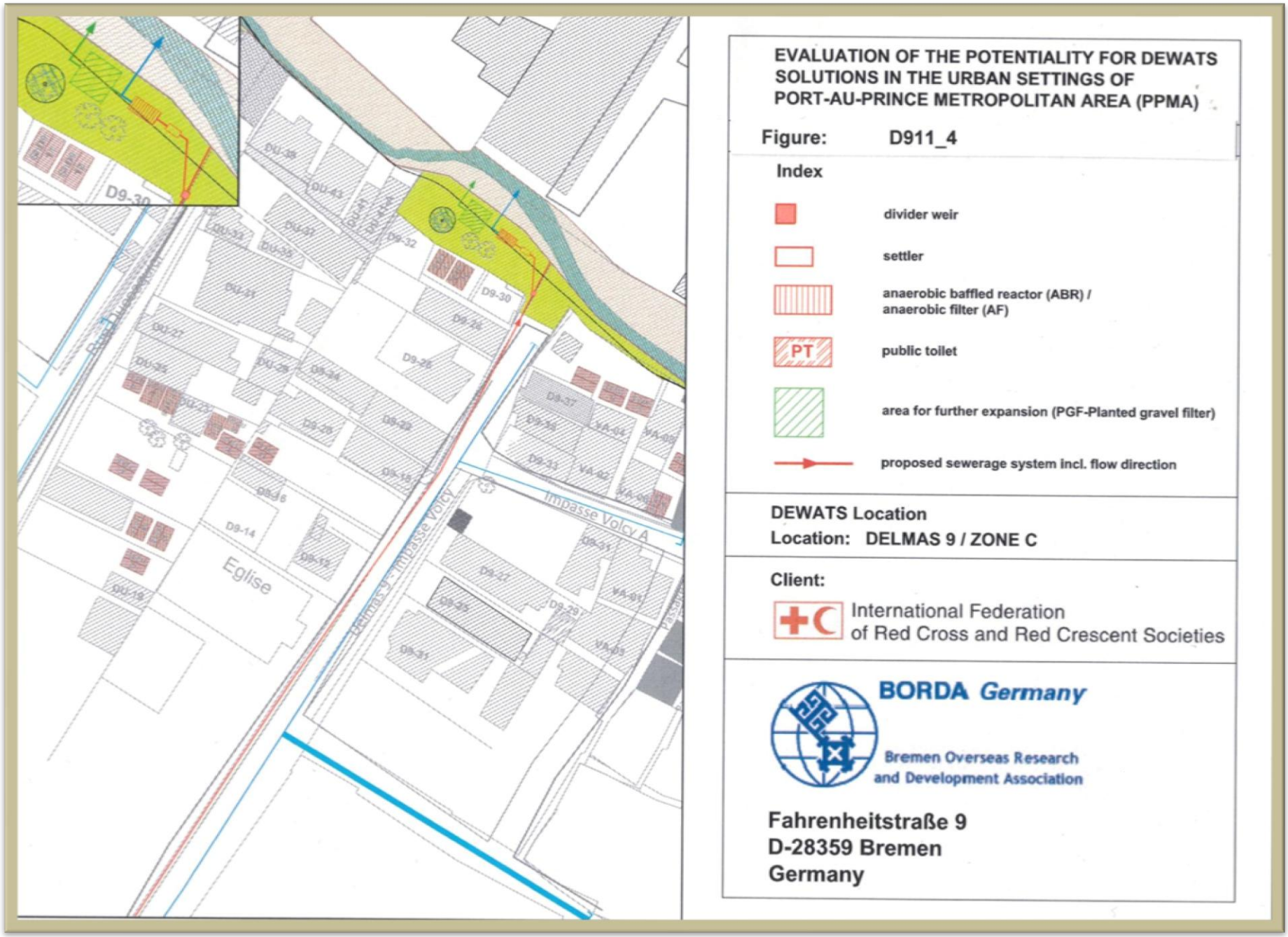
- Reinforcement of the ravine embankment from Delmas 7 to Delmas 13.
- Provision of a footpath and access for emergencies on the ravine embankment.
- Inclusion of treatment modules in the ravine embankment structure.
- Integration of primary and secondary treatment in the ravine embankment structure.
- Provision of recreation areas on the ravine embankment.
- Irrigation of green spaces with treated wastewater at the ravine.
- Integration of solid waste management in the neighborhood.
    - The neighborhood separates organic and non-organic waste at household level.
    - Integrated piggery development to manage the organic residues
    - Public composting unit one per two lanes
- Rainwater harvesting advice to the households including some preferential designs.

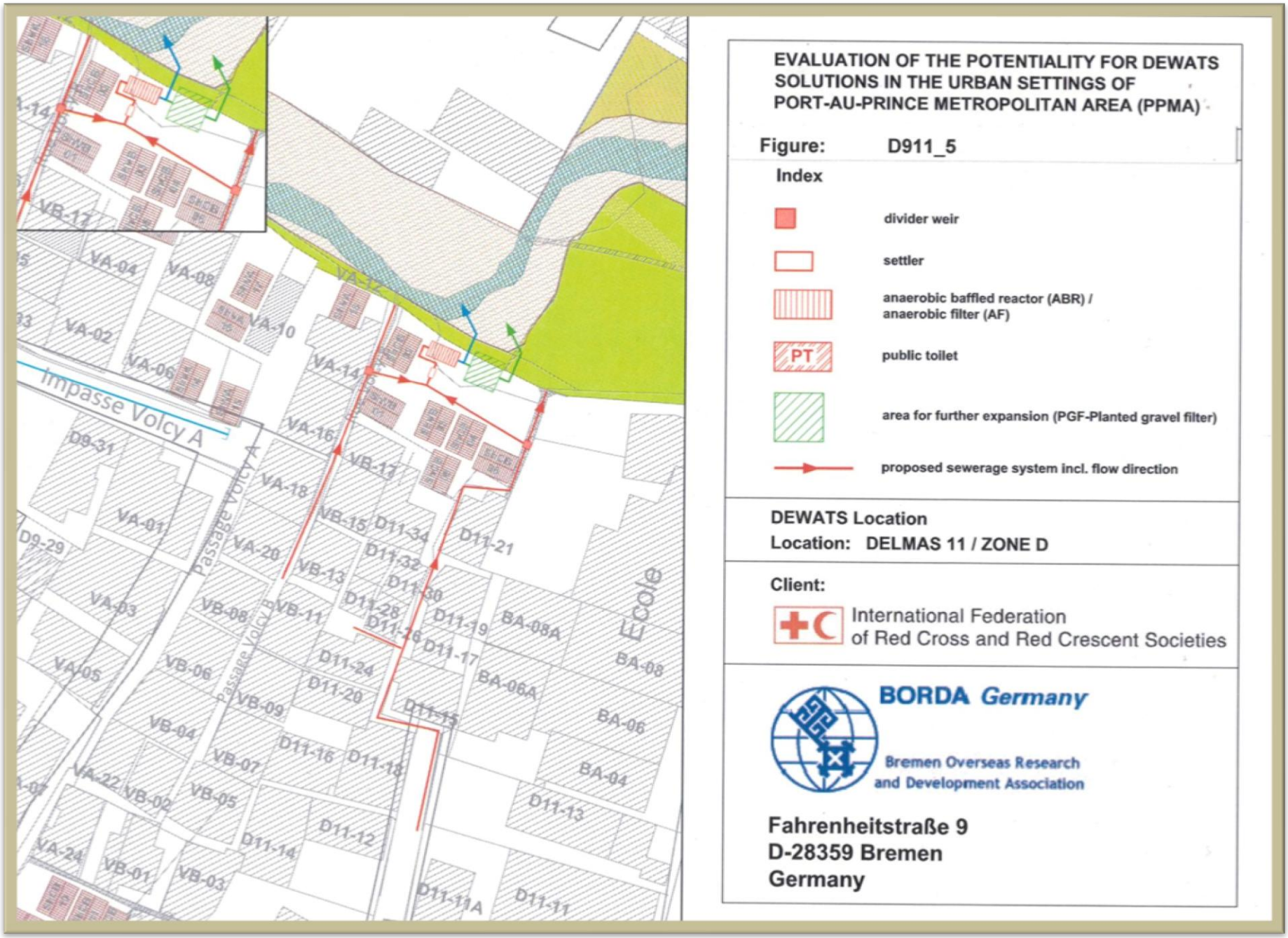
The counterpart for planning, execution and operation should be the concerned government departments like DINEPA and the local CASEC and the community association representing Delmas 9,11,13 as a whole.


Avenue Haille Selassie
21m
46m
2
3
4
5
6
7
Delmas 7
Rue Duvivier
Rue du Cosquier
Rue Pontier
Delmas 9
Rue Clement Benoit
Delmas 11
Rue Barreau
Rue Mery
Delmas 13
Natural Ravine
Route de Delmas
Place Dame
N.
131 m
Google
LEGEND:
- SITE BOUNDARY:
- SPOT HEIGHTS:
- SUGGESTED LOCATION OF DEWATS PLANT: (number corresponds to option presented in report)
- POSSIBLE CLUSTER OF CONNECTED HOUSES:
NOTES:
1) Background map from Google Earth.
2) Topographical information available for spot heights only, no contour information available.
TITLE:
Figure D911_1:
SITE PLAN: DELMAS 9,11,13
PROJECT:
APPLICABILITY OF DEWATS IN THE PPMA.
CLIENT:
DINEPA
International Federation of Red Cross and Red Crescent Societies
SCALE:
0m
50m
BORDA
Fahrenheitstr. 9
D - 28359 Bremen
Germany


EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D911_2
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS 7 / ZONE A
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany
Rue Delmas 7
Rue Delmas 5


DU-40A
DU-40
DU-38
DU-39
Rue Delmas
Rue Dumarsais
Rue Duvivier
Eglise
D9-14
D9-10
EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D911_3
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS 9 / ZONE B
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany


D9-30
Eglise
Impasse Volcy A
Delmas 9 - Impasse Volcy
EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D911_4
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS 9 / ZONE C
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany



EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)

Figure: D911_5

Index

- divider weir
- settler
- anaerobic baffled reactor (ABR) / anaerobic filter (AF)
- PT — public toilet
- area for further expansion (PGF-Planted gravel filter)
- proposed sewerage system incl. flow direction

DEWATS Location

Location: DELMAS 11 / ZONE D

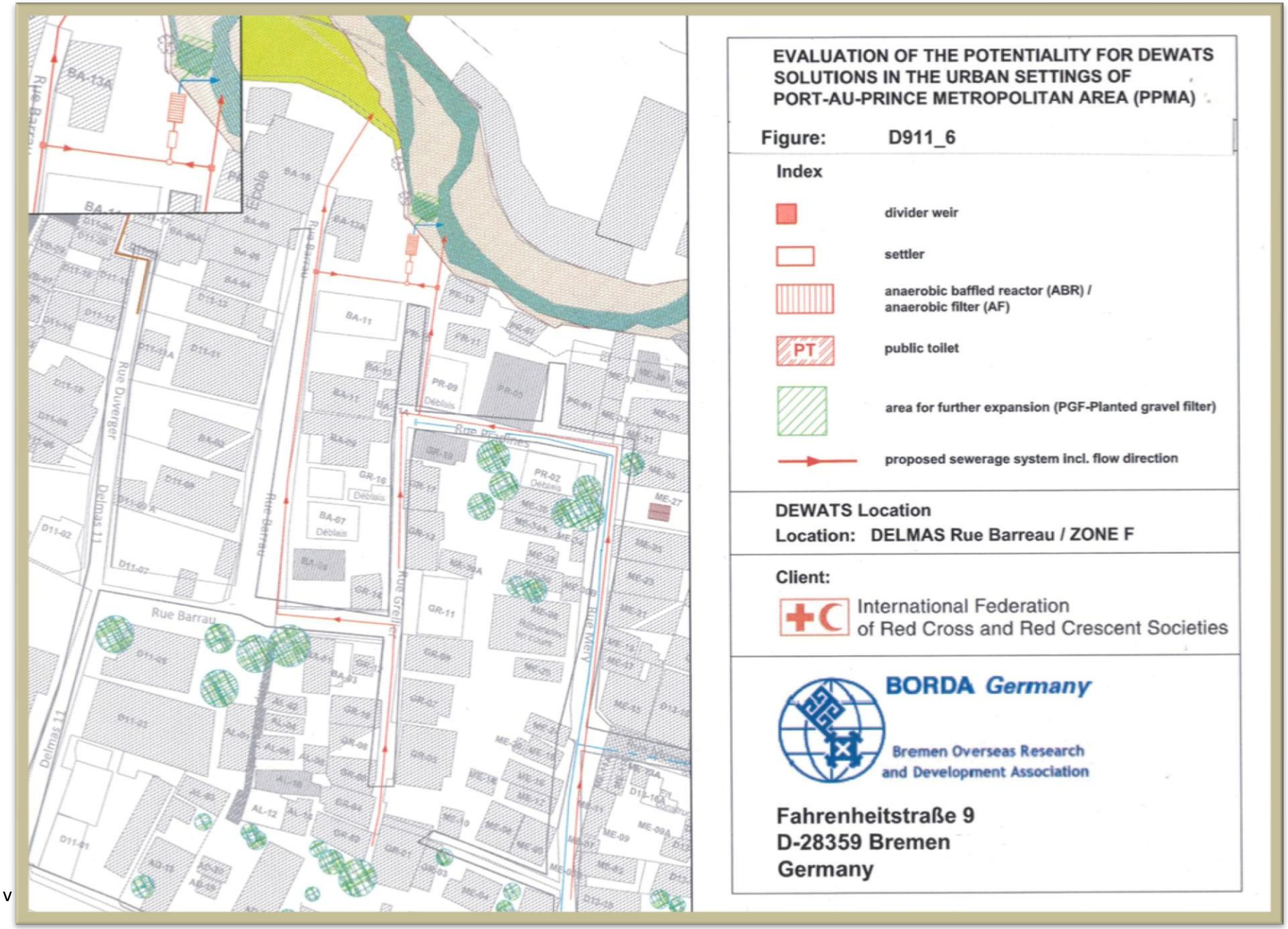
Client:

International Federation of Red Cross and Red Crescent Societies

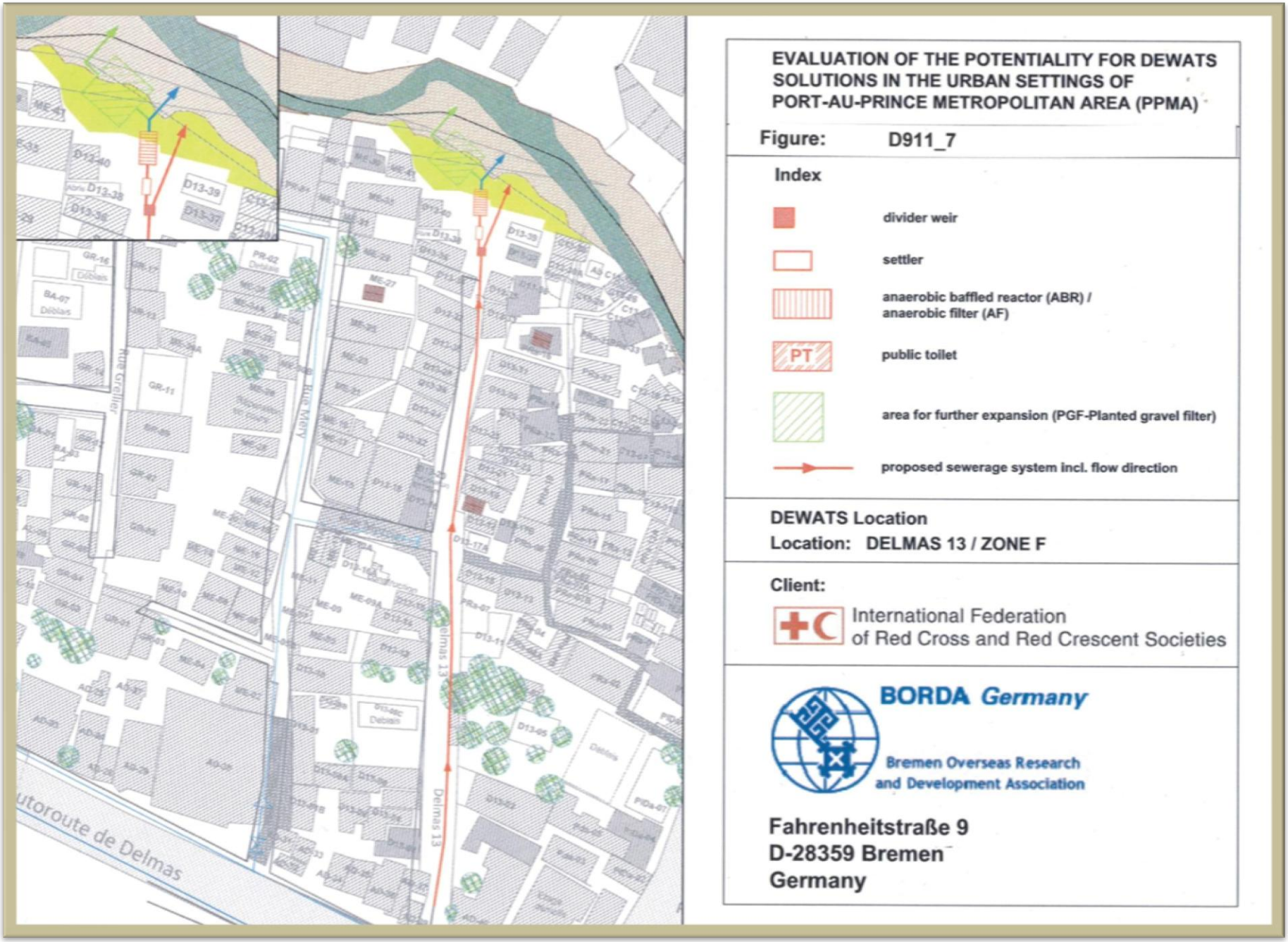
BORDA *Germany*

Bremen Overseas Research and Development Association

Fahrenheitstraße 9
D-28359 Bremen
Germany


EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D911_6
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS Rue Barreau / ZONE F
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany
Rue Barreau
Rue Duverger
Delmas 11
Rue Pressoirs
Rue Greffard
Rue Mercy

v


EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)
Figure: D911_7
Index
divider weir
settler
anaerobic baffled reactor (ABR) / anaerobic filter (AF)
PT
public toilet
area for further expansion (PGF-Planted gravel filter)
proposed sewerage system incl. flow direction
DEWATS Location
Location: DELMAS 13 / ZONE F
Client:
International Federation of Red Cross and Red Crescent Societies
BORDA Germany
Bremen Overseas Research and Development Association
Fahrenheitstraße 9
D-28359 Bremen
Germany
Autoroute de Delmas
Delmas 13

5.4. DEWATS Study Site: Campeche

5.4.1. Characterization of the Site

The site plan for the ARC INA Site Campeche is presented in figure CAM_1 at the end of this section. The site plan shows key physical features of the site as well as some suggested locations where DEWATS may be applicable. See also the Table below for site characteristics:

Table CAM_1: Site characteristics of Campeche

Ref.	Site Name: Campeche	
1	Site area (sq. meters)	180,796
2	GPS coordinates:	18.5245982°, -072.3347413°
3	Site elevation (meters)	From 160 to 70 (90m difference)
4	Description of receiving watercourses	The site is bordered to the North and South by narrow and steep natural ravines.
5	Land use	The site has three main areas: Upper: The camp 'Tapis Rouge', a temporary IDP camp. Middle: A densely populated sloping 'slum' area at the bottom of Tapis Rouge. Lower: A 'middle-income' area near the football pitch.
6	Number of House (for Lower area)	40
7	Population(for Lower area)	200
8	Water Supply	There are 11 water points (including 2 natural springs) in the site area or in its vicinity. There is no public water supply network in Campeche.
9	Sanitation	No sanitation data was available for this site.

5.4.2. Site-specific Considerations for DEWATS

Because Campeche is a heterogeneous site with varied urban typologies, site specific considerations are the key to DEWATS implementation. These have been grouped according to the sites defined in the Table above as Upper, Middle, and Lower.

Upper Campeche

- A large steeply sloping area.
- The temporary IDP camp 'Tapis Rouge' is located on an estimated area of 2 hectares and is being vacated through an incentive scheme. It is likely that the land will turn into a new settlement in near future.
- The Camp has some public toilets blocks in use though maintenance seems to be poor.

Middle Campeche

- Narrow houses constructed in an unplanned manner characterize this area embedded on the steep natural ravines running from the foot of Camp Tapis Rouge down towards Avenue "N".

- The access is mainly through narrow partially cemented paths. In some parts, access has been provided by staircases.
- Some houses have well built latrines with deep pits that may be used for several decades before desludging may be required. This appears to be a substantial investment when compared to the house construction itself.
- The poor sanitary conditions observed in this area point to a likelihood that open defecation is practiced. Nevertheless, not enough evidence could be gathered during the visit.
- The ravine receives mainly grey water and solid waste as well as some human excreta.
- A sanitation complex at Avenue 'N' in the neighborhood of 'Baillergeau' and well operated by a CBO, offers showers, toilets and laundry places. Whereas toilets and showers at a cost of 2 HTG (as a combi-offer) are popular, the laundry facilities at a cost of 25 HTG for 3h are less popular.
- 200 meters above the sanitation complex, adjacent to a water spring, there is an informal laundry area.
- The ravines have several water springs. Some have already been captured with cisterns, whereas some are in use directly at the spring in an improvised manner.

Lower Campeche

- The lower part of Campeche has better planned housing arrangements than the rest of Campeche.
- Most of the roads are unpaved. The main road (Avenue "N") is 8 meter wide while adjacent lanes are 2-4 meters wide.
- There is a football field with an approximate area of 1000 m^2 adjacent to Avenue "N".
- The adjacent steep natural ravine is eroded on both sides. Ravine encroachment is rampant.
- Solid waste is dumped into the ravine.

Photos Campeche

Photo CAM_1: Camp 'Tapis Rouge' being vacated

Photo CAM_2: Toilet Block at IDP Camp

Photo CAM_3: Narrow pathways in Middle Campeche

Photo CAM_4: Uncontrolled construction in Middle area

Photo CAM_5: Toilet Complex on Avenue 'N'

Photo CAM_6: Informal laundry place

Photo CAM_7: Avenue "N"

Photo CAM_8: Football field Campeche'

5.4.3. Opportunities for DEWATS Intervention

Based on the above site-specific considerations, general suggestions may be made on the options for DEWATS intervention at the site. Where possible, suggestions are presented in terms of technical and socio-economic components. Indicative costs for the suggested options are presented in Annex B.

Option 1: Single DEWATS for entire INA site

This option may be excluded as the topography as well as the varying levels of regularization of neighborhoods would not favor a single DEWATS plant to serve the entire neighborhood.

Option 2: DEWATS for "New development" (Upper Campeche)

The future use of the IDP Camp area needs to be ascertained. If houses are to be built on this land, planning for a DEWATS would be advisable at this stage. This would fall under the typology of DEWATS for "New Developments", which has a typical construction area requirement of approximately 8 to 12 m^2 per m^3 per day wastewater flow for primary, secondary and tertiary treatment. The Table below shows the components of this option.

Table CAM_2: Campeche Option 2.

	Technical Components for DEWATS
Toilet	Low flush toilets provided with the houses
House connections	Individual house or house-group connection to SSS along contours
SSS	SSS along contours for black water and grey water
Storm water drainage	Storm water drainage linked to escarpment reinforcement where necessary
WWT: Settling device	Settler or Biogas Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	a) Rock-band linked with pathways and/or escarpment reinforcement as well as landscape requirements. b) Planted drain linked with landscape requirements.
Discharge point	a) Ravine b) Storm water drainage
Sludge disposal	a) Sludge drying bed attached b) Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Developer (with planning support from Donor)
Sanitation Committee	Formed by Residents Association
O+M	Private Service Provider/Resident Association Tariffs as to recover O+M costs; tariff linked with water provision; Operation by private service provider
Ownership	Developer/Residents Association
Monitoring	2 years by donor; subsequently by local authority (e.g. DINEPA).

Option 3: Infrastructure Recovery - Public toilet block (Upper Campeche)

After vacation of the IDP camp 'Tapis Rouge', some toilet blocks may be left behind. Depending on their location and condition of the infrastructure, it could be considered to recover this infrastructure, improve them and permit the neighborhood in the vicinity to use and operate them. This could be a cost-efficient, short-term solution for households with no access to toilets. The Table below shows the components of this option.

Table CAM_3: Campeche Option 4

	Technical Components DEWATS Public Toilet Block
Sanitation Facilities	Existing or refurbished as per demand (Toilets, shower, laundering places etc.)
WWT: Settling device	Settler or Biogas Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	None
Discharge point	a) Ravine b) Nearby tertiary treatment (if available for the new development - see above option 2)
Sludge disposal	a) Sludge drying bed attached b) Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by Residents Association
O+M	Localized service provider (water kiosk, other) Recovery of O+M costs: by agreed upon user fees and the balance by cross subsidy from other basic services in the area (e.g. water from water kiosks)
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently handing over to local authority (e.g. DINEPA).

Option 4: DEWATS for clusters of narrow houses on a steep slope of Middle Campeche

The middle area of Campeche is characterized by high housing density which together with the steep slope at Campeche, makes DEWATS construction technically difficult over most of the neighborhood. Pipelines along steep slopes would not be feasible (high velocity in gravity pipelines installed at such steep gradients causes separation of solids in the wastewater stream, leaving them in the pipeline).

A SSS along contours could be considered for some stretches to collect grey water and allow for individual low flush toilet connections where water access can be provided (e.g. near water springs, water kiosks). Due to reduced water for flushing at household disposal, it may be required to foresee an interval-flushing system for the entire SSS, external and independent from the households.

Space for a treatment system would be difficult to allocate here. Hence, it would need to be located in lower Campeche, either near the football pitch, integrated into one of the wider roads (e.g. Avenue "N") or integrated into the ravine (if linked with fortification of ravine embankments or escarpments). Though technically challenging, the housing density and the low-income group targeted would justify this solution. A separate study would be required to arrive at a final decision. The Table below presents the components of this option.

Table CAM_4: Campeche Option 5.

	Technical Components for DEWATS
Toilet	Low flush toilets.
House connections	Individual houses or house-group connection to SSS along contours
SSS	SSS along contours with maximum slope of 3%
Storm water drainage	Escarpment reinforcement only of selected high-risk stretches to be included in the intervention to secure SSS provided and control critical erosion points.
WWT: Settling device	Settler or Biogas settler (in Lower Campeche)
WWT: Secondary treatment	ABR (in Lower Campeche)
WWT: Tertiary treatment	Planted drain linked with landscape requirements; could be in a second phase
Discharge point	a) after secondary treatment: disposal to the ravine b) after tertiary treatment: disposal to the ravine or storm water drain
Sludge disposal	a) Nearby sludge drying bed b) Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Planning, detail design	Donor with support of specialized Organization
Sanitation Committee	Formed by Residents Association
Operation & Maintenance	Residents Association Tariffs as to recover O+M costs; tariff linked with water provision; Operation by private service provider
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently handing over to local authority (e.g. DINEPA).

Option 5: DEWATS for clusters of houses at lower Campeche (see figure CAM_2)

The football pitch with an area of approximately 1000m^2 offers space for integrating wastewater treatment modules for primary and secondary treatment without affecting the functionality of the field. If 250m^2 can be made available for construction of a DEWATS underground, the wastewater from up to 250 households could be treated near the football pitch. A tertiary treatment cannot be placed at this location as the ground is flat.

The 40 houses (approx.) around the football pitch 'Terrain Campeche' may be connected to a DEWATS plant and the effluent discharged to the northern ravine. This proposal is presented in Figure CAM_2 and costs for the 2 options: (1) Settler + ABR + discharge to the ravine and (2) Biogas Settler + ABR + discharge to the ravine in Annex B respectively.

As a higher treatment capacity may be possible d at the football pitch, the feasibility of connecting the neighborhoods of Middle Campeche should also be evaluated when proceeding with the detailed design. For details see Option 4 above and the chapter below on linking DEWATS with neighborhood activities. The Table below presents the components of this option.

Table CAM_5: Campeche Option 5

	Technical Components for DEWATS
Toilet	Low flush toilets
House connections	Individual house or house-group connection to SSS
SSS	SSS for black water and grey water
Storm water drainage	Restoration of existing drainage or provision of storm water drainage should be considered for inclusion as incentive.
WWT: Settling device	Settler or Biogas Settler
WWT: Secondary treatment	ABR
WWT: Tertiary treatment	a) Rock-band linked with ravine pathways and/or embankment reinforcement. b) Planted drain linked with landscape requirements.
Discharge	a) Into the ravine
Sludge disposal	a) Sludge drying bed at nearby ravine embankment b) Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by existing Residents Association
O+M	Private service provider/Residents Association Tariffs so as to recover O+M cost; tariff linked to water supply; operation by private service provider
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently handing over to local authority (e.g. DINEPA)

Option 6: Public toilets using DEWATS (Lower Campeche)

An existing public toilet block in 'Baillergeau' constructed by GRET and operated by a local CBO was visited during the site visit. Another public toilet in Campeche could cater to the low income neighborhood east-south-east of the football pitch as well as to the users in the vicinity of the playground. This toilet block could be located behind the first row of houses adjacent to the football pitch at the south-east corner or next to the water kiosk at the eastern corner. The effluent could be treated as follows:

1. at a DEWATS unit installed at the football pitch (see also option 5) and the treated effluent discharged to the ravine.
2. at a Biogas-Settler installed under the sanitation facilities for primary treatment, the effluent could be directed to the ABR at the DEWATS located at the football pitch.
3. at a DEWATS unit with Biogas-Settler and ABR installed below the sanitation facilities.

The location may facilitate joint operation of water supply and toilet facilities. However, given the proximity of the existing public toilet block in 'Baillergeau' (150m away), an independent potential-user survey will be required to arrive at a decision on this option.

Being public meeting point, such a public toilet facility could be linked with information services, health and hygiene campaigns, distribution and sales of hygiene and reproductive health articles and so on. The Table below presents the components of this option.

Table CAM_6: Campeche Option 6.

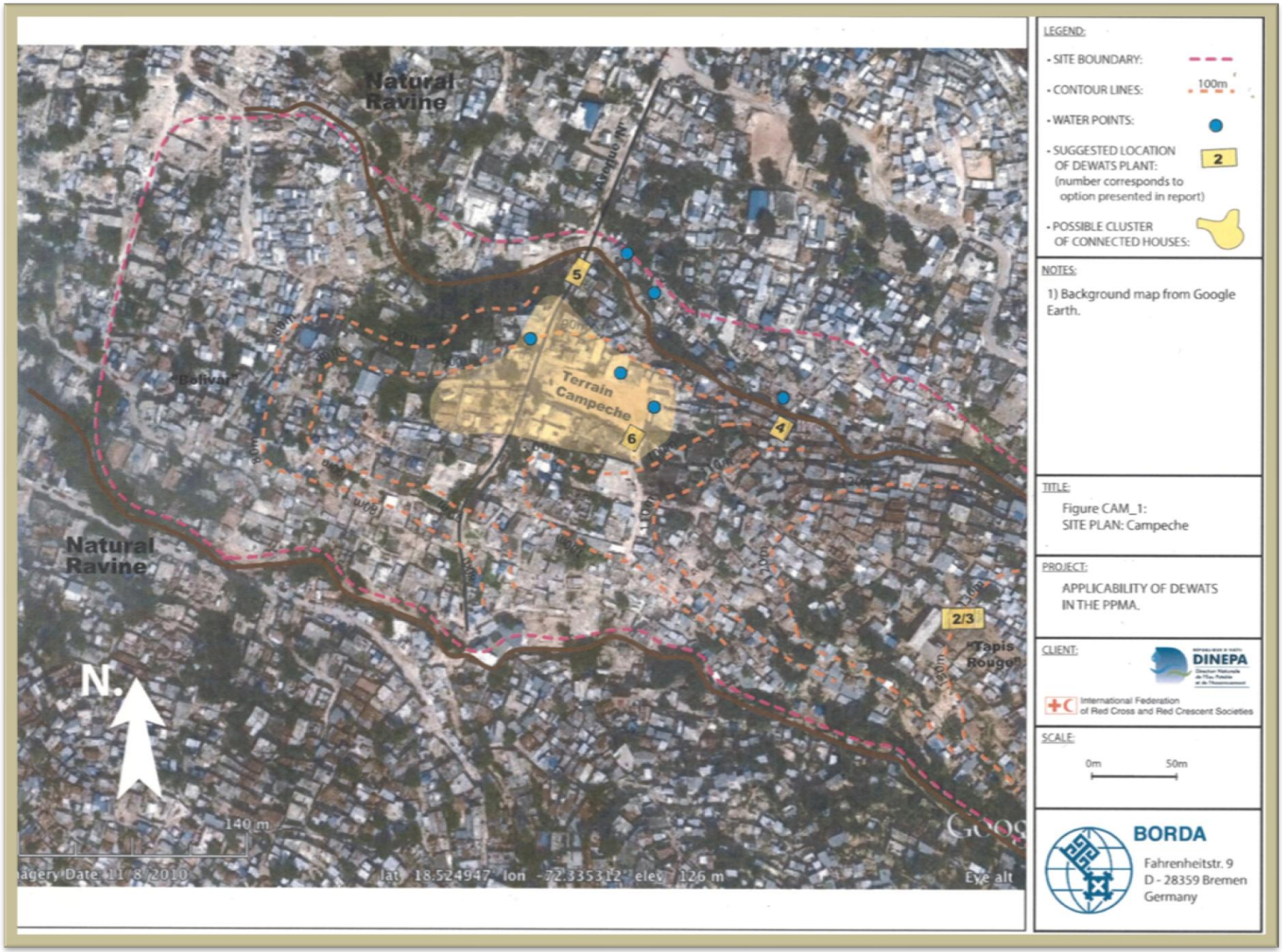
	Technical Components DEWATS Public Toilet Block
Sanitation Facilities	As per demand (toilets, shower, washing place etc.)
WWT: Settling device	a) Settler at DEWATS at football ground b) Biogas-Settler below the sanitation facility
WWT: Secondary treatment	a) At DEWATS at the football pitch b) ABR below the sanitation facility
WWT: Tertiary treatment	None
Discharge point	a) Ravine
Sludge disposal	a) Sludge drying bed at nearby ravine embankment b) Via vacuum-truck to sludge treatment plant
	Socio Economic Components for DEWATS
Initial investment	Donor
Sanitation Committee	Formed by existing Residents Association
O+M	Localized service provider (water kiosk, other) Recover O+M costs: by agreed user fees and the balance through cross subsidy from other basic services in the area (e.g. water from water kiosks). Possible distinction between residents (resident monthly pass) and visitors.
Ownership	Municipality (Commune)
Monitoring	2 years by donor; subsequently handover to local authority (e.g. DINEPA).

5.4.4. Opportunities to link DEWATS with other neighborhood development activities

The different individual options for DEWATS measures presented above for the 3 areas of Campeche also provide the option for integrating large impact neighborhood projects and an opportunity to synergize. With a focus on sanitation and scope for several other settlement improvement measures, the intervention could be aligned with the existing overall city development strategies of the concerned ministries and departments and existing neighborhood development plans. The following integrated project approaches maybe considered:

1. A DEWATS treatment unit to be integrated with simple but relevant improvements of the football pitch (to be planned with the users; e.g. sitting arrangements on the below ground DEWATS modules, light vegetation-strips bordering the field, etc.).
2. Linking as many households as possible to the DEWATS unit at the football pitch, primarily on the steep neighborhood upslope. While providing SSS along contours, it could be linked to the provision of reinforced pathways (by using concrete, recycled tiles, etc.) and protection of erosion-prone tracts along the ravine. Depending on the size of the project, a tile production unit could be established at site to generate jobs. Tapping, protecting and improving existing water springs could make an appreciable impact and attract the interest of residents.
3. Installing a public toilet with services beyond sanitation needs near the football pitch will help serve users of the playground as well as households in the vicinity who have no access to toilets.

These ideas may be expanded or modified during the detailed design.


Natural Ravine
Natural Ravine
Bolivar
Terrain Campeche
5
6
4
2/3
Tapis Rouge
N.
140 m
LEGEND:
• SITE BOUNDARY:
• CONTOUR LINES:
100m
• WATER POINTS:
• SUGGESTED LOCATION OF DEWATS PLANT: (number corresponds to option presented in report)
2
• POSSIBLE CLUSTER OF CONNECTED HOUSES:
NOTES:
1) Background map from Google Earth.
TITLE:
Figure CAM_1:
SITE PLAN: Campeche
PROJECT:
APPLICABILITY OF DEWATS IN THE PPMA.
CLIENT:
DINEPA
International Federation of Red Cross and Red Crescent Societies
SCALE:
0m
50m
BORDA
Fahrenheitstr. 9
D - 28359 Bremen
Germany

EVALUATION OF THE POTENTIALITY FOR DEWATS SOLUTIONS IN THE URBAN SETTINGS OF PORT-AU-PRINCE METROPOLITAN AREA (PPMA)

Figure: CAM_2

Index

- divider weir
- settler
- anaerobic baffled reactor (ABR) / anaerobic filter (AF)
- PT — public toilet
- area for further expansion (PGF-Planted gravel filter)
- proposed sewerage system incl. flow direction

DEWATS Location

Location: CFF Campeche ARC

Client:

International Federation of Red Cross and Red Crescent Societies

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Germany

6. Applicability of DEWATS in the PPMA

6.1. DEWATS Typologies in the PPMA

Drawing on the sanitation considerations of the PPMA presented in section 4, the site-specific considerations for each site visited (see also section 5.) and the basic principles of DEWATS approach (see section 3.1), an indication of standard situations where DEWATS will, in all probability, be applicable in the PPMA, is presented below.

The presented typologies and criteria may only serve as an initial guide to scout for sanitation options and may not replace a detailed feasibility study. The feasibility should be conducted to arrive at a final decision on the applicability of DEWATS at each site. Further, this specially applies when determining the specific technical treatment solution (treatment track) and accompanying socio-economic measures to be applied.

Below are presented basic criteria and parameters defining DEWATS intervention opportunities and helping in categorization of typologies in the context of Port au Prince:

1. **Topography and Drainage**

- Topography should facilitate gravity flow. Pumps will not work at the targeted decentralized locations in PauP.
- Steep slopes increase the complexity of laying SSS.
- SSS should be feasible or public sanitation blocks need to be targeted.
- The top slap of DEWATS should be above flood level.
- DEWATS construction in low-lying area is feasible if a final discharge point is identified.
- Ravines and canals are suitable discharge points.
- If DEWATS are to be located near or at a ravine, erosion protection measures need to be incorporated.
- Roads may be considered as locations for DEWATS treatment modules; their width is relevant. Unpaved road should be preferred.

2. **Land Use**

- Low income and slum-like neighborhoods should be preferred over middle-income and high income neighborhoods.
- At dense low-income neighborhoods, space for laying SSS is required else the public sanitation complex option should be explored.
- At low-income neighborhoods, the public sanitation complex option must be based on a proven demand for it.
- Middle-income houses should have an expressed need for sanitation.
- Neighborhoods with heterogeneous socio-economic groups should be preferably divided for DEWATS projects.
- Neighborhoods to be connected to SSS require at least 70 % household willingness to connect.
- IDP Camps should only be targeted with Emergency DEWATS (prefabricated and removable).
- Improvement projects for intra-block footpaths should be linked to laying of SSS for DEWATS.
- Dual-space use for DEWATS needs to be always considered especially in dense urban area. e.g. parking area with settler below.
- Land needs to be secured before starting a project especially areas at risk of encroachment.

3. **Access to Water and Existing Sanitation Infrastructure**

- DEWATS requires access to water. Existing DINEPA water connection will ease this requirement.

- A minimum of 60l / user should be targeted. If less, external SSS flushing needs to be considered.
- If water springs are located in the vicinity of DEWATS projects, their usage and protection should be integrated into the project.
- Proven lack of access to sanitation infrastructure favors DEWATS projects.
- DEWATS projects should target eradication of open defecation.
- The prevailing sanitation situation should represent a burden (financially, time wise, comfort wise or dignity wise), an expressed desire of change should be identifiable.
- In the PauP context, one should not encourage abandoning latrines in favor of flush toilets.
- Sludge management should be foreseen and inclusion of attached sludge drying beds or desludging by a vacuum-truck.

4. **Solid Waste Management**

- Solid waste management is often linked to DEWATS. Prevailing practices should not interfere in the functioning of SSS, toilets and so on (obstruction, chemicals).
- Linking solid waste management to DEWATS projects should be considered.
- Public sanitation complexes need to provide waste disposal facilities (dustbins).
- Ravine-related DEWATS projects could consider integration of the existing informal animal husbandry practices at the ravine as an organic waste management component.

5. **Interest of Community and local authorities**

- Community association should be in place or to be established.
- Agreements with the community and the concerned authorities should be in written form prior to the start-up of any DEWATS intervention.
- Households are mainly interested in the sanitation components directly related to the household (toilets, surrounding house environment). Government is interested in water source protection and settlement hygiene.
- To the extent feasible, DEWATS projects should be linked to other settlement development projects.

Based on the sites visited, the following urban typologies for DEWATS in the PPMA may be identified. Under the scope of this assignment, this task could be only outlined. For additional details, a further field based analysis would be required.

Ravine-bond settlement DEWATS

Typology 1: Upstream, dense low-income neighborhood, predominantly residential

Steep slopes, uncontrolled urbanization, main dwellers classified as poor or low-income group, high degree of erosion of ravines, difficult access to water.

Most common DEWATS solutions**:** Incorporation of DEWATS difficult, if SSS possible only along contours. The DEWATS location may be found at midstream or downstream level, SSS integration in escarpment reinforcement.

Typology 2: Midstream, mixed neighborhood, predominantly residential

Steep slopes, houses less congested; mixed neighborhoods, predominantly middle-class and low-income groups, water accessible through multiple sources.

Most common DEWATS solutions**:** SSS + settling device + secondary treatment + delivery to ravine or canal; optional tertiary treatment with PGF or if no space, rock-band and planted drain; DEWATS integration in ravine front development.

Typology 3: Downstream, dense low income settlements, predominantly residential

Terrain flat, unplanned slum-like neighborhood. Main dwellers below poverty line. Low laying flood-prone area.

Most common DEWATS solutions: If regularized, public sanitation complexes with conventional DEWATS. If not regularized, public sanitation complexes with emergency DEWATS (prefabricated and removable); discharge to ravine or canal.

Typology 4: Downstream middle-class neighborhood, predominantly residential

Gentle slope, houses not congested, neighborhoods predominantly middle-class, good water and toilet access.

Most common DEWATS solutions**:** SSS + settling device + secondary treatment + discharge to ravine; optional tertiary treatment with PGF or if no space, rock-band. DEWATS integration in ravine front development.

Temporary settlements DEWATS

Typology 5: IDP Camps

Temporary shelter at any available space in the city. Organized by emergency organizations, presently being dissolved.

Most common DEWATS solutions: The present situation in the PPMA does not represent a DEWATS location. If demanded, DEWATS for emergency (prefabricated and removable); settling device + secondary treatment + percolation trench.

New Developments DEWATS

Typology 6: DEWATS for New Developments, proposed residential communities/ institutions

Controlled and planned settlements, access to water and toilets secured, predominantly middle-class or low-income groups.

Most common DEWATS solutions**:** SSS + settling device + secondary treatment + tertiary treatment with PGF+ partial or total reuse of treatment products; DEWATS planned with settlement.

6.2. Benefits of DEWATS in the PPMA

The following summarizes the specific benefits of implementing DEWATS in the PPMA:

- DEWATS is probably one of the few wastewater treatment solutions available to many neighborhoods as defined above.
- DEWATS can be phased (modular expansion) according to wastewater quantity, effluent discharge standards and according to available financing.
- DEWATS can provide indirect opportunities (e.g. creation of recreational spaces), if implementation is synergized with other services and developments.
- DEWATS can stimulate creation of local jobs and training as compared to imported conventional wastewater treatment technologies which also require imported labor and skills.
- DEWATS reduces public health risks, especially during cyclones
- The DEWATS CBS approach (or similar approaches) presents opportunities to mobilize and involve communities in the provision of basic needs services and in the development of their neighborhoods.

- DEWATS can create resources which may be used/reused locally (e.g. biogas or treated wastewater for urban agriculture)
- DEWATS will improve PPMA's urban environment by protecting open water sources (ravines) and ground water from pollution.
- DEWATS is an opportunity for a paradigm shift in approach to wastewater treatment; from expensive centralized systems, to more affordable decentralized systems.

6.3. Roles and responsibilities of main stakeholders

The roles and responsibilities of the main stakeholders envisaged for the provision of DEWATS in the PPMA are described in the table below.

Table: Institutional Framework for DEWATS in the PPMA

Main Stakeholder	Roles & Responsibilities
DINEPA	- Develop, regulate and control the WASH sector - Define the roles and responsibilities of DEWATS stakeholders. - Development of technical standards and guidelines for DEWATS projects in Haiti (including construction and operation and effluent discharge standards).
OREPA Ouest	- DEWATS information management at a regional level - Control of DEWATS providers at a regional level
CTE [(1)]	- Managing the inventory of DEWATS infrastructure in the PPMA - Providing local information, technical dossiers for DEWATS projects. - Providing/monitoring O+M services for DEWATS in the PPMA.
Donors	- Identification and provision of funds to NGOs and government actors for DEWATS dissemination in Haiti - Advocacy to international community for investments in DEWATS. - Keeping pressure on international partner Governments to fulfill financial commitments to the sanitation sector in Haiti.
NGOs	- Implementing DEWATS projects and handing over to communities. - Capacity building of Haitian staff including engineers, social experts, operators, urban planners
Academia	- Research on DEWATS options for Haiti. - Inclusion of DEWATS in related teaching curricula. - Facilitating innovative project implementation by NGOs or government actors by providing professional research competencies and laboratory facilities.
Private sector	- Provision of DEWATS related services to users, including planning, design, construction; operation and periodical maintenance.
Community	- Demanding sanitation improvements - Participation in planning and decision making on DEWATS projects. - Managing/operating established DEWATS
Mayors (Commune)	- Facilitating meeting requirements for land for DEWATS. - Providing authorization for construction activities.
CASEC (Section Communal)	- Facilitating contact with local authority to the communities. - Representing the communities on administrative level with DEWATS service providers in the Project area. - Ensuring alignment of DEWATS projects with other development activities.

[(1)] Proposed CTE involvement as a DEWATS stakeholder is dependant upon CTE's future general involvement in the sanitation sector, which is uncertain at the time of preparing this report.

6.4. Capacity Building Requirements

The fact that DEWATS is a relatively new concept in Haiti, building institutional capacities for planning and implementation is a vital key for success. The key stakeholders need to be confirmed as well as their training needs for effective implementation of DEWATS interventions at city level identified. These stakeholders could be government staff involved in sanitation services (DINEPA, OREPA, CTE), political leaders, private contractors, NGOs as well as the targeted communities. The process could start from creating general awareness and providing basic information on DEWATS interventions, to extensive technical and social training for building capacities to scale-up DEWATS sanitation solutions at city wide level.

The training programs could be in the form of seminars, workshops and customized training programs for various stakeholder groups. A long term strategic action plan should be prepared to achieve the desired objectives.

As a first step, it is recommended that several DEWATS pilot interventions are initiated, planned in the format of 'DEWATS learning projects'. The implementation process is designed from the beginning as a capacity building program alongside real project implementation. It would involve all relevant stakeholders like DINEPA, relevant donor/s, CASEC, community, implementing organizations and academia. It is recommended that different DEWATS typologies are selected for pilot DEWATS training to avoid single-track learning. During such a first training program, a stakeholder specific training need assessment could be conducted.

6.5. Basic Frame of a Neighbourhood-DEWATS Intervention

After an initial pre-feasibility study, to assess "viability in principle", it is recommended that DEWATS interventions follow the basic project implementation steps enlisted below:

A. **Community Information**

B. **Stakeholder Consent**

C. **Participatory Planning**

D. **Detailed Planning (technical and social engineering):**

- DEWATS treatment modules
- Simplified sewer system (SSS)
- Integration in other settlement development measures
- Capacity building, financing, contracting, etc.
- Operation and Maintenance

E. **Clearance from Authorities** (DINEPA, MoE, Mairie, etc.).

F. **Information and Awareness campaign**

G. **Construction of Infrastructure**

H. **Training Households and Operators**

I. **Operation + Maintenance** (periodical maintenance)

J. **Monitoring**

7. Conclusions and Recommendations

Statement on applicability of DEWATS in the PPMA

After consideration of the issues presented here in the context of the PPMA and using the 4 Red Cross sites as case studies, **the Report concludes that DEWATS is feasible in the PPMA**. In view of many other similar sites in the PPMA, DEWATS seems to be feasible not only at the visited sites but at all 6 communes of the PPMA. Further, in view of the negligible realistic sanitation alternatives available, it is suggested that DEWATS should be considered a key technology in an integrated wastewater treatment strategy for the PPMA. This general positive statement on applicability should be viewed in light of the considerable challenges described in the Report and the following list of recommendations:

Capacity Building by means of Learning Projects

To allow stakeholders to evaluate for themselves the applicability of DEWATS and initiate DEWATS capacity building measures across all key stakeholders, it is recommended to start several DEWATS pilot interventions in the format of 'DEWATS learning projects'.

Site specific analysis of physical parameters

Investigation targeting data gaps on water consumption patterns and wastewater characteristics of the different neighborhoods in PMMA should be initiated.

Cost-Benefit Analysis

Wider knowledge on the costs related to the implementation of DEWATS is required. Hence, initiated pilot projects should aim at generating cost-benefit analysis. This will also support the establishment of required tariff structure.

Public Consultations

Public consultations in each neighborhood typology, should systematically assess the community perception, requirements and acceptance of suggested solutions.

Participatory Methodologies

It is recommended to adapt participatory methodologies in the Haitian context and to develop specific tools. The learning projects described above should offer an opportunity for it.

Wastewater composition

A certified National Laboratory is required in the PPMA to provide reliable wastewater analysis services.

Engagement with DINEPA

If DEWATS is to be disseminated in Haiti, DINEPA should train its staff on designing settlement development interventions linked to DEWATS.

Establish DEWATS Network in Haiti

For the purpose of creating a DEWATS 'community of praxis' in PPMA, it is recommended to establish a dedicated platform linked to the WASH Network.

8. References

1 Haitian National Sanitation Strategy Document (DINEPA, March 2012).

2 Réforme du Secteur de l'Eau Potable et de l'Assainissement en Haïti: Les Services Publics d'Alimentation en Eau Potable et d'Assainissement (DINEPA, April 2011).

3 Plan Opérationnel Général 2012-2014. Reforme et Investissements dans le Secteur de l´Eau Potable et de l´Assainissement en la République d´Haïti. (DINEPA/AECID. Mars, 2012)

4 Corps Legislatif. (2009, Mars 25). Loi cadre portant organisation du secteur de l'eau potable et de l'assainissement. Le Moniteur, Journal Officiel de la Republique d'Haiti , 164 (29), pp. 1-12.

5 DRAFT summary of legislation and regulatory text for urban development in Haiti(CIAT, June 2012).

6 "HAITI DEMAIN" OBJECTIFS ET STRATEGIES TERRITORIALES POUR LA RECONSTRUCTION (CIAT, 2010)

7 2012 Population Census Haiti /www.unfpahaiti.org / (UNFPA, 2012)

8 Projets relatifs à la gestion et valorisation des déchets (UNOPS, 2011)

9 Diagnostic "Infrastructures, qualité, gestion et pratiques de l'eau" dans les quartiers précaires de Port-au-Prince (Haïti) (GRET, 2011).

10 Lessons Learned Document from the Sustainable Sanitation Conference (www.oursoil.org/resources) / (SOIL, 2012)

11 UNICEF & WHO (2012) Progress on drinking water and sanitation: Estimates for the use of Improved water sources – Joint Monitoring Programme (JMP). (http://www.wssinfo.org/documents-links/documents/)

12 UNICEF & WHO (2012) Progress on drinking water and sanitation: Estimates for the use of Improved sanitation – Joint Monitoring Programme (JMP). (http://www.wssinfo.org/documents-links/documents/)

13 DEWATS "A Practical Guide" (BORDA, 2009).

14 ENVIRONMENTAL VULNERABILITY IN HAITI: FINDINGS & RECOMMENDATIONS (USAID, April 2007)

15 Etude d'Inginerie, D'Infrastruture et D'assainissement dans la zone de Delmas 9 (LGL S.A. / Croix Rouge Français, Octobre 2012).

16 Republic Of Haiti, Interim Cooperation Framework 2004-2006, Summary Report July 2004. (Republic of Haiti, 2004)

17 OCHA Humanitarian Bulletin Haiti, Issue 25, December 2012. (OCHA, 2012)

ANNEXES

ANNEX A: Additional Considerations for the applicability of DEWATS in the PPMA.

A1) Technical Considerations

The technical Criteria for DEWATS assessment used in the report are:

- **Local availability of construction material (4a)**
- **Appropriate construction techniques (4b)**
- **Appropriate O&M activities (4c)**
- **Disaster-friendly sanitation solution (4d)**
- **Estimated Lifespan (4e)**

Additional technical considerations are presented in this annex and schematically in the plan (Figure A1) at the end of this section.

Figure A1 shows the DEWATS plant at the centre of the DEWATS system with the DEWATS 'users' on the left and effluent discharge to the right. A good understanding of the system parameters labeled 1 to 5 are essential to the design of the DEWATS plant. Where no information is available on these system parameters, assumptions may be made and later be verified through proper measurement and research. The 5 key technical parameters are:

Table A1: 5 key technical parameters for technical applicability of DEWATS.

Ref.	System Parameter	Description
1	Water supply to DEWATS users	Water supply to DEWATS users (l/cap./day) must be known in order to determine wastewater flow.
2	Wastewater into DEWATS.	Wastewater flow (m3/day) and pollution load in terms of BOD_5, COD, SS (mg/l) arriving at the DEWATS must be known in order to determine the size of the DEWATS process units.
3	Treated effluent.	The treated effluent which is discharged from the DEWATS to the environment must satisfy the discharge standards set by DINEPA and enforced at the local level.
4	Sludge removal and transportation.	Sludge must be safely removed and transported from the DEWATS periodically as determined by the wastewater characteristics, the DEWATS design and according to the O&M plan for the plant.
5	Sludge treatment.	Sludge transported from the DEWATS must be treated and safely disposed or re-used (usually off-site).

In addition to these 5 key technical parameters, other important technical considerations are:

Rainwater

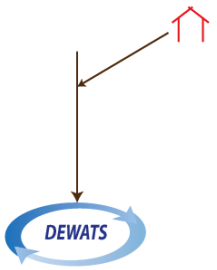
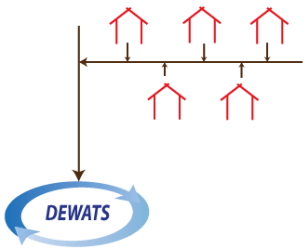
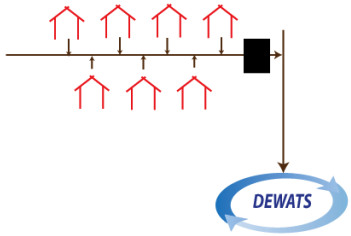
Rainwater must not enter the DEWATS plant. Rainwater, especially the high volumes of rainwater during the rainy season in Haiti, can flush out sludge from DEWATS modules and affect the treatment adversely. Rainwater must be prevented from entering the system or a high flow bypass chamber (spill-weir) must be installed just before the inlet to the DEWATS plant.

User connection and sewerage network

Assuming the household has a water-flush toilet, the sewage must be conveyed to the DEWATS by gravity (i.e. no pumping) with no further negative effects on the environment or on public health.

Typically, gravity sewerage networks are very expensive to construct in the urban context due to technical factors such as the lack of available space, the need to follow natural contours, and the excavation depth needed to install the sewers at the required gradient. Wherever possible in the PPMA, the technical feasibility of sewerage should be facilitated by using pipe aligned to existing corridors (roads, pathways, drainage channels).

The actual configuration of user connections to the Simplified Sewerage System (SSS) must be determined for each individual DEWATS study area, according to the local topography, land use, housing density and the chosen location of the DEWATS plant. 3 kinds of connection options are presented in the figure below:

1) Single house connecting to principal sewer, flow to DEWATS:	**2)** Cluster of houses, connecting to 'communal sewer', connecting to principal sewer, flow to DEWATS:	**3)** Cluster of houses, connecting to 'communal sewer', connecting to communal 'settler', connected to principal sewer, flow to DEWATS:
		

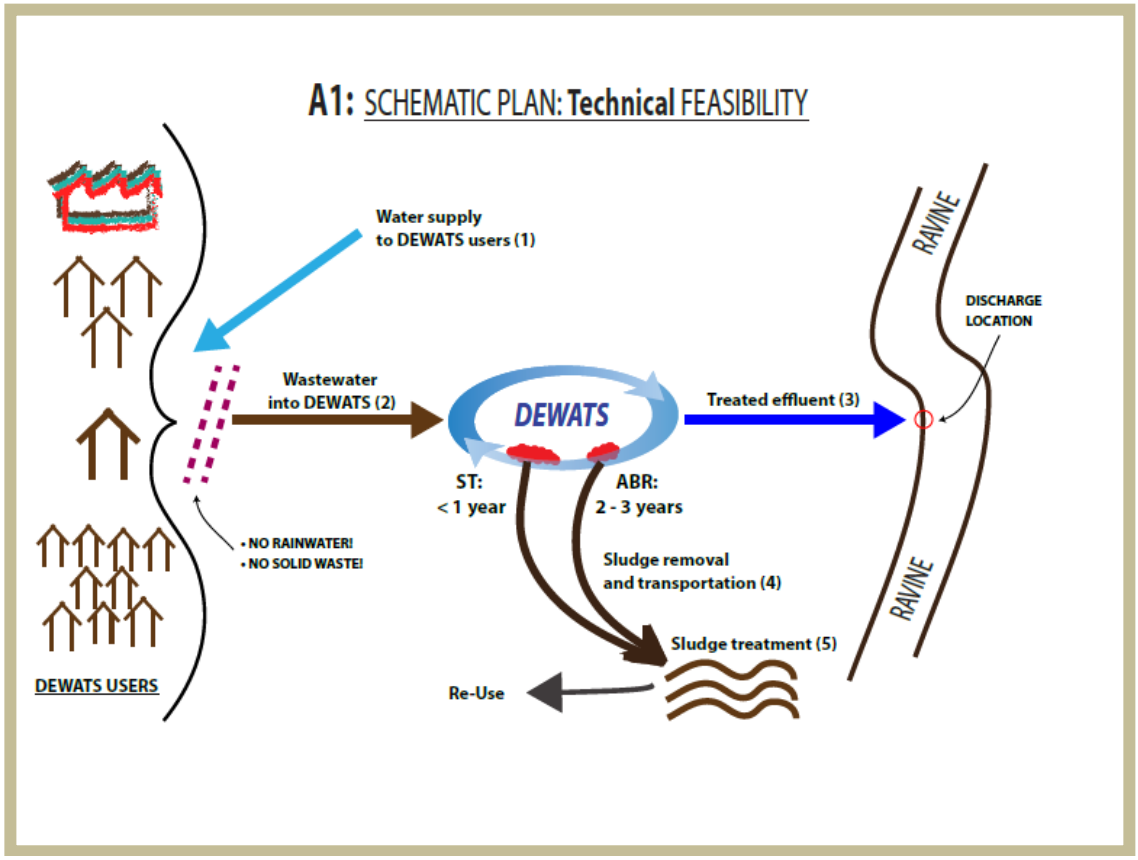


Figure A1) Schematic Plan: Technical Feasibility

A2) Environmental and Community Health Considerations

The environmental and sustainability criteria used for DEWATS assessment in the report are:

- **Addresses the entire sanitation chain (2a)**
- **Effluent treatment efficiency (2b)**
- **Reduction of CO_2 emissions (2c)**

Additional environmental and community health considerations are presented in this annex and shown schematically in the plan (Figure A2) at the end of this section.

Figure A2 shows a community without DEWATS on the left and one with DEWATS on the right. Community health conditions change for the better when DEWATS is introduced. The main environmental factors influencing DEWATS like climatic change, surface and ground water quality, as well food production and energy are indicated.

An understanding of the benefits in terms of environmental protection and community health helps visualize the long-term sustainability of DEWATS and may allow comparison with other possible alternatives. Within this study, only a simplified framework is presented as a detailed analysis for each size is beyond its scope. Environmental system parameters 1 to 4 are essential to the design of the DEWATS plant. Where no information is available on these system parameters, assumptions may be made and later verified through measurement and research. The 4 environmental and community health parameters are:

Table A2: 4 system parameters for environmental and community health applicability of DEWATS.

Ref.	System Parameter	Description
1	Reduction of organic load of wastewater	Pollution load in terms of BOD_5 and COD are reduced. - DEWATS reduces the contamination of receiving water sources.
2	Reduction of CO_2 equivalent	Methane emissions (in terms of CO_2 equivalent) are reduced by substituting fossil fuel energy sources and mineral fertilizer. - DEWATS reduces green house gases.
3	Access to safe toilets.	Increased numbers of people that would gain access to safe sanitation and would be connected to DEWATS. - DEWATS reduces illnesses transmitted by excreta.
4	Reduced open defecation	Increased numbers of people that will shift from open defecation to regular safe toilet use reduces the risk of contact with excreta - DEWATS increases dignity in sanitation

1. **<u>DEWATS reduces the contamination of receiving water sources.</u>**

All community based sanitation CBS-DEWATS options eliminate the main source of ground water contamination in the immediate vicinity of each household, reducing considerably the risk of direct contamination of existing shallow wells and unsealed ground water reservoirs.

The DEWATS options suggested can reduce the organic pollution load of domestic wastewater by over 90%. Nitrogen and phosphorus concentrations will remain unchanged but could be reduced by up to 100%, if a reuse option linked to farming or gardening is included. This reduces contamination of ground water from nitrates, phosphates and coli forms.

2. DEWATS reduces green house gases

The emission of greenhouse gases can be reduced by CBS-DEWATS projects if re-use options of the pre-treated wastewater and biogas are selected and applied. The substitution of mineral nitrogen-fertilizer by effluent from anaerobic DEWATS modules reduces green house gas emission (GHG) from the nitrogen production in the range of 7 kg CO_2 equivalent/kg N.

For a settlement of 150 households, this represents a GHG reduction in the range of 40 tones CO_2-equivalent per year. Similarly, the collection of methane from the wastewater treatment of 150 households and its combustion contributes to the GHG reduction in a range of 80 tones CO_2 equivalent per year. By using biogas for cooking instead of charcoal, the GHG will be reduced to around 20 tones CO_2-equivalent per year.

3. DEWATS reduces illnesses transmitted by excreta

As the cornerstone of public health, access to proper sanitation improves with DEWATS. The high housing density of the studied settlements poses great health risks related to inappropriate sanitation conditions. The access to convenient and safe toilets increases as opportunities increase to connect to a waterborne toilet system thus reducing open defecation and inappropriate toilet systems. DEWATS reduces the number of infections caused by unprotected contact with human excreta especially diarrheal diseases and cholera. Direct contact with human excreta is widely reduced by DEWATS as they are designed as closed systems; handling of excreta is not required and handling of the sediments (sludge) of the treatment components is reduced.

The implementation of CBS-DEWATS in vulnerable and low-income areas reduces the frequency of doctor visits for women (mainly due to reduced child illness).

4. DEWATS increases dignity in sanitation

The provision of a DEWATS sanitation system is to be done in close cooperation with the community (Community Based Sanitation - CBS) and is hence based on their demand and preferences. This usually leads also to overcome prevailing open defecation and with it, one of the main sources of transmission of human-excreta related diseases. Further, CBS-DEWATS provides an environment of dignity especially for women and girls who otherwise are at risk of sexual harassment and assault.

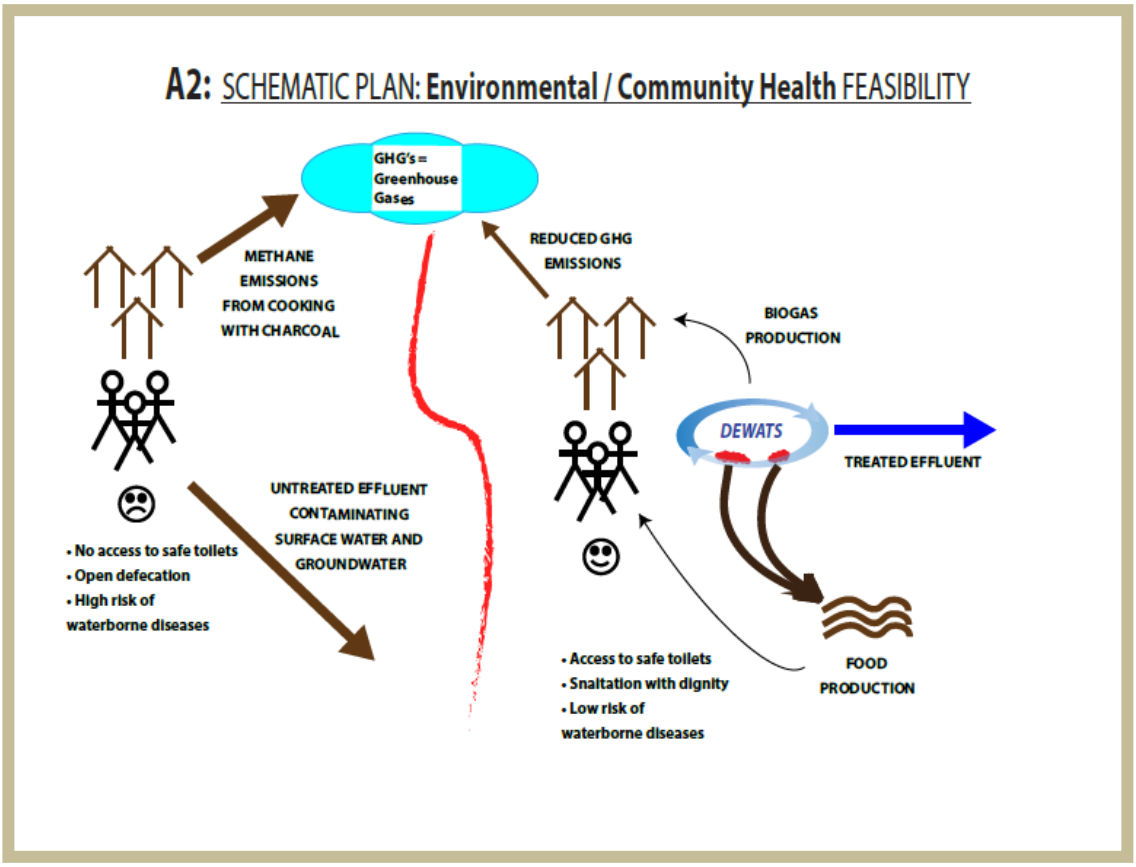


Figure A2) Schematic Plan: Environmental Feasibility

A3) Socio-Economic Considerations

The socio-economic criteria used for DEWATS assessment in the Report are:

- **Estimated cost of initial investment per person (3a)**
- **Estimated annual O&M cost per household (3b)**
- **Interest of local authorities for DEWATS (3c)**
- **Interest of communities for DEWATS (3d)**

Additional socio-economic considerations are presented in this annex and schematically in the plan (Figure A3) at the end of this section.

The term financial and economic applicability is used to encompass both: the financial costs of the system split into (1) construction costs and (2) operational costs; and the economic benefits of the system e.g. the valuation of waste (biogas and compost) and the improvements in the human and physical environments.

DEWATS is a technical solution that functions without electrical or mechanical energy or equipments but it is not a 'no-tech' or 'low-tech' solution. There is always a need for financial inputs for construction, operation, maintenance and information and awareness raising. Operational costs need to be considered at the planning stage and emphasized during the financial and economic feasibility study.

Figure A3 uses the same schematic presentation as in Figure A1 to present how DEWATS costs relate to the technical components of the DEWATS system. These costs, as well as an indication of who may bear the costs are presented below for both capital costs and operational costs.

Capital Costs

Table A3: DEWATS system capital costs.

Ref. from Figure.	Construction Cost	Who Pays?
C_0	Community information and mobilization.	The Haitian Government, International Development Banks, Haitian banks, International Organizations or NGOs.
C_1	DEWATS plant, including training costs for staff.	
C_2	SSS *	
C_3	Effluent discharge	
C_4	Sludge Treatment	Off-site sludge treatment at a central location: this cost should be borne by the sludge treatment entity, be it public or private.
C_5	User connection	The user.

*SSS = Simplified Sewer System

Capital costs (predominantly construction costs) may be covered by a combination of grants (e.g. from International Organizations or NGOs), bank loans or other financing institutions. For the purposes of this study, it is assumed that user contributions to capital costs are not feasible hence not forthcoming for reasons including:

- Sustainable wastewater treatment is a new concept in the PPMA and one which requires a paradigm shift in the prevailing culture of hygiene and environmental awareness. Cultural changes need time for acceptance.
- DEWATS benefits cannot be tangibly demonstrated elsewhere in the PPMA (the first DEWATS plant will be a pilot plant).
- Actual ownership of land (required for DEWATS construction) is unclear in much of the PPMA and legal and social issues around land ownership are complicated.

The only capital cost assumed reasonable and feasible for the user to bear is the user connection (C_5). This may be covered in a one-off connection fee or recovered through tariff payments (see later section on tariffs). A level of ownership of the DEWATS system by the user is a requirement for its sustainable design and later operation. A user connection fee should be explored to support ownership and care of the DEWATS system.

Operational Costs

Table A4: DEWATS system operational costs.

Ref. from Figure.	Operational Cost	Who Pays?
O_1	Operating the DEWATS	The DEWATS 'operating entity[a]' financed by user tariffs.
O_2	SSS[b]	The DEWATS operating entity, financed by user tariffs.
O_3	Effluent quality monitoring	A separate body to the DEWATS operating entity, ideally a state department like DINEPA.
O_4	Sludge Treatment	Assuming sludge treatment to happen off-site at a central location, this operating cost should be borne by the sludge treatment entity with funds recovered from the DEWATS operating entity and financed by user tariffs.
O_5	House Connection	The user.
O_6	Desludging DEWATS	The DEWATS operating entity financed by user tariffs.

[a] The term 'operating entity' is used in this section to describe the body responsible for operating the DEWATS system. The next section on organizational/institutional applicability discusses this entity.

[b] SSS = Simplified Sewer System.

User Tariffs

Tariffs are costs, usually payable according to a measurable usage e.g. water tariffs are usually paid based on the quantity of water consumed. Tariffs may be collected as lump sum payments in the form of monthly or yearly fees. User tariffs are calculated directly from operational costs.

Willingness and ability to pay

If operating costs are high then user tariffs will also be high. This may cause users not to pay or potential users may choose not to connect. This is where financial feasibility becomes integrated with social and environmental feasibility, so that users see the benefits of DEWATS and choose to connect and pay. The payment of DEWATS tariffs to the operational entity must be well understood by the user in terms of tariff amount and schedule of tariff payments. Non-payment of tariffs, in the absence of any external financial support, will cause dysfunction of the DEWATS plant.

How to present DEWATS tariffs to the user?

It is a common approach in countries with both established and new sanitation infrastructure for wastewater treatment tariffs to be 'bundled' with water tariffs for reasons including:

- Users are aware of the need to pay for water and less aware of the need to pay for sanitation.
- DEWATS users require a quantity of easily accessible water; if users need to walk for hours to collect water with a bucket, they are less inclined to flush it down a toilet. Hence, households connected to DEWATS often also have a water connection and these tariffs may be combined.
- There are institutional and administrative processes in place to provide and charge for water supply. These could be modifies and also applied to wastewater treatment.

Simple tariff structures are recommended e.g. Tariff A for a household with 1-8 members, Tariff B for larger household and Tariff C for SMEs.

Another option is to bundle wastewater treatment tariffs with those for solid waste management, if these exist and are adhered to by the users.

Who pays user tariffs? House owner or house renter?

Land ownership issues can complicate the financial feasibility of both construction and operation of the DEWATS. The responsible party (house owner or house renter) must be clearly implicated (i.e. in name on a written contract) in the decision to connect to the DEWATS plant and therefore the decision to contribute to the operation through the payment of the user tariff. For the financial and economic feasibility of DEWATS, the responsibility to pay tariffs over a known time period by the house renter or house owner must be explicitly formalized.

Valorization or commercialization of transformed waste products

Operational costs may be subsidized by treated waste products such as compost or biogas. In the Haitian context, biogas production from a biogas-settler for clusters of 25 households could generate biogas to substitute up to 6 kg of charcoal per day. This could generate income to cover O&M costs. A more detailed analysis and community discussion is required to incorporate reuse options into the wastewater treatment concepts.

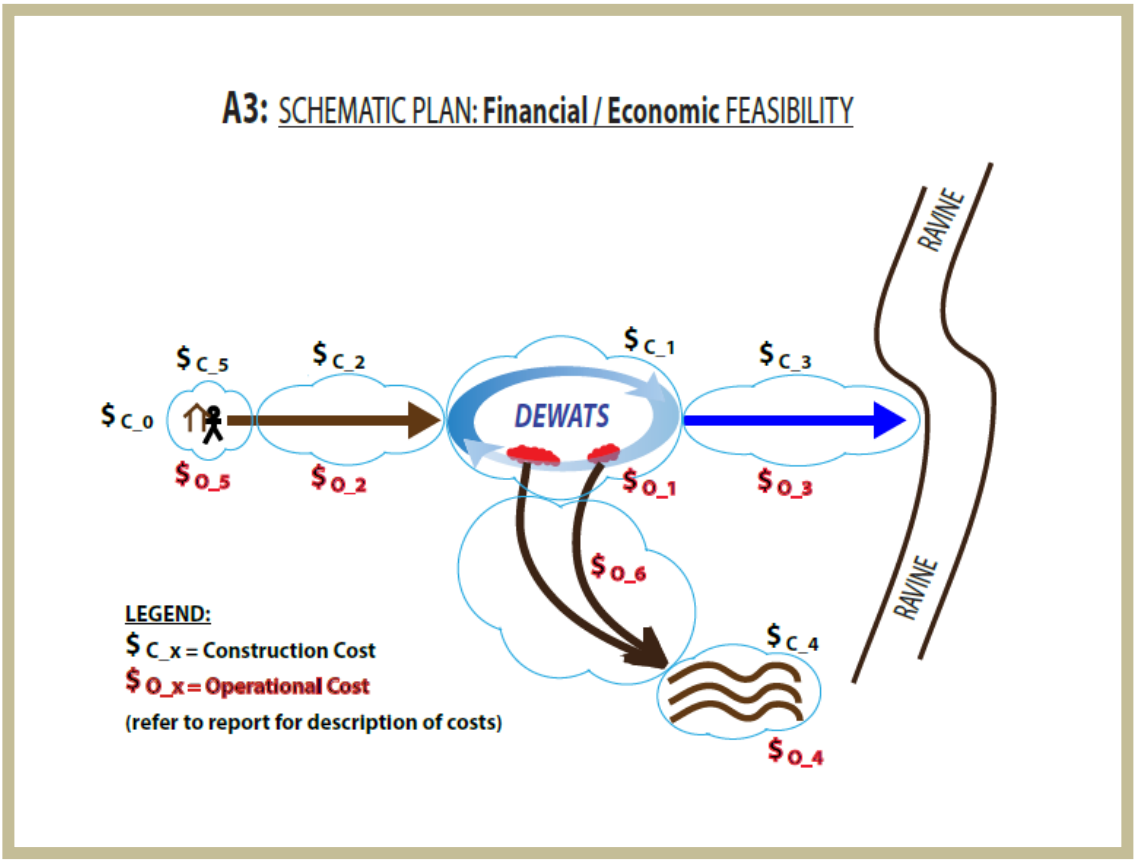


Figure A3) Schematic Plan: Financial/Economic Feasibility

A4) Institutional/Organizational Considerations

The institutional and legal criteria used for DEWATS assessment in the Report are:

- **Compliance with national discharge standards (1a)**
- **Compliance with national strategy of DINEPA (1b)**

Additional institutional and organizational considerations are presented in this annex and schematically in the plan (Figure A4) at the end of this section.

DEWATS may be for a single household, a group of households or an entire settlement. The Institutional and Organizational feasibility study poses questions related to ownership and

responsibility e.g., 'who is responsible for which activity?', 'how do the different individuals and groups interact?', and 'who has overall responsibility for the system?'.

In order to study questions like 'who is responsible for which activity?', 'how do the different groups interact?' 'who has overall responsibility for the system?', the activities to be undertaken and the groups available to undertake them were identified.

Figure A4 identifies the different DEWATS activities for construction and operation using the same schematic plan as in previous sections. Also listed on figure A4 are the potential groups available to undertake the activities. See the table below:

Table A5: DEWATS activities and responsible bodies.

Ref.	Construction Activity	Responsible body
C_1	DEWATS plant	The implementing agency (e.g. RC)
C_2	Wastewater network	The implementing agency (e.g. RC)
C_3	Effluent outfall	The implementing agency (e.g. RC)
C_4	Sludge Treatment	*By others: Outside the scope of this study*
C_5	User connection	Demand from the user; installation DEWATS 'operating entity' or implementing agency.
Ref.	**Operational Activity**	**Responsible body**
O_1	Operating the DEWATS[a]	The DEWATS 'operating entity'
O_2	Wastewater network	The DEWATS 'operating entity'
O_3	Effluent quality monitoring	DINEPA
O_4	Sludge Treatment	*By others: Outside the scope of this study*
O_5	House Connection	The User.
O_6	Desludging DEWATS	The DEWATS 'operating entity'
O_7	Re-use of transformed waste	For biogas; the DEWATS 'operating entity'

[a] Operating the DEWATS requires both routine maintenance (weekly and monthly) and periodic maintenance (yearly). Periodic maintenance cannot normally be guaranteed by the operating entity if it is the community.

The responsible bodies and their interactions are described below:

The DEWATS operating entity

The groups available to act as the DEWATS operating entity will vary according to the study area, however, the 3 basic options in the PPMA are:

1. Community Based Organization (CBO)

CBOs are very common in the PPMA and are a useful gateway to interacting with the community. A due diligence must be done by the implementing agency on the CBO in order to determine whether they actually represent the community and whether they have the capacity to undertake the necessary work. As they are expected to work with a stigmatized issue like human waste, the motivation of the CBO to participate in the project should be thoroughly investigated. This will be part of any detailed feasibility study for a specific site.

2. Water Committees

Water committees are common throughout Haiti, in both urban and rural zones. They can be very efficient and representative of the communities they serve or they may not: a due diligence survey must always be undertaken. In many developing countries, the existing water management organizations also manage sanitation. The major advantage of this is that the organization is already formed and has already received technical and administrative training which may be supplemented

and applied to DEWATS management. Indeed, the DINEPA strategy in rural areas is for the rural water committees to also assume sanitation responsibilities.

3. Private Sector

Private sector involvement in operating sanitation infrastructure in Haiti is presently limited to desludging of latrines and septic tanks (by Bayakou or sludge trucks). These companies or other newly formed companies, may be interested in managing DEWATS if it is commercially viable. The main advantage of a private company over a CBO in terms of managing sanitation is that the private company is outside the community and therefore outside community social dynamics.

The Chain of Custody

The term 'The Chain of Custody' when applied to DEWATS, describes the controlled movement of waste along the entire sanitation chain, from the toilet to the ravine and from the toilet to the sludge treatment plant. A safe and reliable chain of custody requires a clear definition of roles and responsibilities for all of the activities and responsible bodies in the Table above. This chain of custody is elaborated into an Operation and Maintenance (O&M) plan.

The Role of the User

The user must be implicated in the DEWATS system during implementation in order to assume some ownership of and responsibility for the system. The user is responsible for ensuring that only the correct waste matter (i.e. wastewater, not rainwater or solid waste) enters the DEWATS. Hence, an information and awareness campaign is part of every DEWATS project. As discussed earlier, each individual user (house owner or house renter) must be clearly defined.

Identification of Staff and Staff Training

DEWATS construction and operation requires a team of professionals, skilled and semi-skilled workers. The identification and training of staff working in the sanitation sector is an important part of DINEPA's national strategy. Wherever possible, identification and training of staff should be synergized with DINEPA's National Strategy on training.

Research and Dissemination of Information

Since the first DEWATS plant in the PPMA will be a pilot plant, there is a need to evaluate the system performance under Haitian conditions and also share data collected and analysis with the sanitation community in the PPMA. Competent Haitian research institutions should be identified and commissioned to undertake this work in collaboration with the communities.

DEWATS participatory approach

A participatory approach to DEWATS implementation is essential to the success of DEWATS. Community Based Sanitation is an participatory approach adopted when implementing DEWATS with a CBO. CBS is a multi-stakeholder approach with the greatest challenge being to synergize and streamline the process and the contributions of all involved stakeholders.

Informed Choice

Potential households to be connected to DEWATS are provided with varied options for sanitation facilities and services. During the process, users learn about the options available and eliminate those that do not apply to their situation. Users learn about:

- toilet types and layouts of toilet facilities.
- functions and layouts of community sanitation centers.
- service levels to be expected.

Informed choice is usually focused on the users' preferences concerning sanitation interface or toilet type. However, components like sewer layout, treatment components, effluent discharge and reuse of treatment products can also be addressed within community meetings to assess the public acceptance of DEWATS.

Multi-Stakeholder Involvement

The active participation of the various parties involved in the CBS-DEWATS projects should span the entire development process: preparation, planning, implementation, monitoring and final evaluation. Participation improves the sustainability and performance of the project. Ownership ensures stakeholder commitment and participation, thereby reducing supervision costs. The different stakeholder groups are:

- Primary stakeholders – residents and connected users.
- Secondary stakeholders – groups with a direct or indirect responsibility in the program e.g. the implementing agency (RC), DINEPA.
- Tertiary stakeholders – providers of special services for construction, maintenance and sludge management. (BORDA, 2009).

Residents Involvement (Primary Stakeholders)

CBS programs respond to the needs of poor area residents. The community:

- will use the sanitation facility hence the facilities must fit their needs and practices;
- will have to contribute financially to the system; and
- might have an important role in O&M. (BORDA, 2009)

To ensure involvement of poor residents, the following factors need to be considered:

- Sanitation programs should be accompanied by health and hygiene awareness-raising campaigns.
- Program acceptance by local leaders helps to avoid unnecessary interference with social hierarchies.
- Social-settlement structure and stratification, sanitation practices, informal land-holding customs and reservations about infrastructure implementation should be understood and taken into account.
- Women are often the household decision-makers with regard to domestic sanitation and sanitation practice. They must hence be actively involved in addressing problems, identifying underlying causes, recommending possible solutions and ultimately, making decisions to solve the problems.
- Developed over recent years, "demand-responsive approaches" have become the conceptual framework of sustainable sanitation programs. The approach treats users as clients, who express their needs but must provide financial contributions. Neither "demand" nor "willingness to pay" are easily measurable but maybe determined after diligent execution of CBS steps. (BORDA, 2009).

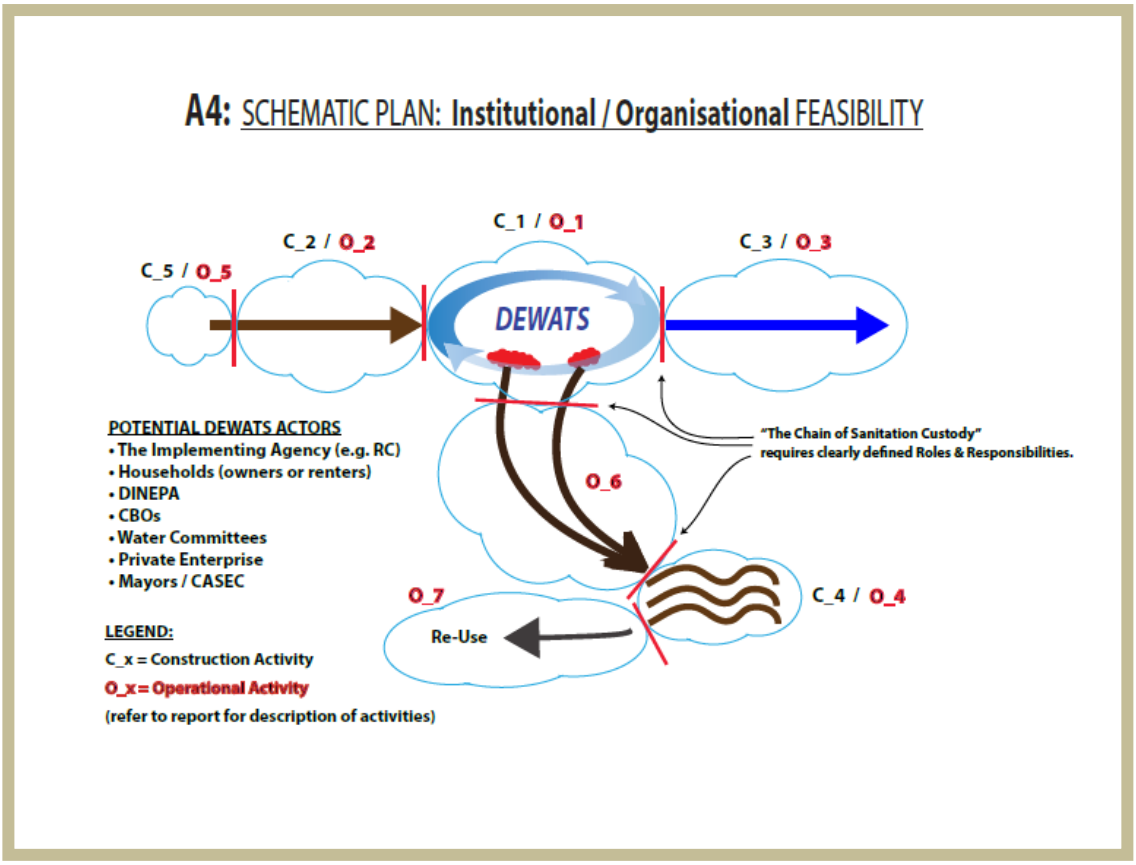


Figure A4) Schematic Plan: Institutional/Organizational Feasibility

A5) Social Considerations

For DEWATS in low-income settlements, a high level of acceptance which ensures social feasibility of the project is especially important. In many situations the project will depend not only on the acceptance but also on the active contribution of the neighborhood. The social feasibility of the project poses questions such as 'what is the impact of the project on the local society? Do they perceive the benefits? Is sanitation a priority for the community?'.

The considerations for the social feasibility of DEWATS in the PPMA are presented in the schematic plan (Figure A5) at the end of this section. These considerations are discussed below:

Population to be connected

The feasibility study may determine that a select group of houses are feasible for DEWATS and should therefore benefit from it. Other groups of houses nearby but in the same neighborhood, may be less feasible and not chosen to benefit from DEWATS. If not handled with sensitivity, this could be perceived as favoritism and create social tensions within the community. Such intricate social dynamics are common in the PPMA and it is beholden upon the implementer of the project to undertake diligent sensitization of the community so that these social implications are understood and can be used to benefit the social feasibility of the DEWATS and not threaten it.

Job creation, training and income generation

Both the construction and operation of DEWATS will generate income which should be shared amongst the DEWATS community members as best as possible; this will also help the community acceptance of DEWATS.

Presence of informal settlements, T-shelters and IDP camps

There are still a large number of informal settlements, tents and transitional shelters within residential neighborhoods of the PPMA. Potential DEWATS sites may be occupied by these informal settlements without land ownership rights. However, their right to humanitarian assistance must be respected especially during Haiti's frequent emergencies.

Population downstream of effluent discharge

Even with the improved effluent quality from the DEWATS site, the concentration of flow from a single point may cause concern for downstream communities who may rely on the water in the ravine for washing clothes and bathing. The DEWATS plant will improve the environment but could be perceived as a new threat. Most existing leaking septic tanks in the PPMA are out of sight hence, out of mind. A broad and comprehensive public consultation process with as many local stakeholders as possible should reduce this risk and be undertaken before proceeding onto engineering design.

Population upstream of effluent discharge

The population upstream of the effluent discharge should be less concerned than the downstream population since the effluent will not be flowing in their direction. However, some individuals earn their livelihood from the solid waste in the ravine and may feel affected by a change in the flow conditions therein .

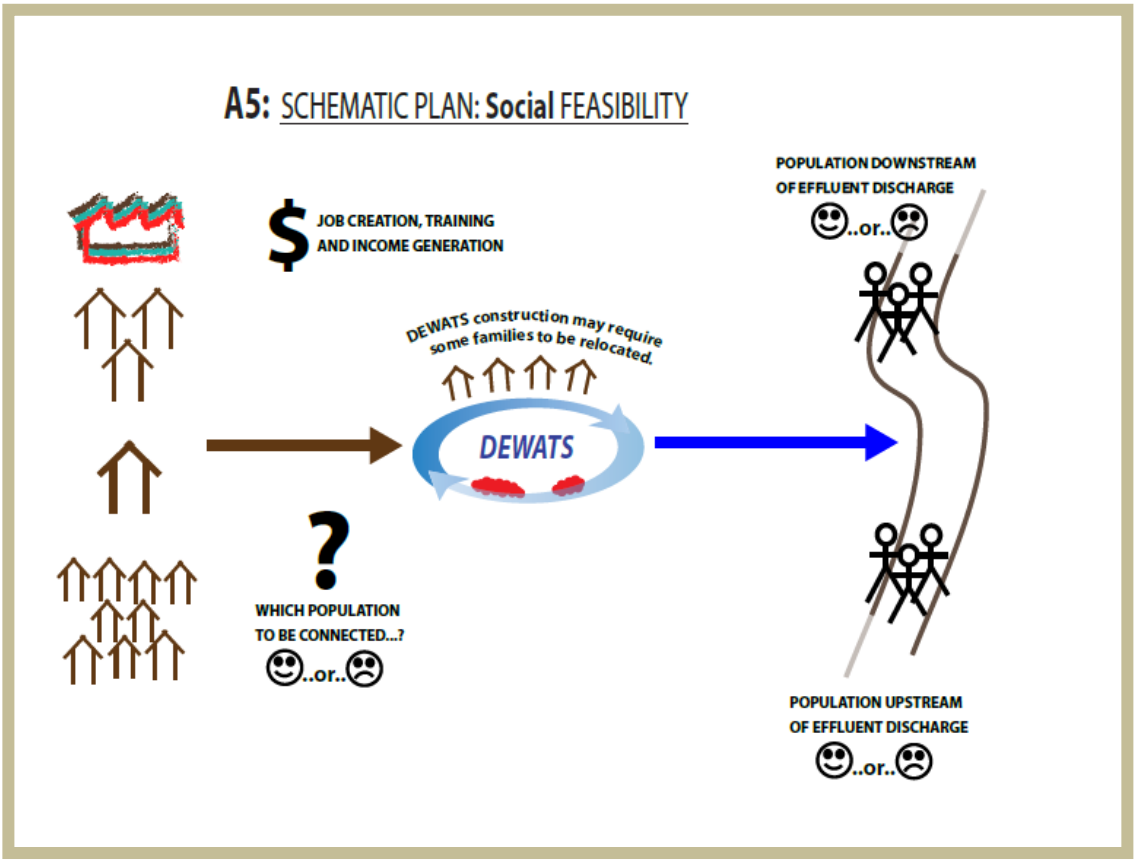


Figure A5) Schematic Plan: Social Feasibility

ANNEX B: DEWATS Indicative Costs

Notes:

1. Presented in the tables below are initial tentative investment costs and operation and maintenance costs for various DEWATS options in the PPMA.
2. At the end of this Annex a break-up of the DEWATS O+M cost is presented.
3. Costs presented are only indicative and only for the DEWATS treatment module; cost for SSS laying or land cost are not included.
4. Any budgeting for DEWATS would require a verification of the cost by a Haitian constructor.
5. Costs are presented only for selected DEWATS options for the sites visited.

ABR= Baffled Reactor; DD= Discharge into Drain; DR=Discharge into Ravine; PD= Planted Drain; PGF=Planted Gravel Filter; RB=Rock-Band; ST=Settler

DEWATS study site: Delmas 30

Option 2: DEWATS for clusters of houses at Impasse Damas			
DEWATS Treatment Option		***ST+ABR+ DR***	***BST+ABR+ DR***
Number of Household	HH	60	60
Expected max wastewater flow/day	m3	30	30
Investment cost DEWATS - Prim. Tr.	USD	51,900	69,600
Investment cost DEWATS - Prim. Tr./cap	USD	170	230
Operation & Maintenance /User	HTG/month	70	70
Investment cost DEWATS -Prim+ Sec. Tr	USD		
Investment cost DEWATS - Prim+Sec Tr./cap	USD		
Operation & Maintenance/use (both)	HTG/month		
Option 3: DEWATS for clusters of houses at Ruelle Fraternite			
DEWATS Treatment Option		***ST+ABR++ DD***	***BST+ABR+ DD***
Number of Household	HH	20	20
Expected max wastewater flow/day	m3	10	10
Investment cost DEWATS - Prim. Tr.	USD	20,500	27500
Investment cost DEWATS - Prim. Tr./cap	USD	173	232
Operation & Maintenance /User	HTG/month	70	70
Investment cost DEWATS -Prim+ Sec. Tr	USD		
Investment cost DEWATS - Prim+Sec Tr./cap	USD		
Operation & Maintenance/use (both)	HTG/month		

Option 4: Public toilets using DEWATS (6 seater, toilet only)			
DEWATS Treatment Option		***ST+ ABR + (RB) +DR***	***BST+ABR+ (RB)+ DR***
Number of Users	Users	200	200
Expected max wastewater flow/day	m3	3	3
Investment cost DEWATS - Prim. Tr.	USD	9,000	11,100
Investment cost DEWATS - Prim. Tr./cap	USD	22	28
Operation & Maintenance /user	HTG/month	18	18
Investment cost DEWATS -Prim+ Sec. Tr	USD	10,000	12,140
Investment cost DEWATS- Prim+Sec Tr./user	USD	50	60
Operation & Maintenance/use (both)	HTG/month	95	95

DEWATS study site: Carrefour Feuilles 'CFF'

Option 2: DEWATS for clusters of houses at Impasse Salem road			
DEWATS Treatment Option		***ST+ABR+ (PD)+DD***	
Number of Household	HH	20	
Expected max wastewater flow/day	m3	10	
Investment cost DEWATS - Prim. Tr.	USD	26,600	
Investment cost DEWATS - Prim. Tr./cap	USD	270	
Operation & Maintenance /User	HTG/month	120	
Investment cost DEWATS -Prim+ Sec. Tr	USD	30,400	
Investment cost DEWATS - Prim+Sec Tr./cap	USD	304	
Operation & Maintenance/use (both)	HTG/month	150	

DEWATS study site: Delmas 9, 11, 13

Option 2: Rue Delmas 7			
DEWATS Treatment Option		***ST+ABR+ (PGF)+DR***	***BST+ABR+ (FGF)+DR***
Number of Household	HH	20	20
Expected max wastewater flow/day	m3	10	10
Investment cost DEWATS - Prim. Tr.	USD	20,550	27,450
Investment cost DEWATS - Prim. Tr./cap	USD	205	275
Operation & Maintenance /User	HTG/month	120	120
Investment cost DEWATS -Prim+ Sec. Tr	USD	38,400	45,300
Investment cost DEWATS - Prim+Sec Tr./cap	USD	380	450
Operation & Maintenance/use (both)	HTG/month	180	180

Option 3: Rue Ducosquier			
DEWATS Treatment Option		***ST+ABR+ (PGF)+DR***	***BST+ABR+ (FGF)+DR***
Number of Household	HH	30	15
Expected max wastewater flow/day	m3	15	15
Investment cost DEWATS - Prim. Tr.	USD	30,800	41,200
Investment cost DEWATS - Prim. Tr./cap	USD	205	275
Operation & Maintenance /User	HTG/month	95	95
Investment cost DEWATS -Prim+ Sec. Tr	USD	57,500	67,900
Investment cost DEWATS - Prim+Sec Tr./cap	USD	380	450
Operation & Maintenance/use (both)	HTG/month	160	160
Option 4: Rue Delmas 9			
DEWATS Treatment Option		***ST+ABR+ (PGF)+DR***	***BST+ABR+ (FGF)+DR***
Number of Household	HH	20	20
Expected max wastewater flow/day	m3	10	10
Investment cost DEWATS - Prim. Tr.	USD	20,550	27,450
Investment cost DEWATS - Prim. Tr./cap	USD	205	275
Operation & Maintenance /User	HTG/month	120	120
Investment cost DEWATS -Prim+ Sec. Tr	USD	38,400	45,300
Investment cost DEWATS - Prim+Sec Tr./cap	USD	380	450
Operation & Maintenance/use (both)	HTG/month	180	180
Option 5: Delmas 11			
DEWATS Treatment Option		***ST+ABR+ (PGF)+DR***	***BST+ABR+ (FGF)+DR***
Number of Household	HH	25	25
Expected max wastewater flow/day	m3	12.5	12.5
Investment cost DEWATS - Prim. Tr.	USD	25,700	32,900
Investment cost DEWATS - Prim. Tr./cap	USD	205	264
Operation & Maintenance /User	HTG/month	100	105
Investment cost DEWATS -Prim+ Sec. Tr	USD	48,000	54,300
Investment cost DEWATS - Prim+Sec Tr./cap	USD	385	435
Operation & Maintenance/use (both)	HTG/month	165	170

Option 6: Rue Barreau			
DEWATS Treatment Option		***ST+ABR+ (PGF)+DR***	***BST+ABR+ (FGF)+DR***
Number of Household	HH	70	70
Expected max wastewater flow/day	m3	35	35
Investment cost DEWATS - Prim. Tr.	USD	60,500	81,300
Investment cost DEWATS - Prim. Tr./cap	USD	170	230
Operation & Maintenance /User	HTG/month	65	65
Investment cost DEWATS -Prim+ Sec. Tr	USD	113,000	134,000
Investment cost DEWATS - Prim+Sec Tr./cap	USD	320	380
Operation & Maintenance/use (both)	HTG/month	125	130
Option 7: Delams 13			
DEWATS Treatment Option		***ST+ABR+ (PGF)+DR***	***BST+ABR+ (FGF)+DR***
Number of Household	HH	50	50
Expected max wastewater flow/day	m3	25	25
Investment cost DEWATS - Prim. Tr.	USD	43,200	58,100
Investment cost DEWATS - Prim. Tr./cap	USD	170	230
Operation & Maintenance /User	HTG/month	75	75
Investment cost DEWATS -Prim+ Sec. Tr	USD	80,700	95,600
Investment cost DEWATS - Prim+Sec Tr./cap	USD	320	380
Operation & Maintenance/use (both)	HTG/month	135	235

DEWATS study site Campeche

Option 3: Infrastructure Recovery - Public toilet block (6 seater, toilet only)			
DEWATS Treatment Option		***ST+ ABR + DD***	***BST+ABR+ DD***
Number of Users	Users	200	200
Expected max wastewater flow/day	m3	3	3
Investment cost DEWATS - Prim. Tr.	USD	9,000	11,100
Investment cost DEWATS - Prim. Tr./cap	USD	45	55
Operation & Maintenance /user	HTG/month	18	18
Investment cost DEWATS -Prim+ Sec. Tr	USD		
Investment cost DEWATS- Prim+Sec Tr./user	USD		
Operation & Maintenance/use (both)	HTG/month		

Option 4: DEWATS for clusters of narrow houses on a steep slope			
DEWATS Treatment Option		***ST+ABR+ (PD)+DR***	***BST+ABR+ (PD)+DR***
Number of Households	HH	100	100
Expected max wastewater flow	m3	50	50
Investment cost DEWATS - Prim. Tr.	USD	86,500	116,000
Investment cost DEWATS - Prim. Tr./cap	USD	173	232
Operation & Maintenance /User	HTG/month	73	73
Investment cost DEWATS -Prim+ Sec. Tr	USD	94,100	123,885
Investment cost DEWATS - Prim+Sec Tr./cap	USD	190	250
Operation & Maintenance/use (both)	HTG/month	91	93
Option 5: DEWATS for clusters of houses at lower Campeche			
DEWATS Treatment Option		***ST+ABR+ (RB)+DR***	***BST+ABR+ (RB)+DR***
Number of Household	HH	40	40
Expected max wastewater flow/day	m3	20	20
Investment cost DEWATS - Prim. Tr.	USD	41,000	55,000
Investment cost DEWATS - Prim. Tr./cap	USD	205	275
Operation & Maintenance /User	HTG/month	120	120
Investment cost DEWATS -Prim+ Sec. Tr	USD	47,000	60,800
Investment cost DEWATS - Prim+Sec Tr./cap	USD	235	300
Operation & Maintenance/use (both)	HTG/month	135	135
Option 6: Public toilets using DEWATS			
DEWATS Treatment Option		***ST+ABR+ DR***	***BST+ABR+ DR***
Number of users	Users	400	400
Expected max wastewater flow/day	m3	5	5
Investment cost DEWATS - Prim. Tr.	USD	17,900	22,200
Investment cost DEWATS - Prim. Tr./user	USD	45	56
Operation & Maintenance /User	HTG/month	10	10
Investment cost DEWATS -Prim+ Sec. Tr	USD		
Investment cost DEWATS- Prim+Sec Tr./user	USD		
Operation & Maintenance/use (both)	HTG/month		

O&M Cost Calculation for DEWATS in Port-au-Prince
(example for DEWATS for 50m3 /day, approx. 100 HH)

	Items	Remarks	Cost/ Month
			HGT
1	DEWATS operator	according to the size and complexity of DEWATS 1/3 to 1 person day.	4,400
2	Basic equipment	(Bucket, shovel, scoop)	700
3	DEWATS minimal repairs & maintenance,	repainting painting, cementing etc.	280
4	SSS regular maintenance	10% piping length/5year to be repaired	670
5	Periodical desludging of settler / ABR	8m3 vacuum truck 4000 HTC/trip	370
6	Periodical maintenance of PGF, planted drains	cleaning filter material every 5 years, plant replacement every 2 years	5,400
7	Miscellaneous und unforeseen expenditure	10% of the above	1,180
8	**Subtotal**		13,000
9	Savings	10%	1,300
10	**Total Cost**		**14,300**

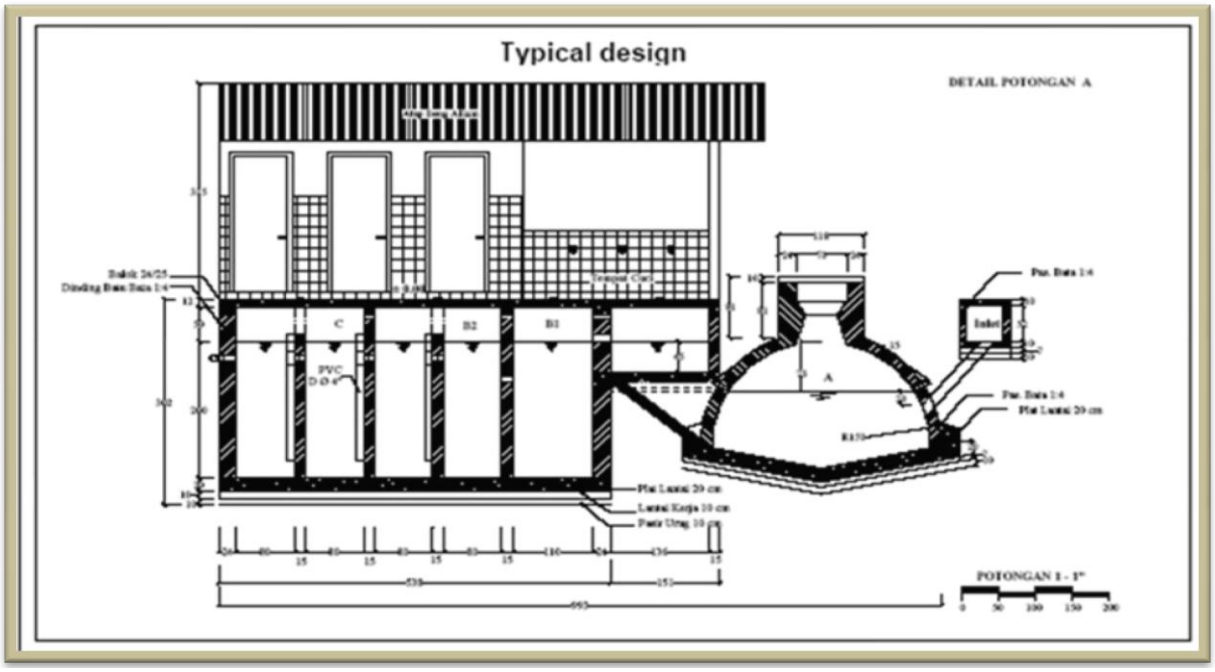
ANNEX C: Public Toilet Options

A public sanitation block for a defined settlement is a CBS-DEWATS option and its specific function, service level, equipment, layout and management structure should represent the users' preferences. Community toilets blocks usually comprise several toilet compartments and can also include showers, laundry facilities and water supply. There are a large variety of available superstructure options.

Integrated concepts can include treatment options such as: septic tanks, biogas-settlers or ABR. Community toilets are a suitable CBS option in settlements where the majority of the households do not have toilets.

Past experience has shown that proper maintenance and operation of community toilets is a major challenge for their sustainability. User fees are a "must" to finance routine operation and maintenance services which ought to be carried out by permanent or part-time O&M staff employed by community groups or private service providers.

The figure below shows a construction design of a public toilet using a biodigester for treatment.



ANNEX D: Consultant's Terms of Reference

International Federation
of Red Cross and Red Crescent Societies

Terms of Reference (TOR)

Evaluation of the potentiality for Decentralized Wastewater Treatment Systems (DEWATS) solutions in the urban settings of Port-au-Prince Metropolitan Area (PPMA)

Joint survey:

International Federation of the Red Cross (IFRC)

Direction Nationale de l'Eau Potable et de l'Assainissement (DINEPA)

Background

On 12 January 2010 an earthquake measuring 7.0 on the Richter Scale struck Haiti. The earthquake's epicentre was some 15 km south-west of the country's capital Port-au-Prince close to the city of Léogane. The International Federation of the Red Cross (IFRC) worked during 2010 and 2011 in an emergency response aiming at providing basic water, sanitation and hygiene service for the Haitian people. In early2011, the IFRC began formulating a long term recovery strategy call INA (Integrated Neighboorhood Approach) that aims at providing a set of services in the sectors of water and sanitation, health, settlements, violence prevention, disaster risk reduction.
As part of INA, IFRC will implement water and sanitation activities in support of settlements activities. The specific urban context of PPMA, that doesn't have any sewage system, requires innovative sanitation solutions
In coordination with the DINEPA (National Water and Sanitation Governmental Authorities), IFRC wishes undertake an evaluation of the potentiality for DEWATS (Decentralized Wastewater Treatment Systems) solutions in the urban settings of PPMA (Port-au-Prince Metropolitan Area). These semi-centralized systems are part of the new sanitation strategy of the DINEPA that would like to develop some pilot projects.

Main objective of the survey

The purpose of the survey is to evaluate the relevance and feasibility of Decentralized Wastewater Treatment Systems (DEWATs) in the PPMA and to provide recommendations as to the most appropriate and technically systems to be implemented in INA communities.

Specific objectives

- To help the Red Cross members to design their sanitation projects and choose the best appropriate technologies and methodologies,
- To support the strategy of DINEPA in sanitation sector,
- To assess the community and local authorities acceptance regarding DEWATs technologies
- To publish a reference document about DEWATs potentiality in PPMA to be shared and distributed to sanitation stakeholders having projects in sanitation sector

Scope

The scope of the study will include:

- Finalization of survey methodology,
- Literature review and desk studies
- Field visits to INA Sites to:
  - Understand demographics and site conditions for implementing solutions
  - Understand spacial conditions and space availability at each site.
  - Understand history of sanitation infrastructure in the community
  - Understand local goverment and municipal sanitation strategy and considerations
- Meeting with the main sanitation stakeholders
- Identification, description and analyse of the different possible DEWATs solutions based on field investigation and meetings
- Perform an analysis of remaining DEWAT solutions against feasibility criteria[4]
- Collect, treatment and analysis of data
- Oral presentation of intermediary findings and final report writing
- Write a Study Report which provide ranked recommendations of DEWAT solutions per INA site

Reporting line

The consultant will report to the IFRC Water, Sanitation and Hygiene Movement Coordinator

Deliverables/outputs

The outcome of the survey will be :

- An oral presentation of intermediary results to the main stakeholders (DINEPA, IFRC, Red Cross members, others…)
- A Survey Report with ranked recommendations of DEWAT solutions per INA site - maximum of 30 pages (without annexes) with the possible following chapters (given as a guideline but could be modified by the consultant):

Chapter	Number of pages
Executive summary	1
Survey objectives	1
Brief introduction of DEWATs in developing countries	1
Survey methodology	1
Typology of encountered urban context regarding sanitation issues (excreta collection system, receiving environment, constraints and characteristics of the sites)	2
Opinion of community members and local governmental authorities regarding DEWATs solutions. History of sanitation infrastructure in the community. Local government and municipal sanitation strategy and considerations	3
Presentation of the different technical solutions to be considered and of their possible institutional arrangements for each of the site (rough estimation of cost, justification, advantages and limits of technology…)	15
Matrix of suggested DEWATs solutions based on miscellaneous criteria[4]	3
Recommendations for the implementation of DEWATs solutions within PPMA	3
Bibliographic references and documentary ressources	1
Total	30

[4] See example in Annex 1

Survey methodology

It is expected that the selected consultant will participate in the further development and refinement of the methodology and criteria for this survey and will work closely with Sanitation department of DINEPA and IFRC. Expected activities will include (though not limited to):

- fields visits of INA sites within PPMA,
- semi-structured interviews with the main stakeholders: IFRC WatSan Movement Coordinator, IFRC Shelter, DINEPA, and other external stakeholders, such as local government authorities.
- focus groups with community members
- review of existing sanitation documents in Haiti

Timeframe

The evaluation is for 20 workings days, of which at least 7 will be spent visiting INA sites. The final report (5 days) can be concluded remotely.
The planning is as following and will be modified according the needs:

Activities	Numbers of days
Preparatory works and documentary review	2
Trip Home- haiti	1
Débriefing IFRC et DINEPA	2
Fields visits / Stakeholders meetings	6
Writing of intermediary note and preparation of oral presentation	2
Oral presentation	1
Trip Haiti - Home	1
Final report writing	5
Total	20

A draft version of the report will be delivered to IFRC and DINEPA who will give their feedback within a delay of about one week. The final version will be then take into account the comments provided by IFRC and DINEPA

Starting: As soon as possible

Location

The consultant will be required to undertake field visit in accordance with security conditions and guidance provided by the IFRC security coordinator in Port-au-Prince. The locations to be assessed are:

- Delmas 9 : French Red Cross
- Delmas 19 : British Red Cross
- Delmas 30 & 33 : IFRC
- Carrefour Feuilles: IFRC

The location to be visited may vary according to the local situation and will be finalized following discussion with DINEPA and IFRC.

ANNEX E: List of Meetings and Site Visits

The following is the list of meetings and site visits undertaken during the consultancy period:

Date	Meeting/Site Visit:	Present:	Discussion Points
7.12.2012	Meeting	CBO for Delmas 9	Acceptance of DEWATS in the community.
10.12.2012	Meeting	Farah Dorval, Edwige Petit. DINEPA Direction d'Assainissement (DA)	Acceptance of DEWATS by local authorities; sanitation legislation.
10.12.2012	Meeting	DINEPA Centre Technique d'Exploitation (CTE)	Technical applicability of DEWATS in the PPMA
11.12.2012	SITE VISIT	IFRC Site 'CFF'	Technical applicability of DEWATS.
11.12.2012	Meeting	CASEC, (2^{ieme}MorneHopital)	Acceptance of DEWATS by local authorities.
11.12.2012	SITE VISIT	ARC Site 'Campeche'	Technical applicability of DEWATS.
12.12.2012	SITE VISIT	IFRC Site 'D30'	Technical applicability of DEWATS.
13.12.2012	SITE VISIT	FRC Site 'Delmas 9,11,13'	Technical applicability of DEWATS.
14.12.2012	Meeting	IFRC, FRC, and ARC	Applicability Study - Progress Meeting
19.12.2012	Meeting	Farah Dorval. DINEPA Direction d'Assainissement (DA)	Applicability Study - Progress Meeting