

WATER & SANITATION FOR ALL

Methodological guide

n° 7



Non-conventional sewerage services

When to choose this option, how to implement
this solution





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When to choose this option

How to implement this solution

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Introduction

Why a guide on non-conventional sewerage services?

Non-conventional sewerage options have been implemented across the world over the last few decades, not only using diverse technological options and management methods, but also in a wide range of contexts and on different scales. A large number of examples can now be found and this solution is attracting growing interest from sanitation stakeholders and their cooperation partners, particularly in Africa.

It is for this reason that, from 2012 to 2013 and with support from the Seine-Normandie water agency, French Agency for Development (AFD) and the Syndicat Interdépartemental d'Assainissement de l'Agglomération Parisienne (SIAAP), pS-Eau undertook a review of various non-conventional sewerage services around the world (in India, Senegal, Ghana, Mali and Brazil). This guide is based on the findings of that review, as well as on the outputs of a workshop held in Dakar in October 2013 attended by several African experts and on lessons learned through Gret's work in Laos and Cambodia.

The aim of this guide is to help contracting authorities and their partners develop sanitation services by providing them with information to aid their decision-making and a methodological framework for implementing these decisions.

The information contained in this guide should in no way be used to replace any of the pre-

paratory studies required or input from experienced experts. It will, however, help you hold more informed discussions, coordinate your non-conventional sewerage project in a consistent manner and provide you with a clear overview of the skills and knowledge required.

What type of sanitation is being discussed?

Sanitation, as considered within this guide, includes the wastewater from households and public premises (schools, health centers, markets, bus stations, etc.), namely:

- greywater, i.e. the wastewater generated from washing dishes, hands and clothes and from taking baths and showers;
- blackwater, i.e. toilet flush water mixed with urine and feces.

This guide does not deal directly with wastewater from non-domestic sources (industry, crafts, certain agricultural activities, etc.) as this type of wastewater (high volume, high pollution load, particular types of pollutants, etc.) requires its own specific collection, evacuation and treatment solutions. Some commercial activities (such as hotels and restaurants) can be connected to non-conventional sewerage, however, as long as the wastewater is pre-treated (to remove fat and grease, for instance) prior to being discharged into the sewers.

Although both important issues, this guide also does not deal with the evacuation and treatment of either stormwater or solid waste.

What is a non-conventional sewerage service?

This guide covers the entire sanitation service. Thus, it deals not only with the non-conventional sewer used to evacuate the wastewater, but also with the access segment of the sanitation chain that includes household facilities (toilets, sinks, laundry facilities, etc.) and the treatment segment to ensure the wastewater is treated prior to being discharged into the environment.

With a non-conventional sewer, wastewater is evacuated through a network of pipes. Thus in this respect, it clearly differs from on-site sanitation. However, it also overcomes some of the constraints associated with conventional sewerage as non-conventional sewers use smaller diameter pipes and simplified connection methods and pipes are laid at a shallower depth, for instance. These specific technical aspects mean that the investment cost is lower than for conventional sewerage.

Non-conventional sewerage services also differ from conventional sewerage by virtue of their scale (as they cover a residential area rather than the whole town), the allocation of responsibilities and the management method used.

- **Technical features of non-conventional sewerage systems**

As non-conventional sewers do not have to adhere to the standards required of conventional sewerage, the technical design can be simplified, which in turn reduces costs:

- the length of the pipework is reduced by using the potential offered by water catchment areas and by crossing private land;
- pipes are laid under sidewalks rather than under roads, meaning they can be placed at a shallower depth;
- the system uses smaller diameter pipes;
- there are simplified, fewer and smaller inspection chambers (the main item of expenditure for conventional sewerage);
- houses are either connected to the sewer through simple junction chambers, sometimes shared between several households, or are connected up directly, without a junction chamber.

- **Scale of coverage**

Non-conventional sewerage is a decentralized system, meaning that it covers a residential area or district and is usually independent of the conventional sewer (although it can be connected to it).

- **Responsibility for the system and the management method**

A non-conventional sewerage service generally comes under the responsibility of and/or is ma-

naged by a stakeholder other than the public authority and 'conventional' sewerage operator. The users themselves can sometimes be involved in managing the sewer.

- **An option not without constraints!**

To successfully construct and operate a non-conventional sewerage service, the contracting authority, contractors and operator all require significant capacities. Furthermore, not only is the investment cost nearly always higher than for on-site sanitation but, spread over the lifespan of the sewer, this cost is also not

necessarily lower, over the long-term, than for conventional sewerage.

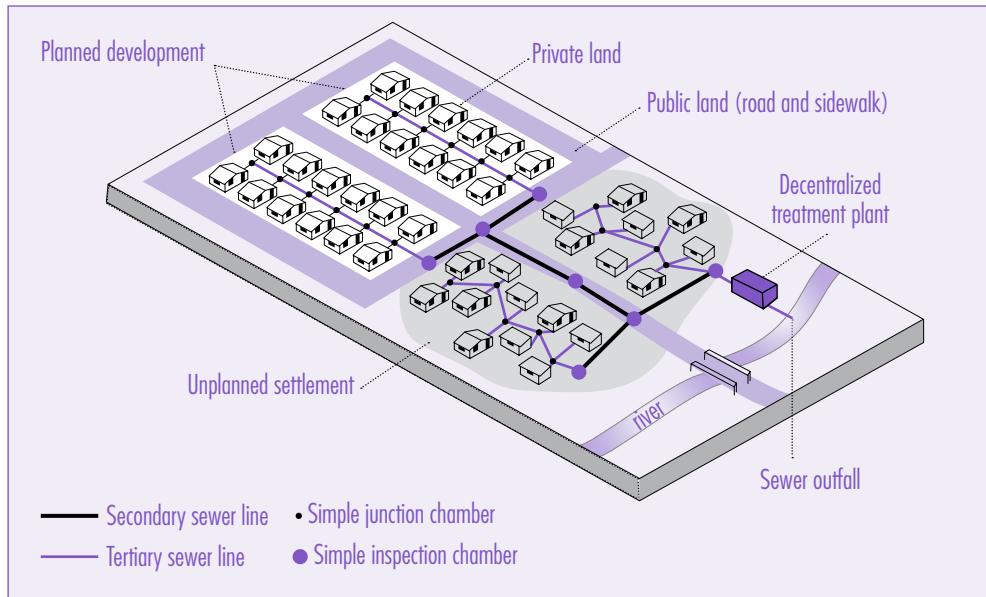
Lastly, non-conventional sewers are vulnerable to blockages from solid waste and sediment, stormwater intrusion and breakages.

In light of this, non-conventional sewerage is thus better suited to urban areas which have solid waste collection services, stormwater drainage and paved or tarred roads.

Prior to beginning development of such a system, it is therefore necessary to ensure that all these requirements are met!

ILLUSTRATION 1

Overview of a non-conventional sewer system



Source: from R. REED

The two main types of non-conventional sewerage:

- simplified sewer systems through which wastewater (grey and black water) is evacuated directly;
- settled sewer systems (also called solids-free sewers), which are used to evacuate wastewater that contains only low volumes of suspended solids. Wastewater therefore needs to be pre-treated in a settling tank prior to being discharged into the sewer.

TABLE 1

Comparison of settled, simplified and conventional sewerage

	SETTLED SEWERAGE	SIMPLIFIED SEWERAGE	CONVENTIONAL SEWERAGE
Pre-treatment method at access segment level	Individual household or shared settling tank	No pre-treatment	No pre-treatment
Diameter of tertiary sewer pipes (on private land, at household or neighborhood level)	40 to 100mm	100 to 150mm	150mm
Diameter of secondary sewer pipes (block of houses or street)	40 to 100mm	100 to 150mm	250mm
Diameter of main sewer line pipes (along main roads)	A non-conventional sewer has no main sewer line; however, it can be connected to conventional sewerage		Up to 600mm for a separate sewer system and several meters for combined sewerage (wastewater & stormwater)
Minimum gradient	0.5%	1%	0.5 - 1%
Minimum pipe depth	30cm (except under roads)		1m (under roads)
Sewer layout	Mainly on private land or under sidewalks		Mainly underneath roads
Treatment method	Decentralized treatment plant or connected to a conventional sewer		Centralized treatment plant

Sources: adapted from TILLEY, 2008, REED, 1995 and recommendations made by Eve Karleskind, conseil général du Val de Marne

What other types of sanitation are used in developing countries?

- **On-site sanitation and mechanical or manual pit emptying:** this is the most common form of sanitation found in African towns, as well as in certain areas of Asia and Latin-America. This type of sanitation usually develops in a spontaneous and informal manner, with small private entrepreneurs providing pit emptying services to meet household demand.

This sanitation chain has developed a poor reputation among decision-makers and their development partners. This is because on-site facilities rarely meet health and environmental standards, manual pit emptying is usually carried out in unhygienic conditions and the lack of treatment and illegal dumping of pit sludge both have a negative impact on public health and the environment. Furthermore, the poorest households are often unable to afford the cost of mechanical pit emptying. Nevertheless, when well-implemented and monitored, there is no reason why this sanitation chain cannot provide a high-quality service; one that is often much more affordable and requires fewer resources and less intensive supervision by the authorities than non-conventional sewerage services.

At the end of the sanitation chain, the treatment plants used to treat the pit sludge also provide a perfectly adequate solution. Moreover, this option is very common in rural areas and on the outskirts of cities in Europe. However, its success is contingent on local authorities first recognizing this on-site sanitation chain as a viable solution to ensure it is effectively developed and managed.

- The conventional sewerage sanitation chain adheres to the standards used in developed countries, with large-diameter pipes and more sophisticated treatment plants. The sewer lines are usually laid under roads, fairly deep (0.80 to 1.5m) underground, and are connected to centralized treatment plants. As the investment and operating costs are extremely high, conventional sewerage is not a viable option for many towns in Africa. This sanitation chain also requires regular attention, heavy maintenance (sludge removal, inspections, etc.) and high-level technical capacities. Many of the conventional sewer systems installed in city centers in Africa are no longer operational as there are insufficient resources to run the service properly (which is also the case on several conventional sewers in Asia, for example).
- **The use of open stormwater drainage channels.** The effluent from domestic sanitation facilities is discharged, either directly or from the pit (using buckets or through a small pipe), into channels originally designed to collect stormwater run-off only (and which are therefore open to the elements). There is usually no means of treating the wastewater at the end of the sanitation chain and, where there is a treatment method in place, this has not been designed to treat blackwater. This option, commonly used in towns and cities with stormwater drainage channels, poses a public health risk as residents can easily come into contact with the wastewater and the pathogens this contains. Furthermore, these channels frequently become blocked by solid waste. The use of this option is actively discouraged.
- **No service:** open defecation or the use of rudimentary, sub-standard latrines is common in towns in developing countries. In addition to the

public health risks posed, these practices fail to provide any comfort, dignity and security, particularly for women and children, who are forced to leave the safety of their home to go to the toilet, not only during the day but also at night.

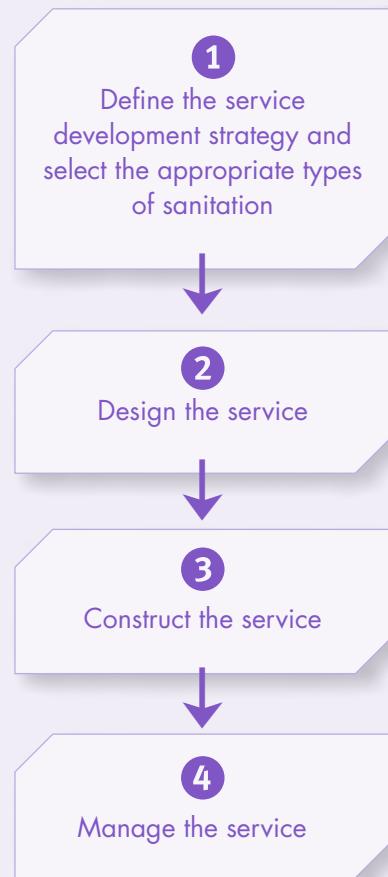
How this document is set out

This guide consists of four parts:

- 1** The first part provides a methodology for planning out the area-wide sanitation service and selecting the most suitable types of sanitation. It sets out the advantages and disadvantages of the non-conventional sewerage option compared to other sanitation systems and outlines a number of conditions that need to be met to ensure that this option is properly aligned to local requirements.
- 2** The aim of the second part of this guide is to inform the decisions that need to be made when designing the future non-conventional sewerage service, both from a technical perspective and with regard to the division of roles and funding.
- 3** The third part aims to focus attention, and that of contracting authorities and their project supervisors in particular, on key aspects of the service construction phase.
- 4** Finally, the fourth part outlines the tools required to successfully manage and monitor the system and thus ensure sustainability of the service.

BOX 1

The steps involved in developing a non-conventional sewerage service



STEP 1.

Define
the sanitation service
development strategy

Prior to selecting the sanitation option for the town or residential area, a detailed diagnostic of the area's service stakeholders' needs and expectations should be carried out that covers all the various service users (sanitation demand stakeholders) and service providers (supply stakeholders).

The findings of this diagnostic will be used to identify the main challenges to be addressed (technical, organizational, financial, etc.) and define the sanitation service development and improvement strategy. This strategy, developed by the local authority in consultation with all stakeholders, will set out the priorities and needs at town level and for each neighborhood (Activity 1.1).

It will then be necessary to assess the feasibility of the non-conventional sewerage service and determine whether this (or another) option is the most appropriate for each neighborhood. The non-conventional sewerage option is hardly ever THE only possible sanitation option for a given area. The decision on whether to select this solution is dependent on a number of related objective criteria being met (Activity 1.2).

These prerequisites are essential as the non-conventional sewerage option is a demanding option, both technically and financially and in terms of human resources. Furthermore, it is only warranted in areas where the 'on-site sa-

BOX 2

Activities to be undertaken when planning service development and selecting a suitable sanitation chain

Activity 1.1

Define the service development strategy for the town



Activity 1.2

- Assess the feasibility of the various types of sanitation option, particularly non-conventional sewerage
- Select the sanitation option to be installed



Activity 1.3

Prepare for the next steps and identify the stakeholders required

nitation + pit emptying' and 'conventional sewerage' sanitation chains are no longer viable. This is thus not an automatic choice, but one that needs to be carefully weighed against the other options and considered in context.

Lastly, and before moving onto the next step, the contracting authority needs to develop an overview of both project delivery and the roles of the main stakeholders involved (Activity 1.3).

What documents should have been produced by the end of this phase?

1 A document setting out the strategy for developing and improving the sanitation service within the area that includes:

- a diagnostic report: technical diagnostic + 'stakeholder' diagnostic (stakeholder needs and expectations);
- a description of the current sanitation situation and challenges to be addressed, both at town level and area by area (using available maps).

2 A feasibility study that includes:

- a topographical, pedological and hydro-geological study report for each area concerned (also using available maps);
- an in-depth demand assessment report for each area concerned;
- recommendations on the feasibility of using the sanitation chain identified as most suitable for each area concerned.

3 A record of the public authority's decision on the sanitation chain selected.

4 An implementation timetable and a document setting out the division of responsibilities as defined by the public authority for its sanitation service development project, which includes the construction of a non-conventional sewerage service.

ACTIVITY 1.1

Define the sanitation service development strategy for the town

An essential prerequisite: the willingness of local authorities

It is always vital to ensure the local public authorities are involved in efforts to improve the sanitation situation as they have at least three essential roles to fulfill:

- defining a sanitation service development strategy for the town;
- financing all or part of the sanitation service investment costs;
- setting out the framework under which the sanitation service(s) is to operate (management method, pricing, quality and performance targets, etc.) and monitor and audit these services.

Before starting the process of selecting a sanitation service type for an individual area, it is therefore worthwhile to first define the sanitation strategy for the whole town.

Experience has shown that decisions made solely by parties from outside the region (external consultants, development partners) rarely lead to real ownership of the solution by local stakeholders, who then play little part in monitoring the various phases of the sanitation service project (design, implementation and management).

Consequently, the quality of the service rapidly deteriorates; it offers few benefits to either the users or public authorities and the investment is often lost.

It is thus vital that major service-related decisions are made by the stakeholder legally designated as responsible for the service: the ‘contracting authority’ (usually the local authority, sometimes the State or a regional or national sanitation operator).

What sanitation strategy and planning documents does the town already have?

Most towns, and large cities in particular, will already have sanitation planning tools in place (a sanitation master plan, for instance). Are these documents up-to-date, relevant, well-known and used by local stakeholders? Should the documents not be comprehensive, as is often the case, the town will need to work on defining a sanitation strategy that has a broader scope than a master plan, meaning it should not be limited to large infrastructure investment programs only, but should include all types of activity (including organizational) that meet the identified needs and stakeholder demand.

The water supply planning documents should also be reviewed as current and future water consumption patterns will heavily influence the choice of sanitation options.

The sanitation strategy must form part of the urban development strategy

Urban development and planning documents contain information essential to the sanitation development strategy. For example, local authorities' recognition of unplanned settlements is a prerequisite for developing a public sanitation service. In addition, the creation of new planned developments will considerably influence the growth of user demand within the areas concerned.

The layout of the roads and the amount of public land available also has an impact on sewage service development, as does the planned development of other basic services, such as stormwater drainage, solid waste management and road paving.

Conduct a diagnostic that includes a technical and socio-economic component¹

The aim of this diagnostic is to provide a clear overview of the state of the sanitation infrastructure within the town. It will examine all the sani-

tation practices used by the town's inhabitants, focusing not only on initiatives already in place for finding local, tailored solutions, but also on the issues specific to each area and to different sections of the population.

- The 'technical survey' component

The aim of this component of the diagnostic is to describe the existing infrastructure and the quality of the service it provides. This involves field visits and working with the local sanitation company and the town's technical departments, who will assist in locating the public facilities to be assessed (networks, treatment plants, public toilets, etc.).

This also involves carrying out a soil survey and analyzing hydro-geographic and topographic constraints (basic map of catchment basins, storm water flow patterns, stagnant water, potential outfalls, etc.) and housing density data.

Supported by sanitation expert opinion, the aim of the technical survey is to create a profile of all public and private infrastructure (type of materials used, etc.).

It provides a sound analysis of the problems and failures observed on public facilities in all sectors of the town and also identifies the (mostly illegal) pit sludge dumping sites (used by both mechanical and manual pit emptiers).

1. This task is described in detail in: Le Jallé & Al., 2010, pS-Eau Guide n° 1. *How to Develop a Concerted Municipal Strategy for Water and Sanitation*, MDP/pS-Eau

- The 'socio-economic survey'
('stakeholder' diagnostic)

Conducting the supply and demand stakeholder assessment and collating information on stakeholder service experience and expectations, in particular, are both essential tasks. In addition to the information obtained, this step plays a key role in raising stakeholder awareness and ensuring their involvement in the subsequent steps of the concerted strategy process.

This process involves:

- identifying the various stakeholders: supply stakeholders and demand stakeholders;
- interviewing these stakeholders to determine their perception of the service and their suggestions for improvement and support.

The demand stakeholders include not only domestic customers, but also commercial and industrial (shops, trades and crafts, industry and services) and institutional stakeholders (schools, health centers, administrative offices). This socio-economic survey component will also involve a more in-depth examination of the area in which the service is due to be implemented.¹

- Analyze and interpret the data

The aim of this step is to:

- develop a profile of the different areas and of the service level within each of these zones;

- clearly identify the interest groups involved, as well as any areas of potential conflict and bottlenecks;
- identify the local potential for support.

- Present and discuss the diagnostic

This step makes it possible to share and develop a jointly validated understanding of the situation within the town and to discuss and place the proposed solutions in order of priority with the aim of establishing an implementation strategy.

Formulate the strategy for the town, area by area²

- Define the service improvement objectives

This step involves setting the strategic objectives, defining the role of each stakeholder and establishing the guiding principles for future implementation. It will then be necessary to check and refine this initial outline by comparing the objectives with the proposals collated from consultation with the relevant stakeholders. This ensures that the service improvement objectives are defined through consultation and by involving all the different stakeholders concerned.

1. See "Analyze the socio-economic aspects and user demand", page 25

2. This step is detailed in the following publications:

- Le Jallé & Al., 2010, pS-Eau Guide n° 1. *How to Develop a Concerted Municipal Strategy for Water and Sanitation*, MDP /pS-Eau.
- Gabert J. & Al. 2010, pS-Eau Guide n° 4. *How to select appropriate technical solutions for sanitation*, MDP /pS-Eau

- **Identify possible solutions**

To complete this task, it is necessary to:

- analyze the solutions put forward by each category of stakeholder;
- analyze the strengths and weaknesses of each stakeholder (at least those required to assist with implementing the strategy);
- determine the possible level of involvement of each stakeholder in implementing the recommended solutions;
- establish the priorities for action.

The potential options will be defined for each ‘homogenous’ area of the town, with these

‘homogenous’ areas having been determined from the existing service level and using a set of physical (sanitation solution in place, soil type, depth of the groundwater table, topography, catchment basins), urban (population density, available surface area, land status) and socio-economic (water consumption, local investment capacity, etc.) criteria as a base.

- **Validate the strategy presentation document**

Under the leadership of the public authority responsible, the strategy is discussed and validated by representatives of all stakeholders.

ACTIVITY 1.2

Assess the feasibility of the various types of sanitation option, particularly non-conventional sewerage

In order to select the most appropriate sanitation option, in-depth feasibility studies are required to inform the final decision.

Four key factors need to be assessed to check that the proposed option is fully suitable:

- the physical context;
- the urban context, and whether there are any

other urban services operating in the area;

- the economic and financial capacities in place for funding investment and operations and meeting the inhabitants' demand for sanitation;
- the existence of the skills and knowledge required, or the capacity to develop these.

ILLUSTRATION 2

Mbao neighborhood in Dakar (Senegal)

Guy Norman



Housing has been built in an area where the water table rises to the surface

Assess the physical profile of the area(s) concerned (1)

From a technical perspective, non-conventional sewerage is an option that can be used in various contexts, notably those for which other types of sanitation solution are unsuited.

• Infiltration capacity (1.a)

The infiltration capacity of the soil determines which sanitation option can be used. As shown in Table 2 on the following page, on-site sanitation facilities are best suited to soils with very high infiltration rates. In contrast, installing treatment systems, such as pits, in soils with low infiltration rates can be challenging and a system such as non-conventional sewerage that evacuates the wastewater is more appropriate.

• Hardness of the ground (1.b)

In areas of rocky ground, digging pits and soakaways – not to mention deep trenches for conventional sewerage – is difficult and costly. However, as long as there is sufficient local gradient (see below), non-conventional sewers can be laid at shallow depths (40cm).

• Level of the groundwater table (1.c)

There is a risk that wastewater from on-site sanitation facilities can infiltrate and pollute the groundwater table, especially if the water table is close to the point of infiltration. Conversely, in areas where the groundwater table rises to the surface, water can seep into these on-site sanitation facilities, meaning pits have to be emptied more frequently, which is costly for the households concerned.

However, the proximity of a water table can also cause problems for non-conventional (and conventional) sewerage projects both during the construction phase (as sophisticated and costly techniques have to be used at this stage to lower the water table in order to dig trenches and lay the pipes), and throughout the operational phase (sewers are never completely watertight, thus water infiltration is to be expected, as is wastewater seepage into the water table).

It is recommended that a hydro-geologist be appointed to assess the risk of contamination of the water table.

• Gradient (1.d)

Wastewater moves through the sewers under the force of gravity. Thus, there must be sufficient

TABLE 2

Analysis matrix used to select sanitation options based on geological conditions (PAQPUD program, Dakar)

SOIL TYPE	RATE OF INFILTRATION (l/m ²)	WASHTUB + SOAKAWAY	VENTILATED IMPROVED PIT LATRINE (VIP)	POUR FLUSH TOILET	SEPTIC TANK	WATERTIGHT PIT	NON-CONVENTIONAL SEWERAGE SYSTEM
TYPE 1: sometimes waterlogged clay soils	< 10					xx	xx
TYPE 2: leached soils with low infiltration capacity	10 to 15	x	x	x	x	xx	xx
TYPE 3: soils with a high rate of infiltration	> 50	xx	x	xx	xx		
TYPE 4: soils with a high rate of infiltration at risk of pollution from shallow water table	30 to 45	xx	x	xx	xx		
TYPE 5: non-leached ferruginous soils with a good rate of infiltration	25 to 35	xx	x	xx	xx		
TYPE 6: rocky soils	< 15					xx	xx
TYPE 7: hydromorphic soils of Niayes	0						x
TYPE 8: chalky and vertisol soils	< 20	x	x	x	x	x	x
TYPE 9: stony soils and the ferruginous soils of Diass	20 to 25	x	x	x	x	xx	xx

Source: ONAS

gradient to enable the sewage to flow freely. In areas where the gradient is too flat, it will be necessary to dig down to greater depths on the downstream sections of the sewer and install lift stations; however, this considerably increases investment and operating costs and makes the system more complex to operate. Non-conventional sewerage thus requires a minimum gradient of 0.5% for settled sewerage and 1% for simplified sewers (which carry wastewater

containing suspended solids and so have higher viscosity).

Please note that these are highly theoretical minimum values and are applicable in optimal implementation conditions only. In the field, steeper gradients are always recommended where possible as the infiltration of solid waste, sand sediment or sludge into the sewer remains unavoidable.

ILLUSTRATION 3

Plan of a "condominial" sewer in a favela in Brazil



Source: from José Carlos Melo

Assess the urban constraints (2)

- **Population density (2.a)**

Sewage systems are entirely suited to areas of high population density as they cover a large number of households, which thus reduces the investment cost per connection.

In contrast, areas of high population density are often unsuitable for on-site sanitation as the soil can become saturated with pathogens and there is an increased risk of environmental pollution.

- **Space available inside plots (2.b)**

In areas with a very high density of buildings, and in unplanned settlements in particular, there is rarely enough space inside plots to install on-site sanitation solutions. In this situation, a 'simplified' sewer (without settling) is the most appropriate as it does not take up much space inside the plot other than that required to install sanitation and washing facilities (showers, toilets, latrines, sinks, etc.).

In these areas, settled sewerage is only an option if shared settling tanks are used and these are installed on public land. The 'shared toilet and shower block' option (potentially connected to a non-conventional sewer) can also be considered here.

- **Layout and width of roads (2.c)**

In areas of high population density, which are generally unplanned settlements with narrow winding streets, vacuum trucks and semi-mechanical pit emptying vehicles are unable to easily access plots and latrine pits.

ILLUSTRATION 4

Inspection chamber blocked by solid waste



Thus, installing on-site sanitation here is not particularly appropriate. A non-conventional sewer would be best suited to this type of area as, compared to conventional sewerage, its shallower depth means the pipes can be laid under the narrow streets without the need for heavy equipment and its simplified design makes it easier to change the direction of the pipework more frequently.

- **Sufficient space within the area for treatment facilities (2.d)**

Unless the wastewater is discharged through an outfall into the environment without treatment (which is not recommended) or flows into a nearby conventional sewer, a large amount of space will be required on which to install a decentralized treatment plant: several dozen square meters for intensive solutions (a few square centimeters per capita) to treat the wastewater from non-conventional sewers and several hundred square meters for a waste sta-

bilization pond (5m² per capita) and to treat wastewater from large sewer systems.

The land tenure status of the proposed site needs to be clearly defined: it is essential that title deeds for the land, along with a building permit for the treatment plant, have been obtained prior to launching the project.

It is also crucial to ensure that there is a natural outlet nearby (river, lake, marshland, sea, etc.) into which the treated wastewater can be discharged.

- **Land status of the area (2.e)**

In order to develop public services within an area, the area concerned usually needs to have been formally recognized by the public authorities: i.e. be planned developments, or unplanned settlements where land tenure has been or is in the process of being regularized. Clarifying the land status of the area will help ensure the sewer will remain in place and operational over the long term.

- **Existence of stormwater drainage, solid waste management and road paving services (2.f)**

To operate effectively, non-conventional sewerage is dependent on other urban network-based services:

- roads need to be tarred or paved to protect pipes from damage caused by the passage of vehicles and to reduce the amount of sediment entering the sewers. Surfacing the roads improves residents' perception of their local area and encourages them to respect public spaces and shared facilities;
- stormwater drainage channels are vital for preventing the sewers flooding during heavy

rain (where there is no appropriate, separate solution in place, stormwater is often discharged into the sewers by the users themselves);

– it is not possible to develop sewage services without considering solid waste management. Like wastewater and excreta, solid waste poses public health and environmental risks. Furthermore, it also blocks the sewers.

Analyze the socio-economic aspects and user demand (3)

- **Water consumption (3.a)**

A sewer system requires a minimum volume of wastewater to function properly: if there is not enough wastewater, the pipes may become clogged. On average, the water consumption required for settled sewers to function effectively is considered to be 20 liters per capita per day. For simplified sewerage, this figure stands at around 50 liters per capita per day.

- **Willingness and capacity to pay for the sanitation service (3.b)**

Determining the willingness-to-pay, which is "subjective data" describing user expectations, and the capacity-to-pay, which is "objective data" on household income, is vital for identifying the financial resources customers are ready and able to spend, both on the initial investment and on paying for the sanitation service.

BOX 3**The importance of a demand assessment**

The financial information required can be obtained by undertaking an assessment of user demand¹ for a non-conventional sewerage service to ascertain:

- users' water consumption levels;
- household income available for financing the investment and operating costs of the proposed option;
- the capacity-to-pay and willingness-to-pay for the sanitation service;
- user practices, etc.

It is recommended that the demand assessment be designed and overseen by a suitably qualified professional, such as a socio-economist/consultant with knowledge of the sanitation sector. This expert would be assisted by a team of interviewers working in pairs. Each pair would include a community facilitator (preferably from the local area or with sound knowledge of the context) and a sanitation demand assessment specialist.

These interviewers may also be involved in the implementation and management phases; thus, they act not only as interviewers, but also as coordinators and project promoters.

- **User practices (3.c)**

User practices heavily influence the choice of sanitation chain.

Aspects to be considered here include:

- the type of service already in place and households' satisfaction with this service;
- the anal cleansing method used (water, paper, other);
- occupancy status (owners or tenants);
- the reasons why households want improved sanitation facilities.

TABLE 3

Indicative investment costs for the different sanitation chains in West Africa

Sanitation Chain	Investment cost per household connected
On-site	€250 to 500
Non-conventional sewerage service	€500 to 1,500
Conventional sewerage	€750 to 3,000

1. See: Roger G., 2010, pS-Eau Guide n°3. *How to analyze the demand of current and future users for water sanitation services in towns and cities in Africa*, MDP-pS-Eau.

TABLE 4

Comparison of conventional and simplified sewerage investment costs in Colombia

		CONVENTIONAL			SIMPLIFIED		
	Unit	Quantity	Cost*	Percentage	Quantity	Cost	Percentage**
Digging	m ³	2,038	2,411,449	14.5%	721	587,382	3.5%
Pipework	m	153	5,870,110	35.4%	151	3,471,726	20.9%
Inspection chambers	no.	27	2,128,380	12.8%	18	1,035,755	6.2%
Accessories	no.				46	442,698	2.7%
Connections	no.	258	6,091,638	36.7%	258	2,380,338	14.4%
Other			82,656	0.5%		74,068	0.4%
TOTAL			16,584,233	100%		7,991,967	48%

* in Colombian pesos, 1988: US\$1 = Col\$ 335

Source: Angulo (1988)

** in proportion to the total cost of conventional sewerage

• Investment capacity (3.d)

The investment cost of a non-conventional sewerage service can vary considerably depending on the geographical conditions of the area concerned. However, this investment cost is nearly always far higher than that of on-site sanitation and (about 50%) lower than the investment cost of conventional sewerage. Nevertheless, this cost needs to be spread over the lifespan of the service: in theory, the lifespan of conventional sewerage is 50% to 100% longer than that of a non-conventional sewer. Thus, conventional sewerage may work out to be the more economical option in the long-term.

There are also certain factors that can considerably increase or reduce these costs:

- population density: the more it increases, the greater the number of potential connections, reducing the cost per connection;
- the ‘cost of the funding’, namely the interest payments that need to be made if project financing has been obtained through loans;
- the cost of the materials available on the local market;
- the technical options selected and households’ existing facilities: if households do not currently have improved sanitation and washing facilities, additional funding for this will need to be included in the budget;
- the importance given to user awareness-raising campaigns, promoting the service and capacity-building, etc.

BOX 4

Should non-domestic users be taken into account?

Non-domestic users include hotels, workshops, shops and public buildings. Unless there is a risk that the wastewater discharged will jeopardize the effectiveness of the treatment plant, plans should be made to connect these non-domestic users to the sewer via a suitable pre-treatment system. This type of user has sufficient capacity-to-pay to help ensure the financial viability of the service.

A more detailed comparative study should be undertaken on a case-by-case basis¹.

It is also important to note that, in Africa, users are not always able to bear the full investment cost themselves. In this situation, the public authorities will be required to introduce subsidies, potentially with the help of development assistance.

To clearly identify the available investment capacity, answers need to be sought to the following questions:

- what investment is required for the proposed options and how much will this cost?
- who will cover the cost of this investment: households, local authorities, the government, international development assistance, etc.?
- what institutional budget is available (from local authorities, the government, etc.) to cover the investment cost of the proposed option?

1. See Step 2 of this guide: Design the non-conventional sewerage service, page 41.

2. In particular, please see Activity 2.5: Define the provisional operating budget, page 73.

- what proportion of the investment cost are the users prepared to bear?

- **Financial capacity, notably of households, to cover service operating costs (3.e)**

Depending on the situation, technical option used and the operator's performance, the operating cost of a non-conventional sewerage service equates to between €0.5 and €5 per household connected per month. The majority of these recurring costs are borne by the users: households' capacity to cover these costs is thus dependent on the level at which the sanitation fee is set, which is based on the findings of the user demand assessment.

Some of these operating costs can be met by the public authorities. However, such public funding should be covered by a firm commitment and be included in a budget (for instance, the local budget)² to ensure this commitment is upheld over the long-term.

Identifying the financial capacity available to cover service operating costs involves determining the answers to three questions:

- what activities need to be undertaken during the operational phase, how much will these cost and who will cover this cost: households, local authorities the government, international development assistance, etc.?
- what institutional budget is available (from local authorities, the government, etc.) for helping finance the operating costs of the proposed option?
- what proportion of the operating costs are the users prepared to bear?

Assess the skills available (4)

For non-conventional sewerage to be installed and operated successfully, the contracting authority, contractors and operator need to be highly skilled and experienced. It will therefore be necessary to ensure that the skills and know-how required are available locally.

Capacities are not fixed and can be developed with the support of local or international expertise. However, in areas where stakeholder capacity is low, it will take longer and be more costly to acquire the minimum capacities required to ensure sustainability of the service.

• The contracting authority's supervisory and monitoring capacities (4.a)

In order to fulfill its responsibilities once the non-conventional sewerage service is operational, the service manager (or contracting authority) needs to have **at least one technician available to monitor the service** and who has an understanding of:

- how the sewer and wastewater treatment plant operate on a technical level;
- the financial management of the service;
- facilitation techniques to foster discussion and avert conflict between stakeholders (users, the operator, etc.);
- legal aspects: for ensuring the operator adheres to the contract and the service is compliant with current legislation.

To ensure the continued use of good practices, the contracting authority will be assisted by hygiene and sanitation officer, who will be able to

impose sanctions should there be any infringement of the regulations.

• Design and implementation skills (4.b)

Skilled and experienced engineering consultancy firms and specialist companies should be used to design and construct the sewer system and wastewater treatment plant. It will often be necessary to provide capacity-building to local contractors as these do not always have sufficient experience of either conventional or non-conventional sewerage.

• Technical, financial management and user relations skills during the operational phase (4.c)

Prior to selecting the non-conventional sewerage option, it is vital to ensure that there is an operator available to manage the service and safeguard its quality and sustainability on a technical, financial and community level.

The operator should have at least one technical operative capable of carrying out maintenance on the sewer, along with the appropriate cleaning, pumping and maintenance tools. This technical operative should be assisted by an accounting officer with the ability to monitor cost recovery and the disbursement of sewer-related operating expenses.

The operator also needs to have a trained information and education officer in place to communicate sanitation service-related information to users and raise awareness of good hygiene practices and proper use of the sewer system.

This officer will also carry out marketing activities to increase the number of connections. For 'small' sanitation services (consisting of one

sewer system or two to three small systems), this role can be carried out by either the technical operative or accounting officer.

Select the type of sanitation option to be installed

Using the approved strategy as a base, it is important to review the possible options for each area under consideration and discuss these with the future users.

This communication and survey phase usually involves 'house-to-house' visits: the interviewers go through the pros and cons of each option with the households, solicit their expectations and ask them to select an option by ranking the proposed solutions in order of preference.

The various options should be clearly presented in a format tailored to the target audience and which includes a number of visuals outlining the pros and cons of each (domestic or shared)

wastewater collection and evacuation solution. Users are generally not directly involved in decisions relating to the treatment segment as technical, financial and environmental criteria are instead used to determine the most appropriate treatment method, which is also contingent on the type of sanitation chain selected.

It is important to describe each option to the households in detail: the indicative investment and operating costs and how much of these are to be covered by the users; maintenance constraints, the advantages of the option (added comfort, fewer smells, etc.); the amount of space required within the plot, etc. At this stage, it is also important to inform the household that the option implemented may not necessarily be the same as the option they have selected. Visits to plots already connected to the sewer may be organized to supplement these household interviews.

The next task then involves reviewing the survey findings and ranking the stated preferences by area to identify trends.

Upon completion of this step, the public authority will have all the information required to select the type of sanitation option to be installed in the area under consideration.

TABLE 5

Criteria for identifying the most suitable type of sanitation option

CRITERIA		QUESTIONS	RESPONSES	CONVENTIONAL SEWERAGE	SETTLED SEWERAGE	SIMPLIFIED SEWERAGE	ON-SITE SANITATION
Physical Criteria (1)	Infiltration capacity of the soil (1.a)	Can wastewater and excreta be absorbed into the soil within the area concerned?	YES	+	+	+	+
			NO	+	+	+	-
	Hardness of the ground (1.b)	Is the soil rocky?	YES	-	+	+	-
			NO	+	+	+	+
	Level of the groundwater table (1.c)	Is there a water table at least 3 meters from the surface?	YES	+	+	+	-
			NO	+	+	+	+
	Gradient (1.d)	Is the gradient sufficient to enable effluent to flow through the sewers under the force of gravity?	< 0.5%	-	-	○	+
			0.5 to 1%	+	+	-	+
			> 1%	+	+	+	+
Urban Criteria (2)	Population density (2.a)	What is the population density?	< 160 inhab/ha	-	-	-	+
			> 160 inhab/ha	+	+	+	-
	Space available in plots for installing on-site sanitation facilities (2.b)	Do people have enough space at home in which to install sanitation facilities and pits?	< 2m ²	+	-	+	-
			2 to 20m ²	+	+	+	+
			> 20m ²	+	+	+	+
	Layout and width of roads (2.c)	Are the roads narrow and winding?	YES	○	+	+	-
			NO	+	+	+	+

● unsuitable - not very suitable + suitable + highly suitable

TABLE 5

Criteria for identifying the most suitable type of sanitation option

CRITERIA	QUESTIONS	RESPONSES	CONVENTIONAL SEWERAGE	SETTLED SEWERAGE	SIMPLIFIED SEWERAGE	ON-SITE SANITATION
Urban Criteria (2)	Sufficient space within the area for treatment facilities (2.d)	Is it possible to connect the non-conventional sewerage to conventional sewerage? If no, is there space available for the wastewater treatment plant that is near an outlet (lake, river, the sea)?	YES	+	+	+
	Land status (2.e)	Is the housing development planned or unplanned?	NO	-	-	+
Socio-Economic Criteria (3)	Stormwater drainage, solid waste management and road paving services (2.f)	Are there stormwater drainage, solid waste management and road paving services within the area?	YES	+	+	+
	Water consumption (3.a)	What is the level of household water consumption?	NO	-	-	+
Willingness and capacity to pay for the sanitation service (3.b)	Do households have the capacity and willingness to pay investment and operating costs and what proportion?	< 20 l/d per capita	-	-	-	+
		20 to 50 l/d per capita	-	+	-	+
User practices (3.c)	Are households aware of the benefits of improved sanitation?	> 50 l/d per capita	+	+	+	-
		YES	+	+	+	+
		NO	-	-	-	+

— unsuitable - not very suitable + suitable + highly suitable

CRITERIA		QUESTIONS	RESPONSES	CONVENTIONAL SEWERAGE	SETTLED SEWERAGE	SIMPLIFIED SEWERAGE	ON-SITE SANITATION
Socio-Economic Criteria (3)	Investment capacity (3.d)	How much can be raised to cover investment?	< €200 per household	-	-	-	+
			€200 to 500 per household	-	-	-	+
			> €500 per household	+	+	+	+
	Financial capacity, notably of households, to cover service operating costs (3.e)	How much can households afford to cover operating costs?	< €1 / household month	●	-	-	+
			€1 to 3 / household month	●	-	-	+
			> €3 / household month	+	+	+	+
Skills Criteria (4)	Service monitoring and supervision capacities (4.a)	What is the level of the contracting authority's supervisory and monitoring capacities?	Low	●	-	-	+
			High	+	+	+	+
	Design and implementation skills (4.b)	What is the level of locally available infrastructure design and construction skills?	Low	●	-	-	+
			High	+	+	+	+
	Technical, financial management and user relations skills during the operational phase (4.c)	What is the level of the future operator's technical, financial management and user relations skills?	Low	●	-	-	+
			High	+	+	+	+

● unsuitable - not very suitable + suitable + highly suitable

ACTIVITY 1.3

Prepare for the next steps and identify the stakeholders required

Draft a provisional implementation timetable

This involves listing the next steps and drawing up a realistic provisional timetable by allowing sufficient time for the completion of each step (see Table 6, page 36).

The end-to-end process of developing a sanitation service takes between 3 and 5 years, depending on the situation, experience of the stakeholders involved, the resources available and issues encountered.

Which key stakeholders should be involved?

- **The users: service stakeholders and beneficiaries**

The users will be the beneficiaries of the future sanitation service. It is thus essential to ensure they are involved at all stages and take real ownership of the sanitation option put in place. This is particularly important as they will need to be responsible for some of the maintenance, at least that of their own facilities, to prevent clogging up the sewer. In addition, they may be asked to cover part of the initial investment, as well as pay operating and maintenance costs.

- **The contracting authority**

The contracting authority is in charge of developing the sanitation service across the area. Their role involves sanitation service planning and selecting the sanitation chain. They own the infrastructure and are responsible for the service for as long as it is in operation. As a rule, the contracting authority also covers all or part of the investment cost. They thus have a crucial role to play in all stages of the process:

- during the design and implementation phases, they are responsible for the service development project, which they monitor closely with support from the project supervisor(s). They contract work out directly to the various contractors;

- during the operational phase, the contracting authority ensures that the set contractual framework is adhered to. They check to make sure that each stakeholder is fulfilling their responsibilities to ensure good service quality and the technical, financial and social sustainability of the service.

Depending on the local situation and the provisions on sanitation and decentralization set out in current legislation, the role of contracting authority can be assumed by:

- the local authority (the most common scenario);
- or the national, provincial or municipal public sanitation operator;

BOX 5**In Brasilia, a public operator undertakes all stages of the service development process**

In Brazil, in the Federal District (the region that includes the capital city, Brasilia), it is the Federal District public operator itself* that acts as contracting authority, project supervisor and operator. It also conducts all user awareness-raising activities. The only activity outsourced to sub-contractors is construction of the actual infrastructure.

There is one multi-disciplinary team, consisting of community officers, facilitators, engineers and technicians, which works on all stages of the service development process, thereby ensuring that social and technical issues are treated with equal importance. As a result, the operator is thoroughly familiar with the service as it has selected, designed and implemented it itself.

However, considerable in-house capacities are required to manage the entire process in this way, which not all operators possess.

* CAESB, the Federal District public operator - Companhia de Saneamento Ambiental do Distrito Federal

- or a ministry or one of its devolved departments;
- or the users as part of an association (also sometimes called the ‘community’ to describe the area’s residents), acting either as the contracting authority or its partner.

Whatever the level of the contracting authority’s initial capacities, these will need to be developed over the long-term, i.e. over the course of several years. The contracting authority should be provided with capacity-building support both upfront and long after the service is up and running.

- **The project supervisor: responsible for coordinating the design and implementation**

The project supervisor – often a specialist or consultancy firm – coordinates and monitors

the service construction process on behalf of the contracting authority. Here, a distinction is made between supervision of the design phase and the supervision of construction.

Nevertheless, it is possible to assign both these tasks to the same provider: the future construction project supervisor, who will conduct the feasibility and detailed technical studies themselves. This will provide them with a thorough understanding of the system as they will have been responsible for its design. However, where this is the case, the contracting authority will need to guard against the construction project supervisor recommending overly-costly technical solutions that will result in them being able to invoice more for the subsequent monitoring of works.

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TABLE 6

Developing a non-conventional sewerage service: the steps and stakeholders involved

	WHO?	PLANNING	ASSESSMENT	MONTH 6	MONTH 9
Contracting Authority (CA)	Local authority, government, a public operator or, sometimes, a residents' association	Coordinates the urban area sanitation strategy development process	Determines the main features of the service		
		Manages the consultation process	Develops an overview of the subsequent steps involved		
		Selects the type of service to be introduced in each area			
Entity assisting the CA	A consultancy firm, NGO or independent consultant	Advises, supports and builds contracting authority capacities for monitoring the quality of studies and assessments			
Government departments & agencies	The ministry or its devolved departments or the national regulatory agency	Defines the national sector framework (strategy, regulation) Finances national investment programs		May be consulted to help select options	
Construction Project Supervisor	A consultant or consultancy firm				
Operator	An association, public or private operator under contract with the contracting authority				
Users		Are consulted on the type of service to be introduced			
Service Providers / Contractors	Consultancy firms, independent consultants or construction companies	Conduct diagnostic assessments and assist the contracting authority with developing its sanitation strategy and selecting the type of service to put in place	Carry out feasibility and technical studies		

		MONTHS 9 to 18	MONTHS 12 to 24	MONTHS 24 to 36
FUNDING	DESIGN	CONSTRUCTION	MANAGEMENT	
Raises finance	Sets out the service framework	Coordinates the tender process	Monitors service quality	
		Monitors the proper implementation of activities	Ensures hygiene rules are respected	
		Approves the completed works	Remains the asset owner	
	Advises the CA and monitors the quality of studies & assessments	Advises the CA and monitors the quality of construction project supervision	Advises the CA and monitors the quality of operations	
			Helps to monitor the service	
	Coordinates studies and drafting of the tender documents	Coordinates the construction work and conducts quality tests (provisional approval)	Support the operator and conducts quality tests (final approval)	
	If identified at this stage, the operator should be consulted on the service design	Attends training	Responsible for technical management	
			Responsible for financial management	
			Responsible for user relations	
			Collects data on the state of the service and reports to the contracting authority	
Contribute to investment by paying all or part of their connection costs	Are consulted on the type of technical options available	Receive awareness-raising on good hygiene practices and sanitation	Pay for the service provided	
		Register for the service	Ensure household facilities and the sewer are maintained in good condition	
		Occasionally help with the digging of trenches	Ensure their service quality expectations are being met	
	Carry out detailed technical studies and financial assessments	Provide equipment and carry out construction work	Can be appointed by the contracting authority to monitor the service	
		Implement awareness-raising and marketing activities		
	Design the capacity-building strategy	Train the operator on technical, financial and management tasks, and on awareness-raising and promotion		

Where it has the skills available in-house, the contracting authority should coordinate user awareness-raising and marketing tasks itself. Alternatively, these activities can be assigned to the construction project supervisor or another supervisor with expertise in these areas.

- **The service providers / contractors: responsible for carrying out the work**

Various service providers and contractors will be appointed by the contracting authority and monitored by the project supervisor(s). They will each be responsible for specific tasks, including:

- topographic, technical and financial studies (these may also be carried out by the construction project supervisor, should they have the skill set required);
- infrastructure and wastewater treatment plant construction (which can be carried out by a

single contractor or a number of specialist construction companies);

- user-focused activities: awareness-raising, marketing and promotion;
- capacity-building, etc.

- **The operator: responsible for managing the service**

The operator is responsible for the technical and financial management of the service, and for user relations activities.

In some cases, the design project supervisor, construction project supervisor and service operator roles are assigned to a single stakeholder. The advantage here is that the operator will already be familiar with the system having been involved in its design and construction (under a Design-Build-Operate, or DBO, contract). Under this type of contract, the operator could also be required to partially fund the investment.

STEP 2.

Design
the non-conventional
sewer service

During this step, studies will be carried out to produce a detailed assessment of the area concerned, upon which the technical (Activity 2.1), organizational (Activity 2.2) and financial (Activities 2.4 and 2.5) decisions will be based. The service promotion and awareness-raising strategy will also be defined (Activity 2.3).

The documents produced at the end of this step

- 1 A feasibility report:** a brief document that outlines the 'strategic' guidelines of the service: the technical option, management and funding method, etc.;
- 2 A detailed technical study** including:
 - a technical dossier containing a detailed plan of the sewer and showing the location of lift stations, pre-treatment and treatment plants;
 - technical specifications for running the service during the operational phase;
 - a planning document setting out the service promotion and awareness-raising activities to be carried out;
 - a detailed investment budget (including the cost of the infrastructure required, as well as the technical supervision, technical monitoring, capacity-building, service promotion and awareness-raising activity costs);
 - a forecast operating budget.
- 3 Regulatory and contract documents** that set out the service framework: municipal sanitation regulations that include regulations specific to non-conventional sewerage services; the contract between the contracting authority and operator; the customer contract between the users and the operator.

BOX 6

Activities to be undertaken during the sanitation service design stage



ACTIVITY 2.1.

Select the technical options for the future service

As a prerequisite: draw up detailed maps of the area concerned

This involves supplementing the initial field studies carried out in Step 1 with more detailed information.

• Topographic and hydro-geological studies

Non-conventional sewers are gravity-based systems that follow the natural slope of the land. It is therefore important to map the exact topography of each catchment area. This study, to be undertaken by an expert surveyor and topographer, should include:

- the different gradients and topographical features of the land;
- the height/level of the connection points, i.e. where household facilities are connected to the system via the junction chamber, as the pipes will need to be laid at a greater depth than the connection points to ensure proper drainage;
- the altitude of the sewer outfall (where the treated wastewater is discharged from the treatment plant, usually into the environment).

If there is no precise map of the area's hydro-geology and soils, there is a risk that, during the drilling phase, contractors may come across features not visible from the surface (rocks or a water table, for example) that could consider-

rably delay construction work and lead to additional costs.

Where the project involves the construction of a (or several) wastewater treatment plant(s), it will also be necessary to identify suitable sites, i.e. sites that are:

- located at the lowest point of the sewer (to reduce the need for lift stations);
- near an outlet (river, lake, marshland, etc.) into which the treated wastewater from the treatment plant can be discharged;
- large enough to accommodate the treatment facilities and legally registered to a clearly defined owner. A site owned by the local authority or the state would be ideal.

Local residents are often opposed to the idea of having a treatment plant nearby and may object to and block its construction. Prior to selecting the site, it is thus necessary to consult with residents to approve the proposed location and ensure there will be no opposition to the project that would cause delays to the construction work.

• Buildings, land tenure and surface obstacles

The space available for installing the sewer will be determined by the morphology of the buildings and by the boundaries separating private and public land. It is therefore vital to have an accurate map of all buildings and to be able

to clearly identify the boundaries between public and private plots. If these boundaries are unclear (as is often the case in unplanned settlements), the public authorities can grant an easement (giving the easement holder the right to access the land) or a right of access to the operator to enable them to carry out maintenance on the sewer. All surface and underground obstacles, such as wells, trees, and other networks (stormwater drainage, water) etc., are also identified at this stage.

Visits are made to households to verify whether their existing facilities and plumbing installations are suitable for connection to the sewer (i.e. flush toilets and drainage outlets that are above the planned level of the sewer). If household facilities do not meet these requirements, a campaign will need to be initiated to replace them and/or provide households with suitable plumbing installations, ensuring that the level at which these are installed facilitates their connection to the sewer.

Decide whether to opt for settled or simplified sewerage

As mentioned above, there are two main types of non-conventional sewerage¹:

- simplified sewers that directly evacuate all types of wastewater (grey and blackwater);
- settled sewers (also called solids-free sewers) that evacuate all types of wastewater following pre-treatment in a settling tank to separate out solid matter.

1. There are also a number of variations on these: simplified sewers that evacuate both wastewater and stormwater, such as can be seen in Rio de Janeiro, and settled sewers that evacuate greywater only, and sometimes stormwater, such as those found in Mali.

BOX 7

Constraints specific to settled sewerage

When selecting the sewer type, it is important to bear in mind that installation of a settling tank (in areas where households do not already have septic tanks) increases not only the investment cost, but also the operating costs, as the tank will need to be regularly emptied (a cost generally borne by the users).

To prevent sludge getting into the sewer, sludge levels in household settling tanks need to be checked on a regular basis. The operator can be put in charge of emptying the settling tanks. Alternatively, 'shared settling tanks' can be installed, which are also to be emptied by the operator. If the operator is not made responsible for emptying the settling tanks, it will be necessary to build the capacities of local companies to ensure they are able to provide users with an affordable service that adheres to public health and environmental standards.

The technical options available for these two sanitation chains are different for each segment.

• Selection criteria

- gradient: as outlined in Step 1, the minimum gradient required for settled sewerage is 0.5%. For simplified sewerage, the gradient needs to be at least 1%. However, these minimum gradients are highly dependent on the volume of wastewater being discharged;

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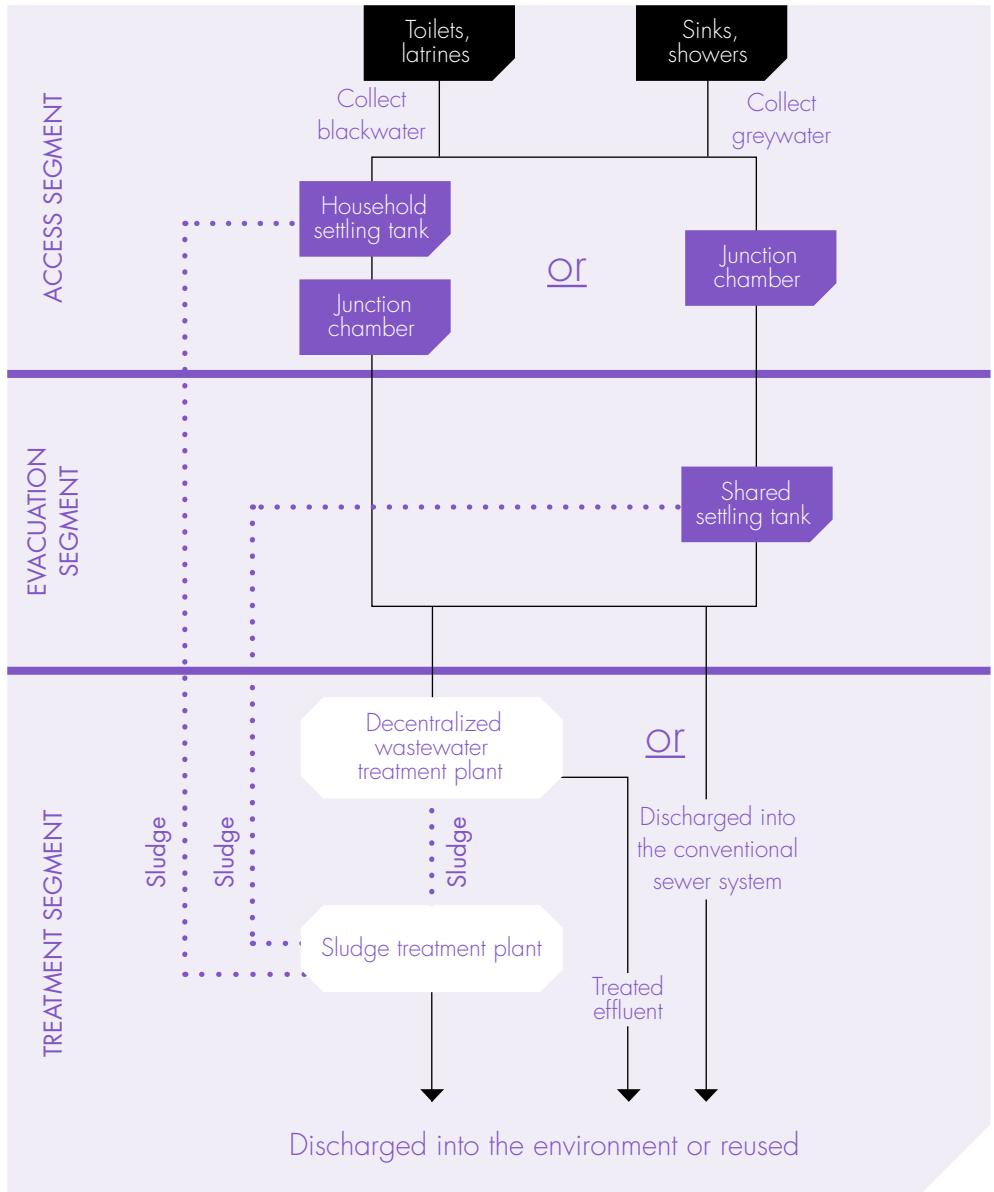
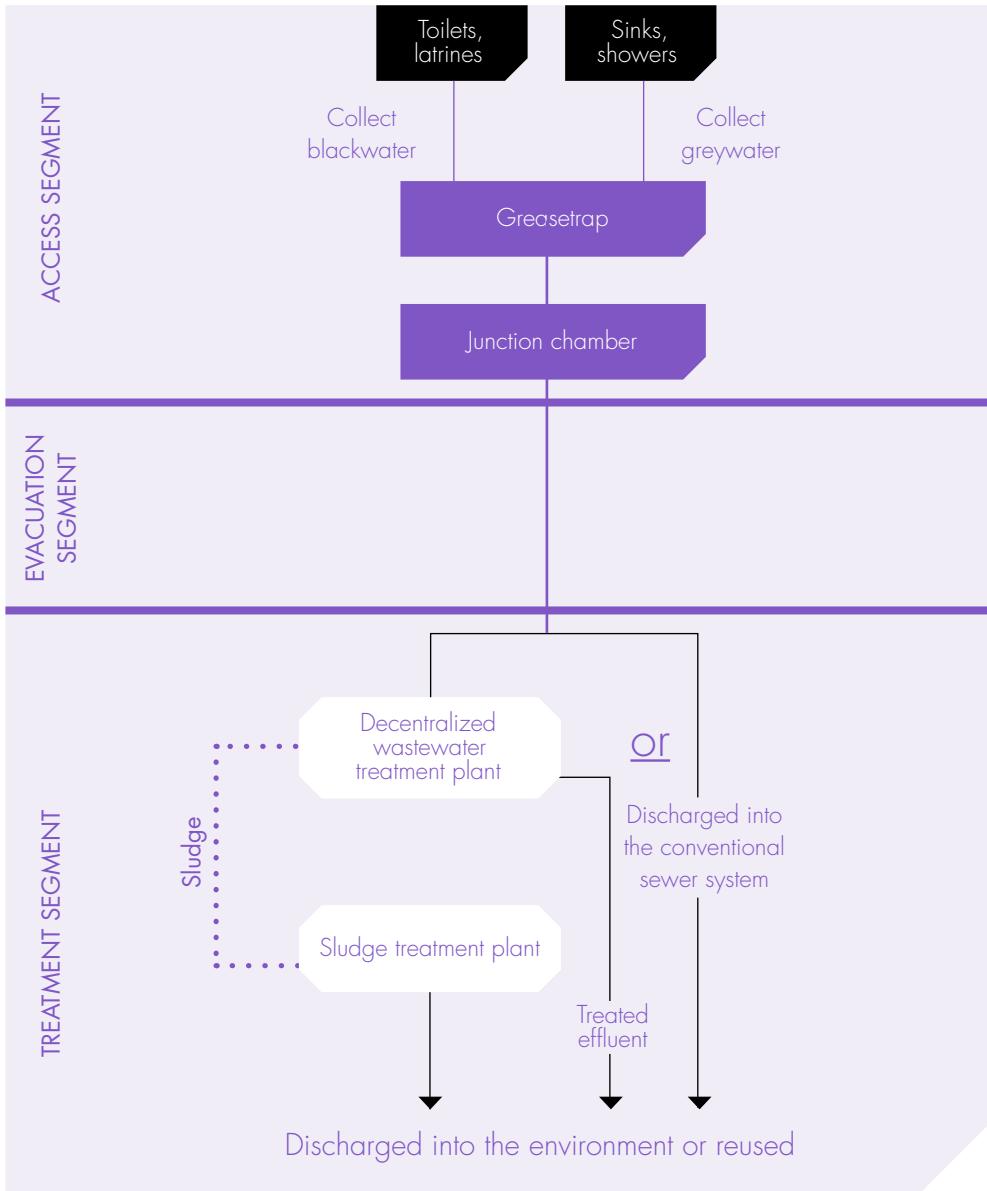
ILLUSTRATION 5**SETTLED SEWERAGE (SOLIDS-FREE SEWER)**

ILLUSTRATION 6**SIMPLIFIED SEWERAGE**

- the flow rate of the wastewater through the sewer, which is proportional to the volume of water consumed. ‘Settled sewerage’ is considered suitable for areas where water consumption is greater than 20 liters per capita per day (this can also include households that obtain their water from standpipes), whereas simplified sewerage can be used in areas where water consumption is over 50 liters per capita per day. However, these amounts can vary depending on the gradient;
- the existence of septic tanks of good quality on household plots would make settled sewerage a suitable option.

• Shared settling tanks

Compared to individual household settling tanks, using shared settling tanks – to which up to several dozen households can be connected – enables economies of scale in terms of both space and (investment and operating) costs. Usually installed on public land, these shared tanks are best suited to highly built-up and poor areas. Shared settling tank projects have been piloted in Senegal, Brazil and Mali.

They make it easier for the professional operator to check sludge levels and prevent sludge from entering the sewers (which is a frequent problem with individual household settling tanks).

When these are well-designed, maintained and ventilated, they give off no or very few unpleasant odors and can easily be slotted into the urban environment. In Brazil, for example, they are located under parks or public gardens.

Wastewater collection facilities (access segment)

This segment includes the household facilities for which the users will be responsible. The list of options presented to them will be based on the findings of the demand assessment.

• Greywater collection facilities

These include showers, sinks, utility sinks and wash tubs.

• Blackwater collection facilities

The recommended options for use with non-conventional sewerage are pour-flush or cistern flush toilets. These toilets have a water seal to prevent smells.

• ‘Shared’ blackwater and greywater collection facilities

In public places (schools, stations, markets, hospitals, etc.), highly built-up areas or plots where there is little space, the most appropriate solution consists of public washroom and toilet blocks with latrines, showers, utility sinks and wash tubs. These public facilities are either connected to the non-conventional sewer or have their own wastewater treatment system.

• Is a grease trap required?

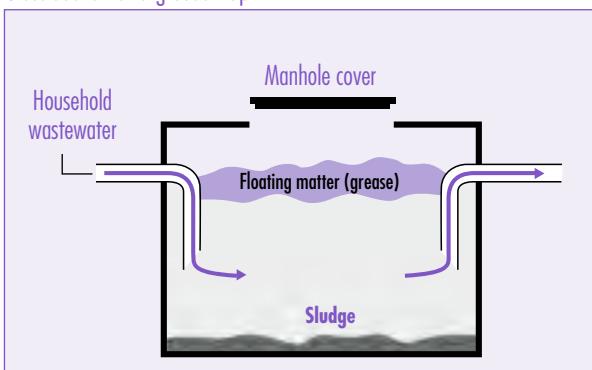
Situated at the greywater outlet point, a grease trap prevents pipes from clogging and is particularly useful in countries where dietary habits mean the cooking water is full of fat (such as in

ILLUSTRATION 7

A utility sink located outside a house

**ILLUSTRATION 8**

Cross-section of a grease trap



Source: from SIAEP Lalinde

West Africa or Brazil). Grease traps have now been made mandatory for restaurants connected to the sewer system in a large number of towns in France.

Grease traps are required for simplified sewers and for settled sewer systems connected to a shared settling tank. However, they do not need to be installed if an individual household settling tank is used as this traps the grease instead.

1. The settling tank is also sometimes known as a 'septic tank' or 'intermediate tank'.

- **The settling system
(for settled sewerage only)**

For settled sewerage, a settling tank¹ is installed before each connection to the sewer. This tank separates the solid matter from the liquid effluent through settling: only the wastewater is evacuated through the sewer, while the solid matter sinks to the bottom of the tank and the grease remains on the surface. In addition to this physical treatment, the settling tank also provides an initial level of biological treatment, as the bio-degradable solid matter is partially broken down through anaerobic digestion. However, some of these suspended solids will also turn into sludge. This sludge builds up in the bottom of the tank, which then needs to be regularly emptied. A settling tank placed before the non-conventional sewer will need to be emptied every 1 to 10 years (depending on its size, type and the volume of wastewater discharged, etc.).

- **Pre-filter**

The pre-filter is a tank with internal compartments and a high outlet (submerged filter) filled with an inert filter material (such as gravel). This material needs to be taken out and cleaned on a regular basis. In urban areas in Africa, the volume of the pre-filter is usually between 5 and 20 liters per user.

A pre-filter (or secondary filter) is useful in settled systems as it ‘traps’ the suspended matter contained in the effluent discharged from the settling tank. It also serves to alert users to the fact that the settling tank is overly full (as the pre-filter becomes clogged).

• Domestic inspection chamber

Wastewater from the various household facilities collects in this chamber, which is also an

access point for inspecting the household’s drainage system.

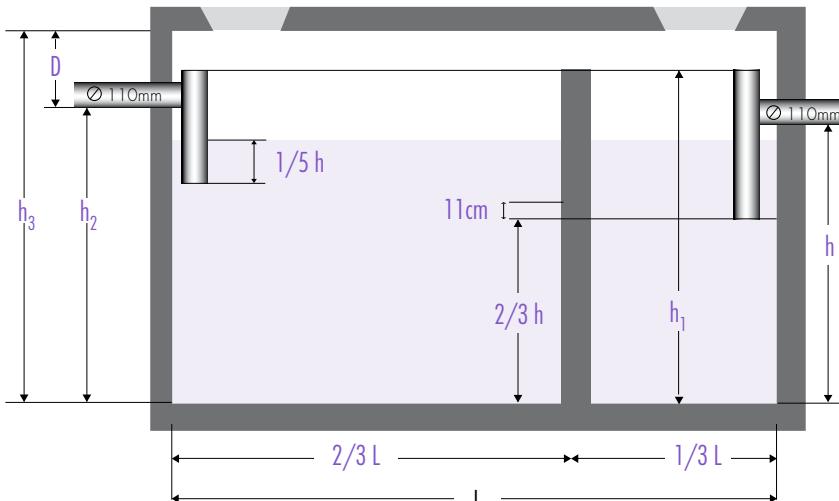
• Other domestic equipment

It is recommended that household facilities be ventilated (an air vent with an outlet on the roof) to reduce smells and prevent the formation of hydrogen sulfide (H_2S), which is corrosive to concrete.

It is also important to ensure that stormwater from the gutters is not able to infiltrate the non-conventional sewerage system.

ILLUSTRATION 9

Cross-section of an individual household settling tank used in Senegal



The minimum usable capacity of the tank is 3m³

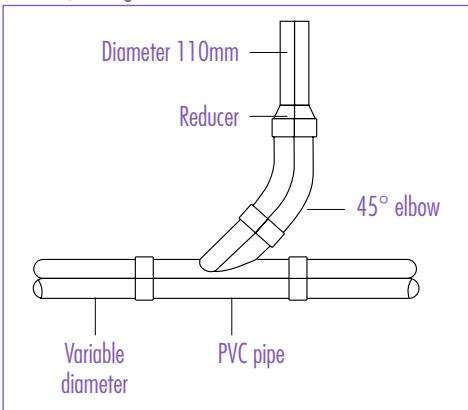
L = inside length of the tank

H = usable height = 1.2m minimum • $H1 = h + 1/5 h$ minimum

$h2 = H + 8\text{cm}$ minimum • $H3 = h2 + D$ (depth of the lower generating line of the inlet pipe)

ILLUSTRATION 10

'Y-shaped' connection used on the ONAS sewer systems in Dakar, Senegal



Source: ONAS

- **The connection**

This connects the domestic plumbing installations to the main sewer. The connection pipe can be attached via a junction chamber or directly onto the sewer line using a 'Y-shaped' connection.

Technical options for the evacuation segment

- **The maximum length of the sewer**

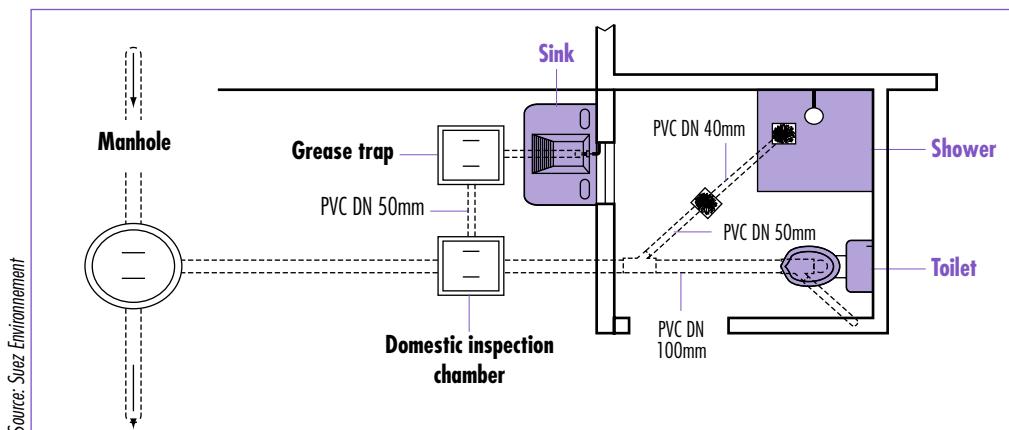
The size of non-conventional sewer networks can vary widely. They can consist of a few dozen household connections (such as in Dakar in Senegal) or several thousand, as in the Asafo district of Kumasi in Ghana.

The maximum length of the sewer (in meters and number of connections) depends on:

- the natural slopes available and the morphology of the catchment basin;
- the potential maximum number of houses to be connected in this catchment basin;
- the average volume of wastewater discharged in liters per capita per day (which is directly dependent on water consumption levels within the area);

ILLUSTRATION 11

Plan of the 'basic sanitation module' used for simplified sewerage in El Alto, Bolivia



Source: Suez Environment

- the potential flow of wastewater at different points on the sewer;
- the capacity of the wastewater treatment plant (which is linked to the size of the plant and thus to the land available for its construction downstream of the sewer);
- whether lift stations are to be installed or not.

• The size of the pipes

There is a wealth of literature available on designing the ‘evacuation’ section of non-conventional sewerage. There is also a PC-based simplified sewerage design program available on the University of Leeds website¹. However, these calculation methods only give theoretical sizes. Other factors not usually included in this type of hydraulic equation also need to be taken into account: particularly, the inevitable intrusion of stormwater and solid waste. Thus, in Salvador de Bahia (Brazil), the diameter of the pipes was increased from 100 to 150mm to reduce the risk of blockages caused by solid waste (rather than for hydraulic capacity reasons).

• Lifespan

Non-conventional sewerage infrastructure has an estimated lifespan of 25 years. However, this may potentially be longer, as the simplified sewer system in Kumasi in Ghana is still working perfectly well after more than 25 years of service.

The lifespan of a non-conventional sewer is also linked to its capacity to meet increases in the demand for connections and in the volume of wastewater discharged. However, in developing towns and cities, sewer capacity often struggles to keep up with the pace of urban development (which is often unplanned or not accompanied by the proper development of utilities). Thus, it is not easy to forecast how each area of the town is likely to develop over the long-term.

• The materials used

Please see Table 7 opposite.

• Sewer layout

The layout is determined based on the detailed map of the area to be covered (see Activity 2.1 above). The sewer layout should also be as short and as straight as possible to reduce costs and minimize potential operational issues. Changes of direction using elbows of more than 45° increase the risk of blockages and make it difficult for cleaning tools to pass through the sewer; as such, they are not recommended.

Wherever possible, the sewer layout should be reviewed and approved by the users (see Activity 3.3 below) to minimize opposition and the risk of conflict during the construction and implementation phases. It is especially important to obtain user approval for the sewer’s tertiary sewer lines, particularly if these cross private land.

¹ www.efm.leeds.ac.uk/CIVE/Sewerage

TABLE 7

The main materials used to construct non-conventional sewers

MATERIAL	PROS	CONS	COMMENTS
POLYVINYL CHLORIDE (PVC)	Light; its flexibility protects it from immediate damage and its smooth surface facilitates the flow of wastewater through the pipes. It is resistant to corrosion, relatively cheap and very widely used.	There is a risk of breakage if crushed by a heavy weight, must be carefully laid in pipe bedding. It can get distorted along its length and lose roundness.	This by far the most common material used for non-conventional sewer pipes. In some cases, it is also used for the (mass) production of manholes and settling tanks.
CONCRETE	Durable and crush-resistant, relatively cheap and very widely used.	Heavy (makes pipe handling and laying difficult), prone to corrosion, rougher surface than PVC.	For non-conventional sewers, concrete is used mainly for manholes or housings to protect the pipes (under roads, for example).
HIGH-DENSITY POLYETHYLENE (HDPE)	This has all the advantages of PVC with increased durability.	This is the same as PVC, but much more expensive and prone to greater thermal expansion.	At the moment, this is reserved for towns with considerable investment capacity or for sections of the sewer laid under roads.
CLAY	Made locally at little cost.	Brittle and easily breakable.	Used on some sewer systems in Asia and Latin America; however, this has now been replaced by PVC.

• Public or private land?

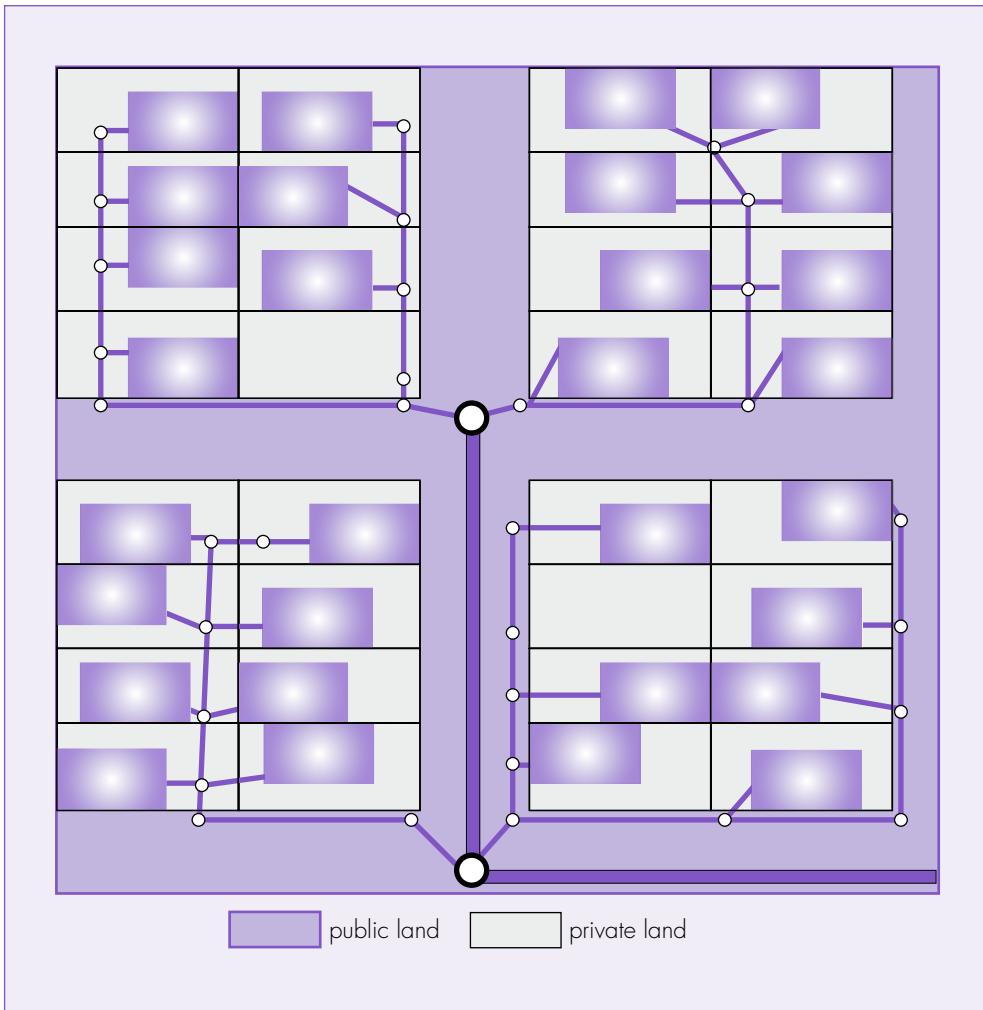
Originally, in Latin America, the 'condominial' sewers often crossed private land, being laid under backyards or gardens. This reduced the length of the sewer and the number of manholes required, but meant that the users had to clean the pipes out themselves and all work together to ensure the sewer functioned correctly (hence the term 'condominial', i.e. 'shared' sewerage).

However, this shared management proved unsuccessful. Thus, Brazil's public operators have since taken over the direct management of these sewers and now require the sewer pipes to be routed across public land.

For other systems, notably in Africa, conventional layouts across public land were used right from the outset. This has increased the length of the sewer but means the operators are able to access them more easily.

ILLUSTRATION 12

Plan of tertiary sewer lines for condominium sewerage



Source: Suez-Environnement

However, in informal settlements, the boundaries between private and public land are not always clear-cut and there are no or very few streets.

Thus, in these areas, the sewer is often routed 'wherever it will fit', alternating between public and private land.

• The depth of the pipes

The depth at which the non-conventional sewer pipes are laid depends first and foremost on the natural slope of the land. In most cases it will be necessary to increase the slope by laying the pipes at an ever greater depth as the sewer progresses downstream.

Wherever possible, non-conventional sewer pipes are laid under sidewalks. However, it is inevitable that certain sections will need to be laid under roads. The recommended depth of the pipes in this case is 60cm, which will of course have an impact on the depth of all the pipework upstream of this point. Pipes are generally laid at depths of between 30cm under private land and several meters on the downstream sections of some systems (in which case, sewage lift stations will sometimes be used: see the following page).

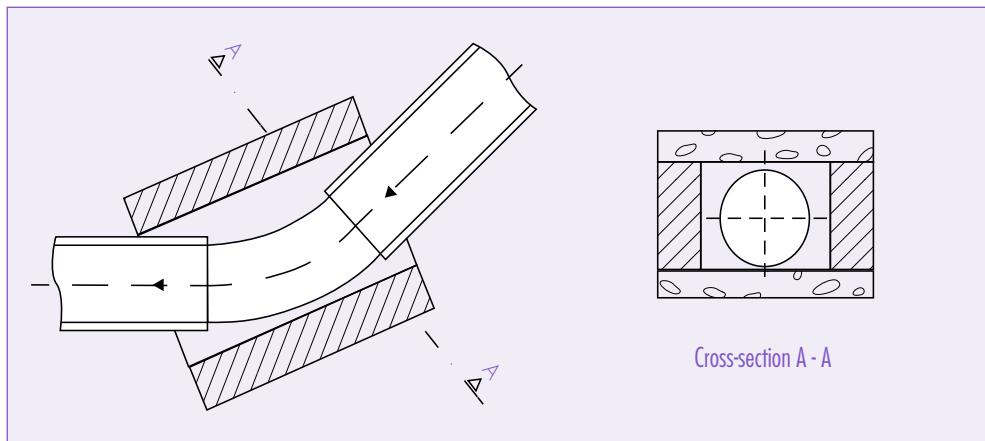
• Protecting the sewer

For the sections of pipework laid under roads, concrete casing is used to protect the pipes from damage. Underground boxes (see Illustration 13) can also be used to protect the pipes at changes of direction or slope.

However, the best way to prevent pipes getting crushed and damaged is to pave the roads. This also improves the cleanliness and appearance of the district, provides greater ease of travel and facilitates stormwater drainage. The inhabitants have more pride in their district, which motivates them to take better care of the facilities, including those used for sanitation, regardless of whether these are found on public or private land. Although there is a sizeable investment cost attached, road paving is thus recommended for ensuring sustainability of the sewer.

ILLUSTRATION 13

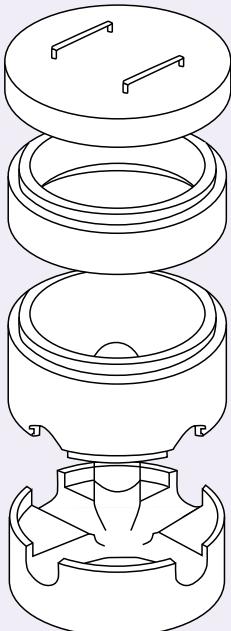
Underground boxes used to protect non-conventional sewerage pipes in Senegal



Source: ONAS

ILLUSTRATION 14

Simple PVC manhole used in El Alto, Bolivia



Source: Suez Environnement

- **Manholes**

Manholes provide access to the sewers for inspection and maintenance. At the bottom of the manhole is the sewer pipe along which the wastewater flows.

So-called 'simple' manholes of 40 to 60cm in diameter are usually used on non-conventional sewers, as opposed to the 1m diameter manholes used on conventional sewerage. These smaller diameter manholes do not provide access for a maintenance operative, but are large enough to insert inspection and cleaning tools.

ILLUSTRATION 15

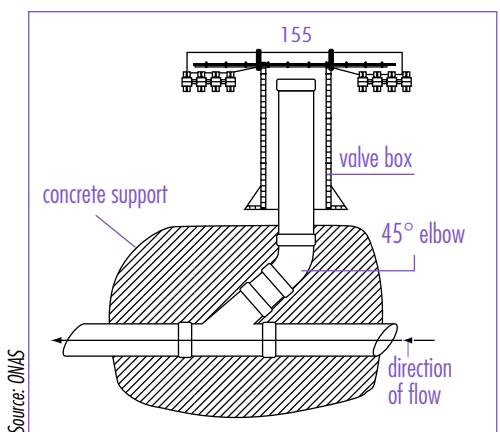
Mass production of simple concrete manholes in Brasilia



Source: GAESB

ILLUSTRATION 16

Inspection tube, used instead of manholes in Senegal



Source: ONAS

- **Sewage lift stations**

These are used to pump wastewater from low-lying to higher sections of the sewer or to the wastewater treatment plant. Their investment and operating costs are extremely high and they are complex to maintain. Although lift stations will no doubt be required in some areas, this option should be avoided where possible.

TABLE 8

French standards for sewer systems in small communities*

Minimum performances of local wastewater treatment plants needing to treat a gross organic pollution load of less than or equal to 120kg/d of BOD5

Parameter	Maximum concentration to not be exceeded	Minimum output to be reached
DB05	35mg/l	60%
DCO		60%
MES		50%

Minimum performances of local wastewater treatment plants needing to treat a gross organic pollution load of between 120 and 600kg/d of BOD5

Parameter	Maximum concentration to not be exceeded	Minimum output to be reached
DB05	25mg/l	70%
DCO	125mg/l	75%
MES	35mg/l	90%

Standards for nitrogen and phosphorus, only applicable above 600kg/d of BOD5

Parameter	Maximum concentration to not be exceeded	Minimum output to be reached
Nitrogen	15mg/l	70%
Phosphorus	2mg/l	80%

* Decree of 22 June 2007

Technical options for the treatment segment

When selecting the treatment method, it is important to take all available technical, financial and human resources into account, as well as the volumes of wastewater to be treated and the amount of land available for the treatment site.

- **What level of treatment is required?**

Wastewater treatment can be broken down into four levels:

- **pretreatment** removes those elements in the wastewater that would create problems during the following stages. As a minimum, pretreatment should consist of screening to remove large particles, but where possible should also include a system to remove sand, grease and oils;
- **primary treatment** removes suspended solids, mainly through settling;
- **secondary treatment** (most frequently using biological processes, but occasionally using chemical processes or a combination of the two) removes the organic matter, which is non-toxic but harms the environment as it consumes the dioxygen in water (required for aquatic life) as it degrades. Secondary treatment can either be aerobic, whereby bacteria utilize oxygen to degrade organic matter in the wastewater, anaerobic or a combination of the two systems (aerobic and anaerobic);
- **tertiary treatment** removes pathogens (i.e. the viruses, bacteria or parasites that are a danger to human health) and heavy metals.

TABLE 9

Factors to be taken into account when selecting a wastewater treatment plant

LEVEL OF TREATMENT	PARAMETERS MEASURED	PROCESSES USED
Pretreatment	Floating solid waste: plastic bags, tree branches, etc.	Screening
	Oil	Oil-water separator
	Sand	Grit chamber
Primary treatment	Total Suspended Solids (TSS)	Settling
Secondary treatment	5-day Biochemical Oxygen Demand (BOD5)	Aerobic treatment: exposure to oxygen and UV rays, in waste stabilization ponds, for instance AND/OR
	Chemical Oxygen Demand (COD)	Anaerobic treatment: microorganisms break down organic matter in the absence of oxygen, in gravel filters, for example
Tertiary treatment	Pathogens (particularly fecal coliforms)	Aerobic treatment: exposure to oxygen and UV rays OR Anaerobic treatment: planted or unplanted sand filters
	Nitrogen (N) and Total Phosphorus (TP)	Complex treatment

National directives (available from the Ministry of Water, the Environment or Health) usually include minimum quality standards for the wastewater discharged into the environment. However, these standards generally apply more to industrial than domestic wastewater.

• Connection to conventional sewerage

This is the simplest solution in areas where this is possible.

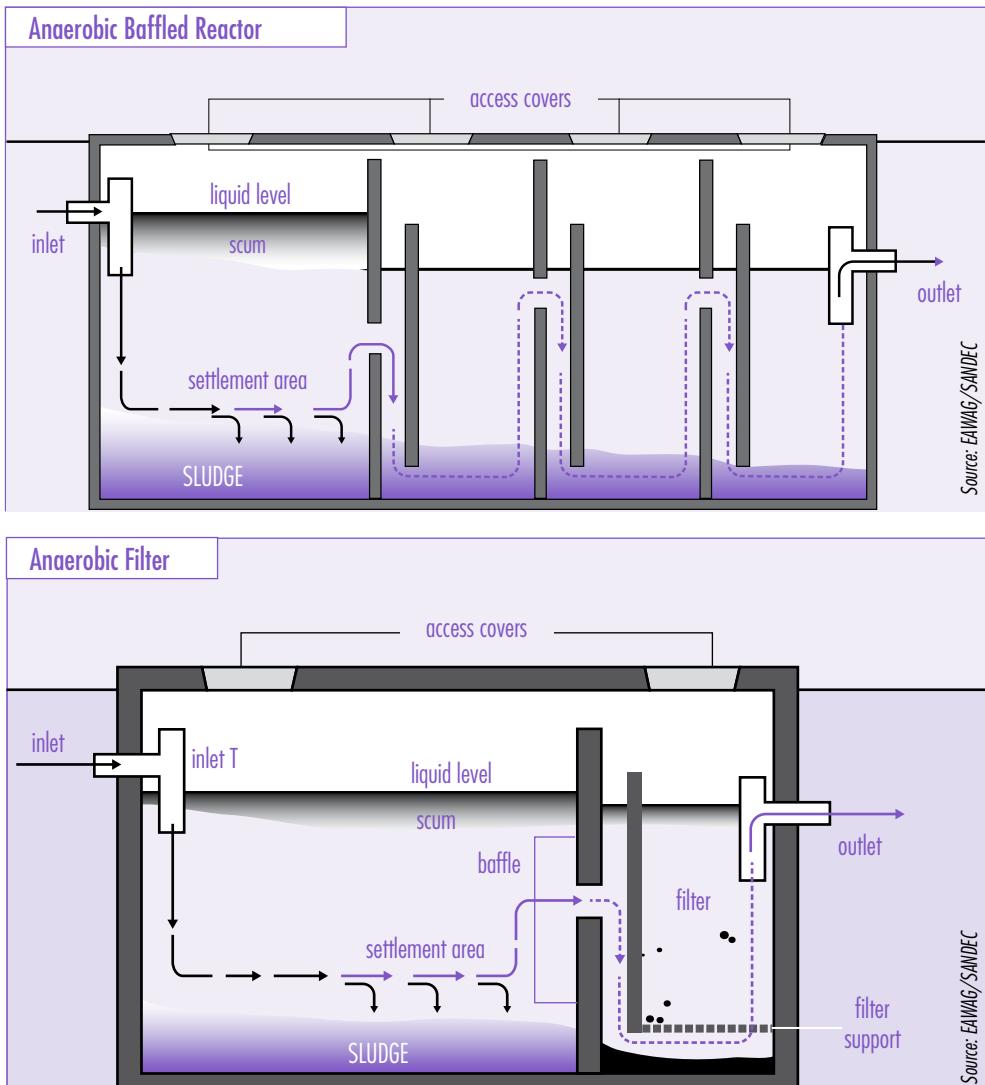
• ‘Intensive’ treatment systems

Intensive wastewater treatment systems can take many forms (and some examples of these are provided below). These are treatment plants of various sizes but which require a smaller footprint than so-called ‘extensive’ treatment processes.

Some intensive systems are simple and fairly rustic, while others use complex technology (such as the activated sludge process) and thus are not recommended for the contexts considered in this guide. Please see the illustrations below.

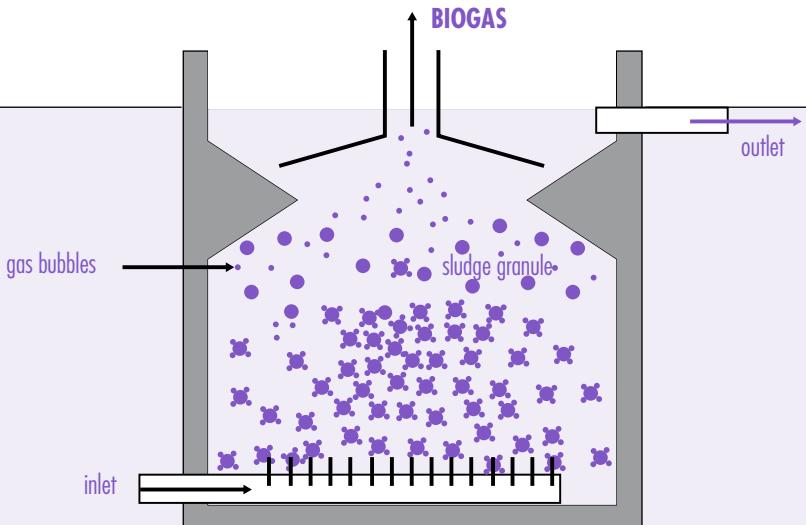
ILLUSTRATION 17

Five examples of low-cost intensive wastewater treatment systems¹



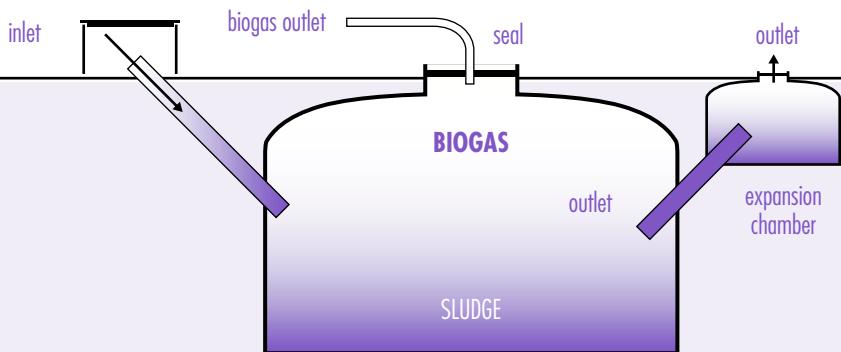
¹ These examples are not exhaustive. For more information, please see: Tilley E. & Al., 2008, *Compendium of Sanitation Systems and Technologies* EAWAG-SanDEC, WSSCC and Gabert J., 2010, pS-Eau Guide n°4. *How to select appropriate technical solutions for sanitation*, MDP/pS-Eau, pp. 116-125). Source for the 5 diagrams: EAWAG/SANDEC

Upflow Anaerobic Sludge Blanket Reactor (UASB)

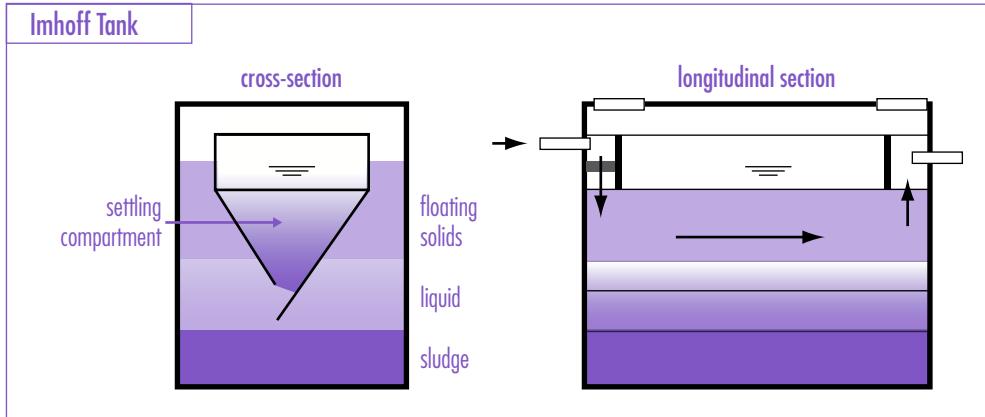


Source: EWAG/SANDEC

Anaerobic Biogas Reactor



Source: EWAG/SANDEC

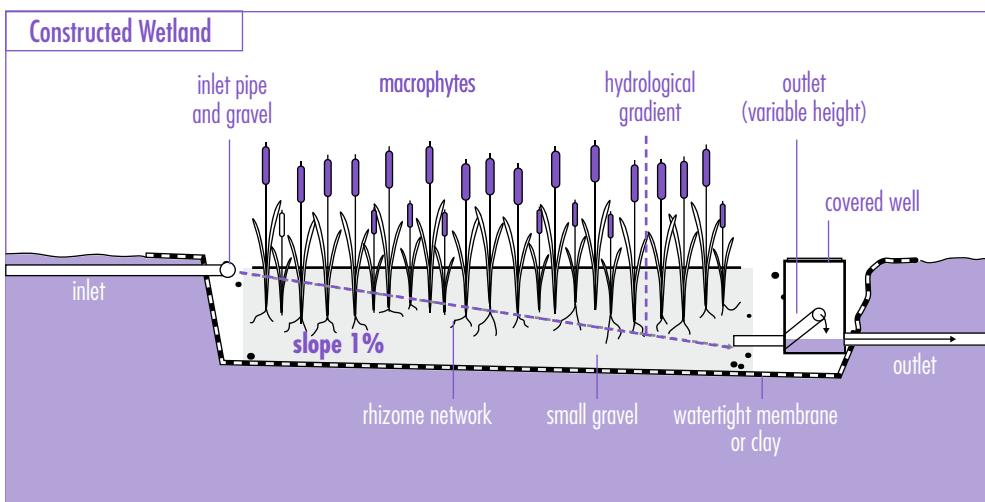


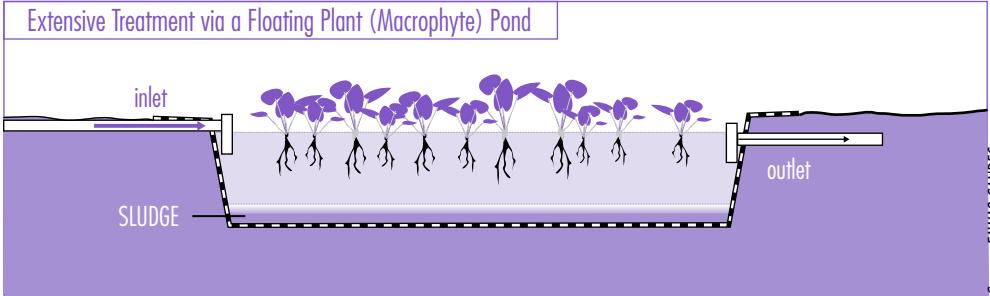
- 'Extensive' treatment systems

'Extensive' treatment is carried out using natural processes through planted filters, waste stabilization ponds or constructed wetlands. These systems have a large footprint (requiring between 1 and 5m² per inhabitant equivalent), but are relatively simple to maintain (although the residual sludge must be removed and the ponds regularly cleaned) and can be esthetically attractive.

ILLUSTRATION 18

Two examples of extensive treatment systems





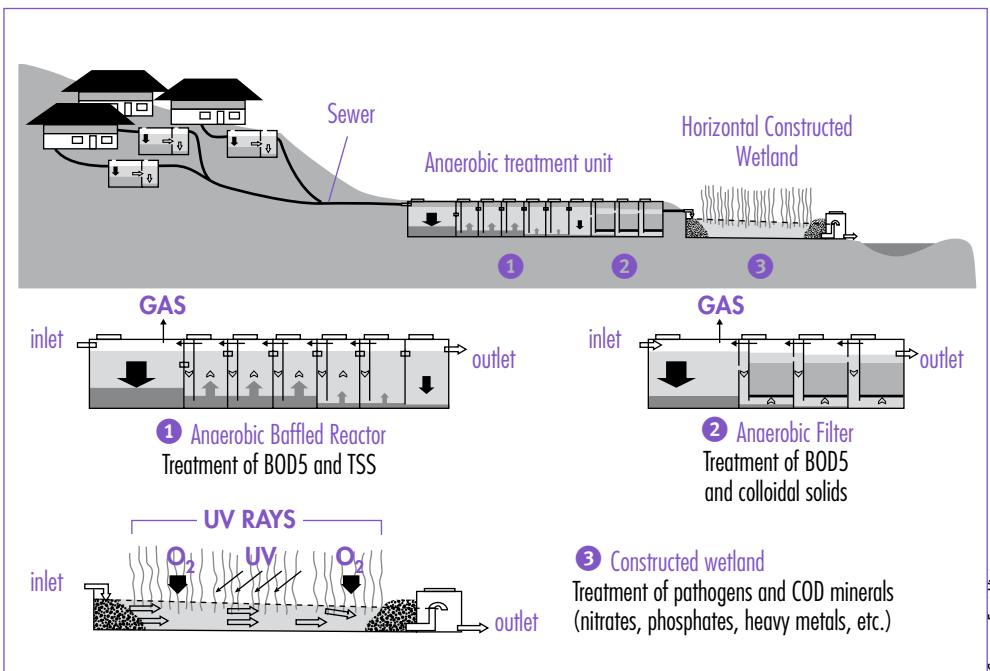
Source: EAWAG SANDEC

- Combining several treatment systems

It is possible to combine different treatment technologies to optimize the treatment potential of both intensive and extensive systems.

ILLUSTRATION 19

Examples of DEWATS-type combinations (Anaerobic Baffled Reactor + Anaerobic Filter + Constructed Wetland)



Source: East Vietnam

- **Discharge without treatment**

This option, which is not at all recommended, is sometimes used by default (for example, wastewater is discharged into a river with a very high flow rate), often where there are insufficient financial resources to construct a treatment plant or when this breaks down. It is important to properly assess the impact of this option, particularly to ensure there are no environmental or health risks for people living downstream, which can rarely be guaranteed in urban areas.

- **Sludge treatment solutions**

Like individual and shared settling tanks, all treatment plants, whether intensive or extensive, produce sludge at each stage of the treatment process. It is essential that this sludge is treated using solutions such as:

- solar or planted drying beds (potentially supplemented by composting of the treated sludge). However, this solution requires a lot of land (around 50m²/1,000 inhabitants);
- anaerobic biogas reactors, which are much smaller than drying beds.

- **Is it possible to use the treated wastewater and residual sludge?**

There are a number of options available for using treated wastewater and its by-products, including: biogas production, the land application of treated wastewater for agriculture, sludge composting, etc. These technologies are perfectly safe for the environment as long as the appropriate public health and environmental quality standards are met.

ACTIVITY 2.2.

Assign roles for operation of the service

Responsibilities can be apportioned in a number of ways. Thus, the assignment of roles will depend on the capacities of the parties involved and their willingness to participate in running the service.

Contracting authority responsibilities

During the operational phase, the role of the contracting authority, often the municipality, is to monitor and audit the quality of the service being provided by the operator and, if need be, take, or require the operator to take, ac-

tion to ensure the appropriate standard is maintained (see also Activity 4.4: Monitor and audit the quality of the service).

The contracting authority should thus allocate at least one member of staff – even part-time – to this role and ensure they are familiar with what is required to safeguard the social, financial and technical sustainability of the service.

TABLE 10

Minimum human resources required by the contracting authority

	TASKS	JOB PROFILE	HOURS
Sanitation Service Technician	<ul style="list-style-type: none"> • Monitors and controls quality of the service provided by the operator. • Facilitates stakeholder consultation. • Advises elected officials on the options available for the service. 	A technician also trained in the social, legal, economic and institutional aspects of sanitation services.	At least 25% of the technician's time to be spent on each non-conventional sewerage service.
Hygiene and Sanitation Controller	<ul style="list-style-type: none"> • Ensures compliance with sanitation regulations in the area. • Provides continuous awareness-raising by reminding users of good practices. 	A facilitator or technician trained on hygiene and sanitation issues, facilitation techniques and communication.	At least 1 full-time employee for 10,000 inhabitants.

BOX 8

Capacities of the municipal sanitation department in Kumasi (Ghana), contracting authority for the non-conventional sewerage service

Within its municipal sanitation department, Kumasi (a city of around two million inhabitants) has a multi-disciplinary team that includes:

- three engineers: the operations manager and his deputy + one civil engineer;
- a public health expert;
- a community-relations expert.

This team oversees all sanitation services within the municipal area.

It also monitors the quality of the service provided by the private operator, Environmental Engineering Limited, which operates the non-conventional sewerage service in the district of Asafo, by carrying out sewer inspections with the operator and gathering feedback from users.



Kumasi municipal officers paying a visit to monitor the non-conventional sewerage service

This staff member should carry out regular inspection visits, collect monitoring indicator data, be familiar with national regulations, understand the terms of the contract in place between the contracting authority and the operator and put in place remedial action when required.

The contracting authority is in contact with all service stakeholders – users and operator – and

should facilitate discussions between these two parties.

There should also be at least one staff member assigned to the role of hygiene and sanitation controller. For small-scale sanitation services, these two roles may be carried out by the same person, provided that they are able to allocate enough time to each one.

TABLE 11

Minimum human resources required by the operator of a non-conventional sewerage service¹

	ACTIVITIES	HUMAN RESOURCES REQUIRED ²
Coordination	Monitoring the relationship with the contracting authority and supervising teams	A minimum of 1 manager, with 25% of their time dedicated to each sewer
Technical management	A technician assigned to undertake technical monitoring and maintenance of the sewer and the treatment plant.	A minimum of 1 technician, with 25% of their time dedicated to each sewer
Business and financial management	<ul style="list-style-type: none"> • Billing and bill collection • Monitoring and managing the operating account 	A minimum of 1 specialist, with 25% of their time dedicated to each sewer
User relations	Ongoing promotion and awareness-raising	A minimum of 1 specialist, with 25% of their time dedicated to each sewer

1. This table shows the minimum human resources required for a small-scale non-conventional sewerage service (with a few hundred users) connected to a decentralized wastewater treatment plant.
2. The operator's staff often divides their working time between several systems. Many operators are in charge of more than one system, or combine this role with that of solid waste collection, small-piped water supply or electricity operator. The same member of staff can also carry out two roles: user relations and technical management or business and financial management, for example.

TABLE 12

Premises and tools required by the operator

	PREMISES	EQUIPMENT
Technical management	Storage area for storing tools and equipment	Manual cleaning equipment, vacuum trucks and a hydro-cleansing tanker ¹ , spare parts (pipes, manholes, etc.), monitoring and maintenance documents.
Business and financial management	An office with a computer and phone line	Accounts management tools and documents (general ledger and journal, etc.) and business management documents (customer contracts, payment receipts).
User relations	An office (or kiosk) to receive users	Awareness-raising and communication documents.

1 If the operator does not own these tools himself, he can hire them or appoint a contractor when required.

TABLE 13

Strengths and weaknesses of the different non-conventional sewerage service management methods in use

OPERATOR	STRENGTHS	WEAKNESSES
The municipal technical department ('direct management')	Ensures the municipality's involvement in monitoring the service. The public authority is directly accountable to the users.	Local authorities do not always have the capacities or budgets required. When there is no specific sanitation service budget, it is difficult to determine the service costs and revenue, which does not encourage effective management. Moreover, the contracting authority is both 'judge and defendant' as they monitor and check their own service management.
Public operators (national, provincial or municipal)	They have considerable human resource and technical capacities. Their management autonomy ensures greater financial transparency and improved management monitoring.	The provincial and national operators are sometimes reluctant to report to local authorities and to take their requirements into account. It is essential to put a contract in place between the operator and contracting authority (and ensure this is properly monitored).
A private operator	The private operator has a vested interest in ensuring the service is properly managed and users are satisfied with the service. He often manages other services (water, solid waste, electricity), which is a guarantee of good performance.	The contracting authority's lack of monitoring capacities may lead to misunderstandings, or abusive practices on the part of the operator: lack of transparency, forgoing maintenance to maximize profit, etc. If the service is not profitable enough, the operator may neglect or withdraw from their management duties.
An association	In theory, it is in the users' interests to be involved in managing the service.	Volunteers' motivation falls over time. The operator often lacks the necessary skills and resources. Associations are not always recognized by the public authorities. This is often considered to be the most cost-effective form of management; however, the tasks to be carried out and the costs involved are similar to those for all other types of management.

The role of the operator

The operator is in charge of the technical and financial management of the non-conventional sewerage service and is also responsible for user relations (promoting the service, damage prevention and encouraging proper use of the sewers, collecting user fees, etc.). Prior to appointing an operator, it is important to have a clear idea of the tasks involved in the operational phase and ensuring that the potential operator has the capacities required to carry out the role (also see Activities 4.1, 4.2 and 4.3).

The role of the users

In all cases, the users should:

- maintain their domestic plumbing installations, i.e. all the facilities within their home through which wastewater is discharged;
- pay the service fee in accordance with the tariff listed in their customer contract;
- inform the operator of any problems with the sewer;
- report, either directly or via their representatives, on their level of satisfaction with the service provided (they may also provide recommendations for its improvement).

As part of an association, users may also:

- take on the role of contracting authority for the service, or share this role with the local authority or operator. This model is often selected in areas where the ‘traditional’ contracting authority shows little interest in developing and monitoring the service.

However, in practice, this model is not always

easy to implement as the users and their representatives often do not have the capacities required to take on the contracting authority role;

– operate all or part of the service, such as the sewer line that connects the houses to the main sewer. However, it is to be noted that, in many places where this has been attempted, such as Brazil, Indonesia and Africa, for example, operation of the sewer system by the users has been unsuccessful. This option is only to be used where there is no other operator capable of undertaking this role. In this situation, the capacities of the users’ association will need to be significantly improved by making it more professional (recruiting trained staff) and remunerating those users involved for the time spent on association governance.

The division of responsibilities is documented and regularly monitored

The division of responsibilities and the breakdown of tasks assigned to each stakeholder needs to be clearly documented in contracts and regulatory frameworks to prevent any misunderstandings.

• Municipal (or provincial) sanitation regulation

There is often already regulation in place setting out the general sanitation framework for the area. In most cases, this will just need to be adapted to cover the aspects specific to non-conventional sewerage services. This regulation sets out the roles and responsibilities of each stakeholder for each type of service, as well as users’ rights and obligations, sanitation fee-setting rules and monitoring procedures.

It must be consistent with the national sanitation regulatory framework, be debated by the public authorities and binding on all stakeholders. Its proper application is monitored by the Hygiene and Sanitation Controller, who can impose sanctions for non-compliance with its directives.

• The contract between the contracting authority and the operator

Whether the operator is public, private or an association, they should have a formal agreement in place with the contracting authority in the form of a contract that sets out the rights and obligations of each party: quality targets; service performance; sanitation fee tariffs and connection costs (as well as the process for reviewing these);

any penalties to be paid by the operator should they fail to adhere to the contract; and, finally, contract review and monitoring mechanisms.

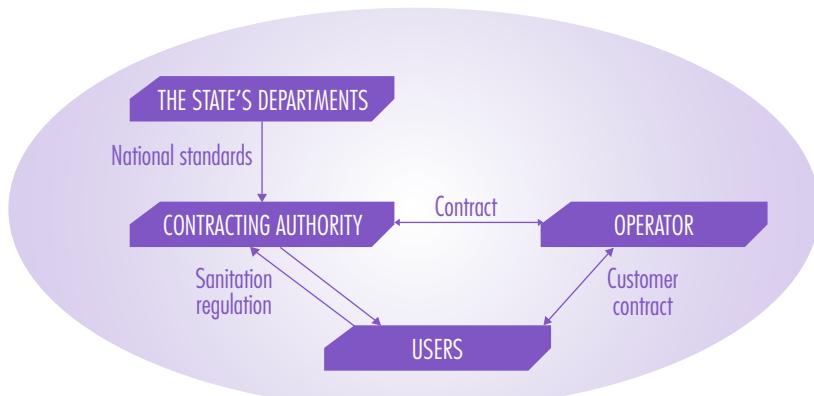
• The contract between the users and the operator

The customer contract sets out the rights and obligations of the service users and the operator, notably as regards pricing and payment methods and the process to be followed by users needing to contact the operator in the event of any issues.

It also reminds users of the conditions and rules to be observed, such as good practices and domestic plumbing installation maintenance responsibilities, and also outlines the possible sanctions to be enforced in the event of a breach of contract.

ILLUSTRATION 20

The standards and contracts that set out the sanitation service framework



During the operational phase, adherence to this framework should be regularly monitored by the contracting authority, in conjunction with all stakeholders, if possible. In all the examples studied in Africa, Latin America and Asia, sus-

tainability of the services is being threatened by the lack of both a clear division of responsibilities and a documented framework formalizing service operation.

ACTIVITY 2.3.

Define a service promotion and user awareness-raising strategy

As with all public network services, sustainability of the non-conventional sewerage service can only be guaranteed if it has a sufficient amount of users.

The more customers who use the service, the greater the revenue received, which enables financial stability to be achieved and sustained. It is thus vital to promote the service provided through non-conventional sewerage to encourage (ideally all) the households within the service area to commit to using the service.

Non-conventional sewers are particularly vulnerable to poor user practices. The small diameter of the pipes means they can easily become blocked by solid waste, with adverse consequences for all those users living upstream of the blockage.

The risk associated with this type of practice alone is reason enough to carry out active awareness-raising with users to ensure their actions do not negatively impact the service with which they are provided.

What does service promotion and awareness-raising involve?

- Awareness-raising activities aim to ensure users adopt appropriate hygiene and sanitation practices and use the non-conventional sewerage service correctly.
- Service promotion activities aim to attract new customers, encouraging them to connect to the sewer and use the service. These activities are carried out to increase the number of customers both when the service is launched and on an ongoing basis.

User behavior and demand are contingent on factors and motivations that are difficult to assess. When designing a service promotion and awareness-raising strategy, it is important to involve specialists who are both familiar with the local context and experts in communication (specialist NGOs, advertising and marketing firms, etc.). It is also a good idea to involve the facilitators and interviewers who worked on the preliminary diagnostic and feasibility study.

Developing a service promotion and awareness-raising strategy¹

Whether the aim is to promote the service or raise awareness, the strategy development process should center on three main questions:

- what are the intended objectives of the strategy?
- what messages are to be communicated?
- how are these messages to be communicated?

• The strategy objectives

Prior to designing any of the promotion or awareness-raising activities, it is important to clearly and precisely define the required outcomes as regards:

- **changes in practices.** The objectives will be both qualitative (discontinuing unsafe practices) and quantitative (increase in the number of users employing appropriate practices over time).
- **uptake of the service.** These objectives will be predominantly quantitative (the number of households connected and the increase in this figure over time).

It is often useful to have a sound understanding of the baseline situation in the area concerned to ensure the objectives set are realistic. The diagnostic will contain the information required, including the responses to the following questions:

- which and how many people use unsafe practices (that create health risks or risk damaging the sewer)?

– how interested are people getting a connection to the sewer? If there is considerable interest, then the promotion activities can be scaled back (at least in some instances; however, the diagnostic itself can generate bias, thus the interest expressed needs to be confirmed).

Based on a review of numerous field experiences, as a minimum, the promotion and awareness-raising objectives should ensure that users:

- adopt good hygiene practices (handwashing, installing sanitation facilities, disposing of wastewater using the appropriate facilities, etc.);
- use their domestic sanitation facilities for wastewater only (and not for the disposal of solid or toxic waste, etc.);
- maintain their domestic sanitation facilities;
- pay for a connection to the sewer;
- regularly pay to use the service.

• Key messages

The aim of promotion and awareness-raising activities is to influence people's willingness to adopt appropriate behaviors. Thus, communication is very important, as is the content of the messages delivered. People are not always prepared to adopt the same behavior for the same reasons; developing an understanding of individual motivation is therefore essential.

If it has been carried out correctly, as well as providing social and cultural definitions of sanitation and hygiene, the diagnostic should also have identified inhabitants' motivations for adopting new practices.

1. See Désille D. & al., 2013, *Concevoir et mettre en œuvre une stratégie de sensibilisation à l'hygiène et de promotion de l'assainissement*, pS-Eau.

BOX 9

User motivations for connecting to a non-conventional sewerage service

- To have a modern service "like the rich" or "developed countries" (this reason is given in nearly all cases);
 - To save on pit emptying costs (one of the main reasons given in Senegal);
 - To have a cleaner house and thus be able to invite the family-in-law and arrange the daughter's marriage (one of the main reasons given in Pakistan);
 - Improve the state of the street and reduce neighbourhood disputes (one of the main reasons given in Mali);
- Health and hygiene-related issues were not instinctively mentioned as being of concern!**

The messages should be designed around these motivations as, as levers of change, they are likely to have the greatest influence on all the target groups identified. These levers of change will vary in accordance with the objectives, which can be health-related (safeguard young children's health), social (social conformity, prestige), economic (minimize the income lost through ill-health), or religious (notion of physical and spiritual purity).

The methods used to finance connection to the non-conventional sewer will have an impact on

all or part of the messages developed. Communication for a strategy of partially subsidized connections will differ from that in which households are required to pay the full connection cost themselves.

Once the most relevant messages have been identified, it is important to make sure that they are easy to understand. It should also be ensured that the behavior change required is simple to adopt and does not require users to learn new complex practices that will complicate their daily lives. Users need to feel that changing their behavior is more advantageous than not changing anything at all.

• Message communication aids

There is a wide range of tools and methods available for carrying out promotion and awareness-raising activities. Although there has been an upsurge in the use of marketing approaches over the last few years, the more traditional, participatory approaches remain highly popular with project designers and managers.

The activities implemented in the field frequently involve a combination of interpersonal communication (small user groups, house-to-house campaigns) and mass communication (radio, press, etc.). There is no 'one size fits all' promotion and awareness-raising package. The approach used will depend on the context and on the skills and competencies available. It is important to bear in mind that effective communication requires specific skills, thus it is advisable to assign this task to experienced professionals.

ACTIVITY 2.4.

Finance the investment

Establish the provisional investment budget

In order to calculate the investment budget, it will be necessary to draw up a comprehensive list of all expenditure items associated with non-conventional sewerage construction (see Table 14 on the following page). The cost of each item then needs to be estimated using information obtained from similar projects in the region and estimates provided by the construction project supervisor.

In addition to the infrastructure costs (hard components), the budget should also include all the soft activities, such as studies, social support measures and monitoring.

It is also important to bear in mind that developing non-conventional sewerage services in Africa costs between 500 and 1,500 euros per household connected.

There are a number of factors that can influence the overall cost of non-conventional sewerage:

- the characteristics of the site (rocks or infiltration) can cause complications during the construction phase or require costly technical solutions (lift pumps);
- the skill level and knowledge of those involved in the project (consultancy firms, construction companies);

– the emphasis placed on soft activities.

It is important never to omit the soft activities in an effort to reduce costs as these are vital for ensuring the satisfactory operation of the future service.

Identify and raise the financial resources required

From the demand assessment and within the sanitation strategy, it was determined that the non-conventional sewerage service was an appropriate option given the resources available.

This list of available resources now needs to be refined further:

- The municipality's (or local authority's) own resources

These resources come from the municipal budget, which is funded by local tax revenue and/or a government grant. Some local authorities (those that are well-off or cover cities) may be able to obtain a loan from a development bank.

It is important to ensure that this finance is actually available. To avoid any unpleasant surprises, each specific budget heading needs to be voted into the municipal budget or guaranteed through written and binding commitments.

TABLE 14

Main expenditure items and indicative breakdown of costs for a non-conventional sewerage service project

ACTIVITIES	TO WHAT DO THESE COSTS CORRESPOND?	PERCENTAGE OF THE TOTAL	COSTS EXPRESSED IN:
SOFT (30 TO 50%)			
Project management and contracting authority assistance	Mainly the human resources assigned by the contracting authority and technical partners to undertake project management tasks	5 to 10%	Working days
Technical supervision of the design phase	Mainly the human resources assigned by the consultancy firm(s) to carry out feasibility studies and detailed technical studies	5 to 10%	Working days
Technical supervision of the construction phase	Mainly the human resources assigned by the construction project supervisor to monitor the construction work	10 to 15%	Working days
Awareness-raising and promotion	Mainly the human resources assigned by the service providers to design and deliver promotion and awareness-raising activities, to which the cost of developing and disseminating communication aids also needs to be added	5 to 10%	Working days + service providers' fees for developing and disseminating the various communication aids
Capacity-building	Mainly the human resources assigned by the service providers responsible for capacity-building	5 to 10%	Working days
HARD (50 to 70%)			
Domestic facilities & plumbing installations	Appropriate household sanitation facilities: shower, toilet, sink, grease trap, domestic inspection chamber	0% (if households already have these installed) to 10%	Unit cost for each type of facility
Settling tanks	Only required for settled sewerage. Can be individual or shared	0% (if households have septic tanks) to 10%	Unit cost for each type of tank

ACTIVITIES	TO WHAT DO THESE COSTS CORRESPOND?	PERCENTAGE OF THE TOTAL	COSTS EXPRESSED IN:
HARD (50 to 70%)			
Connections	Earth-moving, materials and installing the connections	1 to 5%	Cost per connection
Sewer system	Earth-moving, materials, pipe-laying and installing manholes Road construction or rehabilitation	30 to 50%	Cost per meter Cost per manhole
Lift station(s)	Earth-moving, parts and materials, construction and installation	Up to 25%	Fixed price
Wastewater Treatment Plant	Earth-moving, materials and construction of the wastewater treatment plant	Up to 25%	Fixed price
Maintenance equipment	Manual cleaning tools, hydro-cleansing tanker, etc.	5 to 10%	Fixed price
Land	Acquisition of land for the wastewater treatment plant and/or lift station(s)	Varies depending on the area	Cost of a m ²
CONTINGENCY			
Include contingency of 5 to 15% to cover any difficulties encountered during the implementation phase, to compensate residents or carry out additional soft activities.			

• State subsidy

This is usually made available through major sanitation sector investment programs (often financed through a development bank loan). Applications for this subsidy can be submitted by the contracting authority (local authority or public sanitation operator).

• Development partner support

Issued by a development cooperation agency or NGO, this grant can be financial (in the form of a grant or loan) or practical, such as materials or technical assistance (whereby specialists provide free expertise).

- User contribution

As a general rule, the users cover part of the cost of their household sanitation facilities and sewer connections, but rarely all of the cost, at least not in Africa. In some parts of Asia, however, where construction costs are particularly low, the users' contribution sometimes covers the entire investment cost of both the sewer and the wastewater treatment plant.

- The future operator

A private operator can invest in the project by providing 'moveable' assets (usually in the form of tools), which will remain their property in the event of termination of contract. These assets can include maintenance tools, the electricity generator for the lift station, IT equipment, etc.

ACTIVITY 2.5.

Define the provisional operating budget

List all future operating costs

In order to accurately calculate the costs to be recovered, it is necessary to list all expenditure items along with their corresponding amounts (see Table 15 on the following page).

Identify sustainable resources to finance operations

Once all the costs to be recovered have been clearly listed, the next stage involves identifying the corresponding sources of financing (see Table 16, p.75).

The sanitation fee, paid each month by the users (or customers) connected to the non-conventional

sewer, is one of the main sources of financing and also the most sustainable, as payment of the fee is a condition of the customer contract. Ideally, the revenue received from this fee will cover all of the service costs.

However, the price at which this fee is set is a compromise between the need to finance the service and the households' capacity or willingness to pay. Thus, additional resources will need to be obtained, notably through subsidies from the public authorities, to introduce cross-subsidies between richer and poorer users.

Additional grants from the public authorities are often also necessary to renew all or part of the infrastructure or cover the cost of any major unforeseen event (such as a natural disaster causing serious damage to the system and equipment).

TABLE 15

Indicative breakdown of the various expenditure items involved in operating a non-conventional sewerage service

EXPENDITURE ITEM	PROPORTION OF THE TOTAL OPERATING BUDGET	EXPENDITURE MADE BY:
Checking and maintaining domestic plumbing installations (including emptying any individual settling tanks): '1st level maintenance'	Not included in the operating budget	The users
Secondary sewer line maintenance: 'second level maintenance'	10 to 15%	
Maintenance of the main sewer lines, unscheduled maintenance of the primary sewer line, maintenance of the entire system: '3rd level'	10 to 15%	
Maintenance of the wastewater treatment plant(s): '4th level'	5 to 10%	
Repairs, maintenance and power supply of any lift pumps: '4th level'	15 to 30%	
Financial and commercial operations	3 to 5%	
User relations, awareness-raising and service promotion	5 to 10%	
Depreciation of maintenance equipment: hydro-cleansing tanker, vacuum truck, manual cleaning tools, etc.	3 to 5%	The operator (using sanitation fee revenue + any public funding)
Rent and operator's miscellaneous costs	3 to 5%	
Operator's employees' salaries	10 to 15%	
Operator's profit (if private operator)	5 to 10%	
Reserve for contingencies (major repairs)	3 to 5%	
Any duties and taxes	3 to 15%	
Depreciation of the infrastructure	3%	
Hygiene controls	3%	
Service monitoring and audits	5%	The contracting authority (using local tax revenue or government grant)

TABLE 16

Sources of financing to cover operating costs

SOURCE	USED TO FINANCE:
Users' own funds	First level maintenance: checking and maintenance of their domestic plumbing installations. In certain cases, notably where the operator is failing in its duties, users can club together to cover second level maintenance, i.e. maintenance of the tertiary sewer line. However, this type of mechanism only covers 'emergency' corrective maintenance and is highly dependent on the users' goodwill and organizational ability. This is thus rarely a sustainable source of financing for the service.
Sanitation fee paid by the users to the operator	Ideally, this should cover all of the service operating costs, including those in the 'wastewater treatment' segment. Where possible, the sanitation fee can also be used to cover the cost of monitoring, promotion and awareness-raising activities.
Resources from local and national tax revenue	As is the case with most conventional sewer systems, the public authorities can finance part of the operating costs for non-conventional sewerage services out of their own funds. This mechanism enables cross-subsidies between rich and poor users to be introduced. For this to be a sustainable source of financing, this funding needs to be approved through national legislation and form part of a written commitment.
Use of treated wastewater	Although this is carried out with the – laudable – aim of preserving the environment, it rarely generates enough revenue to constitute a sufficiently sizeable source of financing for the service.

How to collect the users' contributions to financing the service

There are a number of different options available:

- **Sanitation fee included on the water bill**

The sanitation fee is collected when the water bill is paid. It can also be included on a different utility bill, such as electricity, for example.

Adding the sanitation fee to the water bill, which is based on there being a direct correlation between the volumes of water consumed and wastewater discharged, is the most effective option as penalties can be imposed in the event of non-payment.

However, where water and sanitation are each managed by different operators, as is often the case in Africa, both operators need to cooperate effectively if this option is to be successful.

• Sanitation fee collected ‘house-to-house’

This collection method is common for sewers managed by an association. A sanitation fee collector, employed by the contracting authority or operator, goes round and collects the sanitation fee from the users each month. This option is only effective if each user is willing to pay for the service; however, the assumption is that ‘social pressure’ from the community will encourage those less willing to pay.

In practice, this method usually has very low collection rates (around 25 to 50% at best), regardless of the context (Asia, Africa, Latin America). In addition, this collection rate generally falls over time, and as the impact of the awareness-raising messages disseminated during the launch phase diminishes.

The sanitation fee collector nearly always lives in the area in which he works, meaning he risks becoming unpopular with his neighbors if he pursues users for payment too strongly. Furthermore, there is very rarely any means of imposing penalties on those who do not pay. Lastly, this option is costly due to the amount of time the fee collector has to spend on his rounds, particularly if he has to pay households more than one visit.

• User contributions to repair breakdowns

This is the simplest option. Users only pay a contribution if there is an emergency and they have no other choice but to ‘put their hands in their pockets’. However, this method is only generates enough financing to cover the minimum amount of maintenance. Moreover, this maintenance is never preventive and by no means ensures the sewer’s technical sustainability or enables the system to function at its optimum le-

vel. In addition, the further along the sewer the breakdown is from their house, the less inclined the user is to pay for the problem to be fixed. Users rarely voluntarily come together to finance repairs to the downstream sections of the sewer if there are problems on the main sewer line or at the treatment plant, for example. This financing mechanism is thus not recommended. It is sometimes implemented in areas where the operator is failing to uphold their contractual obligations.

Define the medium and long-term financial targets

The provisional operating budget should pursue positive financial targets: the profit generated though these positive targets will be used to finance service improvements or extension, or to replace worn-out equipment and facilities. This profit will also demonstrate to potential operators that the service is financially viable.

The business plan is a multi-year operating budget (for example, over 10 years) that allocates revenue to expenses, sets out the medium and long term investment required and establishes financial targets for the period covered by the plan.

The precarious financial stability of sanitation services can be further weakened by frequent unforeseen complications:

- a technical problem or unanticipated operating expense, which can lead to service costs going through the roof;
- a lower than anticipated connection rate, conflict between users and the operator or a lack of awareness-raising, which can result in financial resources falling to dangerously low levels.

STEP 3.

Construct
the non-conventional
sewer service

The construction phase involves selecting the works contractors (Activity 3.1) and building the infrastructure (Activity 3.4). However, it also includes ‘soft’ activities that are vital for ensuring the sustainability of the future service: stakeholder capacity-building (activity 3.2), user awareness-raising and service promotion (Activities 3.3 and 3.5).

Documents produced at the end of this step

1 Technical documents

- tender selection criteria;
- procedures manual;
- start-work orders;
- construction site log book;
- minutes of weekly construction site meetings;
- sign-off documents;
- as-built drawings.

2 Capacity-building documents

- capacity-building strategy/plan outline;
- training material.

3 Contractor and service provider contracts

- between the contracting authority and the works contractor(s);
- between the contracting authority and awareness-raising and promotion service provider(s);
- between the contracting authority and the capacity-building service provider(s).

4 Awareness-raising and promotion document

- communication aids; user manual.

BOX 10

Activities to be undertaken during the non-conventional sewerage service construction stage



ACTIVITY 3.1.

Select the contractors

The contractor selection process is prepared by the construction project supervisor in conjunction with, and on behalf of, the contracting authority. The skills and resources required of the works contractors will vary and, in most countries, there will be a number of potential candidates. It is thus recommended to conduct a tender process, as these are high-value contracts that amount to between 50 and 57% of the total budget.

The exact procedure and process to be followed will depend on the national regulatory framework in place for public procurement.

The main tasks to be carried out by the contractor selection commission involve:

- preparing the tender documents;
- receiving the bids;
- opening and assessing the bids.

ACTIVITY 3.2.

Build the capacities of service stakeholders

The sustainability of the future service depends on this activity, thus by no means should it be overlooked. However, in most non-conventional sewerage projects, capacity-building is not given sufficient importance and is too often used as a variable for adjustment to compensate for delays and overspend on other activities (particularly infrastructure construction).

The objectives and how to meet them

In order to define the capacity-building objectives, it is first necessary to:

- gain a detailed understanding of the role of each stakeholder during the operational phase, draw up the list of tasks to be carried out and identify the corresponding skills and competencies that each stakeholder will need to possess;

- identify the internal and/or external expertise available for training the stakeholders concerned;
- in conjunction with the experts appointed, develop a capacity-building plan that includes the objectives to be met by each stakeholder, the activities to be carried out, the time required for each activity and an activity timetable;
- define how to verify and evaluate the extent to which these capacities have been improved.

What type of capacity-building activity should be carried out?

The process should begin by reviewing the project and the non-conventional sewerage service financial, social and technical sustainability requirements with each stakeholder.

However, it is not enough to organize activities such as formal presentations given by 'experts' at this point. Instead, stakeholders must be presented with different scenarios based on actual situations they may encounter. For example:

- for the contracting authority: what to do in the event that the operator fails to uphold their contract or users repeatedly misuse or damage the sewers, etc.

- for the operator: what to do if users refuse to pay or if there is a leak on the system, etc.

It is also possible to set up group role-playing exercises, involving the contracting authority and the operator for example, to build familiarity and develop mutual trust with a view to preventing misunderstandings or conflict in the future.

Where possible, it is always useful for stakeholders to carry out field visits and visits to other non-conventional sewerage services, which could lead to regular meetings and sharing of best practice with their counterparts.

Who should deliver capacity-building?

Capacity-building can be delivered by training centers, consultancy firms, NGOs, or public or private operators with experience of managing non-conventional sewerage services.

It would also be possible to draw on the experience of small-piped water scheme operators, as these are found in most countries and certain aspects of their work are similar to those of a non-conventional sewerage service operator.

ACTIVITY 3.3.

Involve and raise the awareness of users

A few months have now passed since the end of the demand assessment and users' motivation for improving the service may have waned. In addition, it is important to anticipate and inform local residents of any disruption that may arise during the construction work that may otherwise cause conflict, leading to delays and increasing costs.

It is thus vital that, throughout this phase, the facilitators in charge of awareness-raising and promotion work closely with the infrastructure construction teams to ensure a good relationship is maintained with residents and future users.

Project kick-off meeting

This should be attended by the households, the contracting authority (elected officials, managers and technical departments) and the various contractors and service providers.

If the project covers a very large area, it may be advisable to sub-divide this into smaller areas and hold a meeting in each one to ensure everyone is able to have their say. It is important to ensure there is an acceptable attendance rate, i.e. at least 50% of all households. Neighbourhood association representatives or traditional, religious or political authorities can be called upon to ensure residents attend. The meeting should be led by an awareness-raising and service promotion expert familiar with the area and its inhabitants.

The meeting agenda should be as follows:

- **Review of sanitation in general and of non-conventional sewerage services in particular**

The meeting will start by highlighting a number of important points:

- a reminder of the benefits of improved sanitation;
- the necessary involvement of all stakeholders, including the households, under the maxim: "for them and with them";
- a reminder of the option selected by the households: the non-conventional sewerage service; its advantages, disadvantages and user costs.

The communication tools – posters, models and other demonstration materials – should then be presented. It would also be possible to ask residents of other areas already using non-conventional sewerage services to provide testimonies or to arrange group visits to plots that already have a sewer connection.

- **Introduction to the project team**

The members of the project team are introduced to the households: the construction team, the awareness-raising team, the construction project supervisor and the operator. The users are encouraged to make these teams feel welcome when they are working in the neighborhood over the coming months.

It is important that the residents recognize the awareness-raising team, understand their role and know where to find them as this team will be households' main contact up to the time the service is launched.

• Outline the next key steps

The project timetable and implementation procedures are presented to the attendees:

- the construction/installation of domestic facilities (where this is included in the project);
- excavation works, earth-moving and pipe-laying: how these will be carried out, any household involvement required, the inevitable disruption for local residents and the compensation or mitigation measures to be put in place, etc.;
- technicians' visits to households to check household facilities, plumbing installations and the connection to the sewer;
- the sewer connection payment: price, payment methods, who to contact to request a connection.

• Review the role of the service users during the operational phase

During the demand assessment phase, residents were informed of the household sanitation facility maintenance requirements, but these were not explained in detail (a detailed explanation will be given during the visit to install the connection).

Thus, at this stage, it is necessary to remind households of their responsibilities as service users and all the tasks they need to carry out of during the operational phase: the monitoring

and maintenance of their plumbing installations, payment of the sanitation fee and proper use of all facilities and equipment.

These obligations should also be included in local sanitation regulations and the customer contract.

• Approve the sewer route and layout

The planned sewer layout is presented to all stakeholders to ensure there are no objections. Sewer construction can sometimes be held up by residents refusing to allow the sewer to pass near a place of worship, for example, or objecting to the construction of a wastewater treatment plant. It is thus necessary to anticipate all potential objections at this stage. Should there be any opposition to the layout, it is still possible to find an alternative route for the section of the sewer concerned or negotiate with the residents raising the objection.

If there are any sections of the sewer that pass over private land, it will also be necessary to obtain written authorization from each of the landowners concerned.

• Identify representatives

Residents will select representatives to act as a central point of contact for the project team, so they can keep households informed of forthcoming activities. If there is already a users' association or neighborhood committee in the area, these are obvious candidates to take on this liaison role for the non-conventional sewerage service project.

ACTIVITY 3.4.

Build the infrastructure

Prepare the construction work

- **The provisional construction work timetable**

This should adhere to the timeframes set out in the contract and be endorsed by the contracting authority and construction project supervisor.

- **Notification of work to other service operators**

Notification should be provided to all other service operators with networks in the area: water, telephone, electricity, etc. In return, these operators should provide plans of their networks and any other useful information to enable precautions to be taken to prevent damage to these networks during the trench-digging phase.

Should the sewer route pass under roads, the roads department will grant authorization to dig up the necessary road sections. Once the pipes have been laid and the trenches refilled, the roads should be repaired and returned to their original state.

- **The service order to start the construction work**

The service order, which is prepared by the construction project supervisor and signed by the contracting authority, triggers the start of the construction work.

Construct the wastewater treatment plant

The work usually starts with construction of the wastewater treatment plant as this is located at the lowest point of the system and takes the longest time to build. Water tightness tests are carried out on the plant once construction has been completed.

Treatment quality can be tested by opening up the sewer once the initial connections have been installed. However, it is to be noted that a wastewater treatment plant only starts operating at optimum efficiency after several months, the time required for some of the biological treatment processes to take place.

Construct the sewer

Sewer construction begins with the downstream section and work then proceeds upstream.

- **The procurement and storage of pipes and manholes**

The construction company orders the necessary items from their suppliers and stores them in a secure location to prevent damage and theft.

PVC pipes (the most commonly used type) must be stored out of direct sunlight to prevent heat damage.

For locally made pipes (notably those made of clay as used on some sewers in India), it will be necessary to factor in the manufacturing time and carry out quality checks.

• Trench-digging

Following the plan of the sewer system drawn up during the detailed study phase, the sewer route is marked out using stakes placed 10 to 15m apart.

The trenches can then be dug manually using spades and shovels, as non-conventional sewer pipes are usually laid at shallow depths. However, if a road needs to be dug up or pipes laid under rocky ground, a jackhammer will need to be used.

On the downstream sections of some sewers, where it is necessary to 'create' a slope, the trenches can reach depths of several meters. This will thus involve major excavation work and require the use of heavy machinery and shutting to prevent the trenches collapsing.

Where there is a near-surface water table (or, in coastal areas, seawater intrusion through capillary action), there is a risk the trenches will flood, or even collapse if the soil is very soft, particularly if these trenches are (over 1m) deep. It may thus be necessary to shutter the sides of the trench and lower the groundwater table by pumping water out. The cost of this work will need to be taken into account during the design phase.

In all cases, the slope at the bottom of the trench needs to be accurately measured.

• Laying pipes and installing manholes

The first step of this task involves placing the manholes at each end of the section of sewer pipe to be installed and checking they are at exactly the right depth. A bed of sand (5 to 10cm deep) is then placed in the trench to help ensure the slope of the pipe is accurate and provide stability to the buried pipework.

Pipes are joined together using a simple joint or seal. There needs to be some natural flexibility in the joint to enable the sewer to tolerate ground movement without cracking.

The joints between the pipework and the manholes are made out of cement-based mortar.

• Quality control of the sewer system

Prior to backfilling, the pipes must be carefully checked to ensure that the slope is correct and the joints are watertight. This is tested by filling a section of the sewer with water, after having closed the manholes and the section's downstream outlet.

• Backfilling the trenches

Once the quality of the pipe-laying and manhole installation has been checked, the trenches can be filled in.

To prevent settling and subsidence, or damage to the pipes, the backfill must be properly compacted. It is thus recommended to lay the backfill in successive 20cm layers, each of which should be firmly packed down before the next layer is added.

Colored plastic film should be placed in the backfill, a few decimeters above the pipes, as

a marker and to prevent work on other networks causing damage to the pipes.

• Creating as-built drawings

The aim of as-built drawings is to mark out the exact location of each part of the sewer. This can sometimes be quite different to the initial construction work plan as unforeseen obstacles, for example, could have forced the contractor into making changes (with the approval of the contracting authority and following consultation with the design project supervisor).

The as-built drawings should be safely stored in several locations, in both paper and digital format. The contracting authority and operator will be given several copies. These drawings are vital tools for operating and monitoring the sewer. However, during our review of non-conventional sewerage services around the world, the as-built drawings for many of the systems studied appeared to be missing.

• Clearing and rehabilitating the site

Once the construction work has been completed, work should begin to clear and return the site to its original condition.

Monitoring of the work by the construction project supervisor

The construction project supervisor is responsible for the quality of the work and for meeting deadlines. They should thus be on-site for all key stages of the construction process and pay close attention to the work being carried out.

The construction project supervisor role is not limited to inspection, however. They also have an important part to play in works contractors capacity-building by providing ongoing back-up support.

• Monitoring documents

The construction project supervisor has a number of tools at their disposal to ensure the quality targets set by the contracting authority are achieved and all deadlines are met:

- daily construction site monitoring records that list all key points and events and review the progress made. These records are collated into the construction site log book;
- the minutes of the weekly construction site meetings, during which the teams discuss the progress made over the previous week, analyze any problems and plan the week ahead. In addition to the contractor staff (site manager, team leaders and construction project supervisor), the contracting authority may also attend these meetings;
- the procedures manual(s) that provide the contractor with clear information on the steps to be undertaken and the resources required.

The risks and how to anticipate these

During this construction phase, it is important to avoid damaging other networks. This can occur if the contractor fails to take sufficient notice of their location or the as-built drawings of these networks are unavailable or inaccurate.

The most commonly encountered risk is miscalculation of the slope, meaning wastewater does not flow properly through the pipes. It is also common to find that there is not enough difference in depth between the sewer and the point of connection to domestic plumbing installations, or even that the connection points are lower than the level of the sewer. Here again, these issues, which should have been anticipated during the design phase, are caused by a lack of precision when verifying pipe-laying and manhole installation during construction.

Other obstacles to be anticipated include unexpected water infiltration or hidden rocks, both a common cause of delays and increased costs. Sometimes, these will require slightly modifying the sewer route. Money should be set aside in the investment budget to address these contingencies.

Earth-moving work can sometimes cause ground movement that damages local houses, particularly those in informal settlements that are poorly built and have shallow foundations and are constructed on unstable land. A budget allocation for compensation (included under the 'contingencies' heading in the investment budget, for example) can be used to compensate for any damage.

The construction work will inevitably cause disruption to residents and in public areas, both

due to noise and disruption to traffic. The work carried out prior to the start of construction to inform the public of this disruption should be continued throughout the construction phase, particularly if there are complaints received or conflict with residents. This task is to be carried out by the facilitators who are out in the field on a daily basis.

The land status issues mentioned previously are relatively common and can mean ownership rights of the land required either for construction of the wastewater treatment plant or for laying the sewer lines will need to be clarified. Thus, prior to starting the construction work, it is important to have all the necessary authorizations in place, verify the validity of the land titles for the land to be used and carry out extensive consultation with residents in the area (see Activity 3 of this step).

Other frequent problems encountered are due to lack of competencies on the part of the contractor and include substandard workmanship, delays, work that is not completed or non-compliant, etc. This is why particular care must be taken when selecting both the construction company and construction project supervisor.

Acceptance of completed work

During the acceptance of completed work phase, the contracting authority conditionally or unconditionally approves the infrastructure by confirming that the work has been properly carried out and undertaken in conformity with the final contract.

ACTIVITY 3.5

Connect the users and launch the service

Connecting the households

- Should connection be optional or mandatory?

The most commonly used option involves making connection to the sewer and, thus, use of the sanitation service, optional. If there is a high quality service, sufficient awareness-raising and appropriate pricing, the demand for connections can reach 100% after a few years of operation.

If the number of connections remains low, it will be necessary to ascertain the reasons for this: are the prices too high or is the quality too low? Are there other, cheaper yet satisfactory solutions available? Does the operator lack the motivation required to develop the service? Solutions will then need to be sought for overcoming these constraints.

Some contracting authorities systematically connect all households. This maximizes the environmental and public health impacts of the project, reduces the unit costs of connections and ensures there is enough wastewater discharged for the sewer to function correctly. In areas of very high demand, implementing this approach should not be a problem.

Regardless of the approach selected, it will often be necessary to subsidize part of the connection cost, particularly for the poorest households.

In some cases, the contracting authority can make connection mandatory for all households that could potentially be connected to the sewer. This is notably the situation in Brazil (although there is some flexibility in the application of this rule) and in France for connections to conventional sewerage.

- Signature of the customer contract and payment of part of the connection cost

The user pays part or all of their contribution to the connection cost upon signing the customer contract. This payment must be collected before the connection is installed as it may later prove difficult to get some of the households to pay once they have already been connected. In most cases, this contribution will cover only part of the connection cost, with the remainder being paid in installments (see Box 11: Financing mechanism options for household connections).

There may be an initial wave of contract signatures following the project kick-off meeting, and people may also approach the operator. House-to-house canvassing by someone working on behalf of the operator can also be used to increase the number of customers. Marketing of the sanitation service should be continued throughout the operational phase.

BOX 11

Financing mechanism options for household connections

- A ‘one-off’ contribution: the household pays the entire cost of the connection upon signature of the customer contract.
- Payment in installments: the household pays their contribution directly to the operator (who transfers it to the contracting authority) in installments - over a period of 36 months, for example - at the same time as they pay their monthly sanitation fee (which covers operating costs over the lifespan of the service).
- Microcredit: the household pays their connection fee in a lump sum using a loan obtained from a micro-finance institution. The household then pays off the loan and interest rate payments in installments.
- Subsidy: the contracting authority (or one of their partners) subsidizes all or part of the connection cost by disbursing the subsidy to the provider in charge of installing the connections or to the operator, who passes this on by reducing the connection cost paid by the household. In Africa, nearly all connections for poor households are (at least) partially subsidized.
- Output-Based Aid: this is a specific type of subsidy. The operator canvasses households to find new customers and the contracting authority disburses the corresponding subsidy for each connection once 10 to 20 connections have been installed and the quality of the work has been verified. The advantage of this solution is that it provides the operator with an incentive for increasing the number of connections and requires them to install connections of good quality. However, the operator does need to have the financial capacity to cover the cost of the work upfront.
- Payment in kind: the poorest households can also pay all or part of their contribution to the connection cost ‘in kind’ by helping with earth-moving work or providing materials.

• Checking household plumbing installations

If household facilities and plumbing are not installed by a provider under contract with the contracting authority but by the users themselves, the construction project supervisor must first check that these plumbing installations conform to the established guidelines and can

be connected to the sewer. Where this is not the case, the construction project supervisor can require them to be brought up to standard or refuse to install the connection.

- **The connection**

The connection is installed, either by the construction company contracted to build the sewer or by a provider under contract with the household, to the standards established by the contracting authority, who will carry out quality controls. Once the sewer is operational, households will submit requests for new connections to the operator, who will either install the connection or carry out quality controls on those connections outsourced to a different provider.

Raise households' awareness of how the sanitation service operates

During installation of the household connection, it is recommended to remind the inhabitants of the rules to be respected: checking and maintenance of domestic plumbing installations and all facilities (and particularly the fact that it is

forbidden to pour stormwater down the manholes); and payment of the sanitation fee, etc. However, it is also an opportunity to provide the user with the operator's customer relations department's contact details and the specific number to call in the event of a problem.

Launch the sanitation service

The service is launched once the sewer is already operational. This is an important and symbolic step that reinforces the households' sense of ownership of the service. It is also an opportunity to initiate a new marketing phase by collecting testimonies from the new users of the sewer on the benefits of using the service, for example.

STEP 4.

Manage the non-conventional sewage service

Once the non-conventional sewer has been put into commission, it is important to ensure it remains operational over the long-term by carrying out proper maintenance (Activity 4.1), financially managing the service to ensure its financial stability (Activity 4.2) and continuing to take the users' expectations and requirements into account (Activity 4.3).

Regular monitoring and auditing of the service are vital for ensuring that each stakeholder is assuming their responsibilities and meeting their objectives (Activity 4.4).

Lastly, it is often useful to continue providing advice and capacity-building support during the first few years of service operation (Activity 4.5).

Documents produced at the end of this step

1 Maintenance documents

- maintenance manual;
- activity reports;
- activity log.

2 Accounting documents

- general journal, which lists all financial transactions;
- general ledger;
- customer file;
- payment records and payment receipt booklet.

3 Service monitoring and auditing documents

- service monitoring reports;
- reports on decisions taken following sanitation service audits.

BOX 12

Activities to be undertaken to properly manage the service

Activity 4.1

Carry out maintenance on service infrastructure and equipment

Activity 4.2

Undertake financial management of the service

Activity 4.3

Manage user relations

Activity 4.4

Monitor and audit the quality of the service

Activity 4.5

Support service operation over the first few years

ACTIVITY 4.1.

Carry out maintenance on service infrastructure and equipment

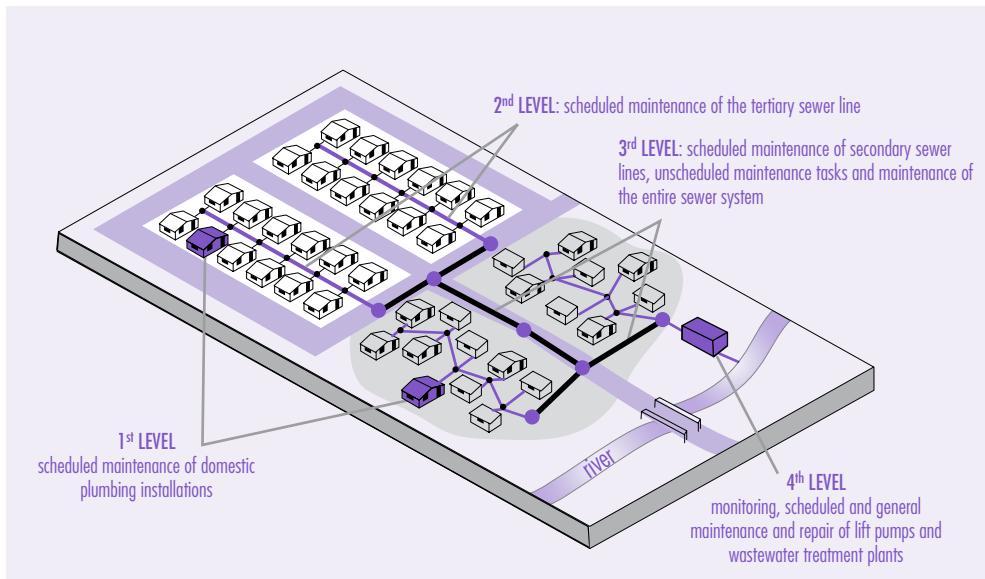
Maintenance includes both scheduled maintenance, which involves performing routine tasks to keep infrastructure and equipment, etc. operational, and general maintenance and repairs that consists of carrying out activities to restore equipment and plumbing installations, etc. to working order, such as following a breakdown, for example, or replacing worn out parts.

What maintenance tasks should be carried out, how often and using which tools?

The diagram below shows the four levels of maintenance required for non-conventional sewerage, ranked in accordance with the complexity of the tasks to be carried out and the skills and equipment required.

ILLUSTRATION 21

The four levels of non-conventional sewerage maintenance



- **First level:** the monitoring, scheduled maintenance and repair and maintenance of domestic plumbing installations

The households are responsible for the scheduled maintenance of domestic plumbing installations. There are no specific tools required as this simply involves inspecting the wastewater disposal facilities on the plot (sink, utility sink, showers, toilet and any screen filter, grease trap, settling tank or junction chamber) on a weekly basis, cleaning them and removing any blockages. If households are unwilling to carry out these tasks themselves, they can hire an independent maintenance operative.

If there is an individual settling tank on the plot, the household must monitor the sludge levels and remove this sludge before it overflows into the sewer. If the level of sludge is high, the settling tank will need to be emptied by a pit emptier.

To ensure households are not being negligent and allowing sludge from the settling tank to flow into the sewer (which would seriously impede its operation), the operator should undertake regular inspection visits to each plot (every six-months). These visits can also be used to remind households of good scheduled maintenance practices, help them ensure their facilities are working effectively and respond to any questions and concerns they may have (see Activity 4.3 of this step on operator and user relations).

Should a household (repeatedly) fail to comply with the rules, the operator should contact a neighborhood representative to attempt mediation. If this is unsuccessful, the household can be reported to the public authorities (the municipal

hygiene and sanitation department, where this exists) and sanctions imposed (see Activity 4.4 of this step).

For heavier maintenance or repairs, the household can call on the services of the operator, who will bill the household for the repairs as the plumbing installations are on private property. If the household would prefer to use a different maintenance operative, then this operative would need to follow the operator's recommendations.

- **Second level:** scheduled maintenance of the tertiary sewer line

The service operator is responsible for carrying out this level of scheduled maintenance (except in some, seldom successful, cases where households have been put in charge of these tasks).

Tasks involve regular visual (surface) inspections of the sewer or, for the better equipped operators (as in Brazil), sewer inspections using cameras or other sophisticated inspection devices.

Preventive cleaning of pipes and manholes inhibits the buildup of solid waste and sediment and minor blockages. These tasks can be carried out using hand tools (picks, flexible rods, cleaning balls). However, mechanical equipment, such as high-pressure sewer cleaning equipment, is generally more effective.

Lastly, if there are any shared settling tanks connected to the sewer system, the operator is in charge of regularly checking sludge levels and determining when the tanks need to be emptied (at least once a month).

ILLUSTRATION 22

Hand tools used by the private operator to clean the tertiary sewer lines in Ramagundam, India



pSFau

- **Third level:** scheduled maintenance of secondary sewer lines, unscheduled maintenance and maintenance of the entire sewer system

Not all non-conventional sewers have secondary sewer lines. However, for those non-conventional sewers that do, these secondary sewer lines require the same type of inspection and maintenance as the tertiary sewer lines, albeit using heavier equipment capable of cleaning larger-diameter pipes and removing larger blockages.

The blockages that frequently clog the tertiary sewer lines are impossible to remove using light equipment.

Thus, the only option is to use equipment designed for larger-diameter pipes, for example high-pressure hydro-cleansing tankers.

The most frequent maintenance task, on both tertiary and secondary sewer lines, involves replacing broken manhole covers that have either been driven over by vehicles or improperly handled or replacing those that have been stolen (a common occurrence in areas where the manhole covers are made of cast iron).

As soon as a leak is detected on the (tertiary or secondary) sewer line, the damaged section needs to be dug out, the connection repaired or the broken pipe or manhole replaced. This operation will require the use of trucks (for transporting the materials), lifting equipment (for moving the materials) and sometimes digging machinery (particularly on downstream sections of the sewer where the pipes can be laid at great depths). It should be possible for the operator to hire this equipment if necessary.

The operator should also conduct visual surface inspections to locate illegal connections (it should be easy to spot where work has been carried out to install the illegal connection). The offending household is to cover the cost of any work required to bring the connection up to standard and formalize their use of the service (sign a customer contract, pay any sanitation fee arrears and a fine, etc.). In the event of any conflict, the municipal hygiene and sanitation department may impose sanctions.

- **Fourth level:** scheduled and general maintenance and repair of lift pumps and wastewater treatment plants

Wastewater treatment plants that use no electro-mechanical equipment should nonetheless be inspected on a regular basis and scheduled maintenance tasks carried out. Tasks include checking that there is no solid waste impeding operation of the plant and regularly emptying the compartments of intensive wastewater treatment plants (using vacuum trucks and manual cleaning equipment) or waste stabilization ponds.

In the event of heavy rain, checks should be undertaken to ensure that the treatment plant does not get flooded by stormwater run-off (as this would cause serious damage to the plant and lead to severe pollution downstream). Lastly, the performance of the wastewater treatment plant should be monitored by regularly measuring the quality of the treated water discharged, with the operator forwarding the results of these quality tests to the contracting authority (see Activity 4.5 of this step).

Where there are lift stations on the non-conventional sewer, the operator should diligently monitor these to ensure they are functioning correctly (visual inspection and inspection of the control panel) and be in a position to immediately take remedial action or call on a specialist team if required. Lift pumps are fragile and costly items of equipment. Regularly ventilating this equipment using air pump systems will help prevent the formation of hydrogen sulfide (H₂S), which is corrosive and dangerous to human health.

ILLUSTRATION 23

Ventilating a lift station on a non-conventional sewer in Dakar



- **Maintenance monitoring documents**

The operator's maintenance manual, which serves as a daily maintenance guide, lists all the technical management tasks that are to be carried out on the sewer, lift stations and wastewater treatment plant.

The operator also keeps an activity log in which they list all the tasks carried out, the location, cause of the problem, type of equipment and spare part used, as well as anything that will require particular attention in the future. Regularly updating this log book makes it possible to continually monitor the 'health' of the sewer.

For instance, where frequent maintenance is required on the same section of sewer, this usually means something is broken or there is

a technical fault and so a major maintenance operation will be required. The information contained in the activity log is included in the activity report that the operator produces for the contracting authority.

Table 17 lists the maintenance tasks required for the entire sewer system, the person/entity responsible for carrying out these tasks, the tools required and the recommended frequency with which they are to be performed.

TABLE 17

Breakdown of technical monitoring and maintenance tasks

	TASK DESCRIPTION	WHO IS RESPONSIBLE FOR THIS TASK?	WHO CARRIES OUT THIS TASK?	EQUIPMENT AND TOOLS REQUIRED	FREQUENCY
	<ul style="list-style-type: none"> Deal with small blockages and leaks (plumbing) Inspect and clean the screen filter, grease trap and connection chambers 	THE USERS	The users themselves or a provider of their choice (tradesman, plumber)	Picks, brushes, plumbing tools	Weekly: inspect and clean plumbing installations
FIRST LEVEL	Settled sewerage with individual settling tanks:				
	<ul style="list-style-type: none"> Check the level of sludge in the tank and have this emptied if necessary Perform inspections and remind users of their responsibility to empty the settling tank 	THE USERS OR OPERATOR THE OPERATOR	Provider (manual or mechanical pit emptier) The operator (with the support of the municipal hygiene and sanitation	Vacuum truck or manual pit emptying tools Household inspections	Monthly inspection of sludge levels and emptying every 1 to 10 years depending on the size of the settling tank Six-monthly

	Task Description	Who is responsible for this task?	Who carries out this task?	Equipment and tools required	Frequency
SECOND LEVEL	Inspect the tertiary sewer lines	THE OPERATOR	The operator	<ul style="list-style-type: none"> • Visual surface inspection • Inspection camera and other inspection devices 	Monthly
	Clean the sewer and manhole (preventive maintenance)	THE OPERATOR	The operator (or one of their providers)	<ul style="list-style-type: none"> • Hand tools: picks, brushes, flexible rods, spades, cleaning balls • Mechanical equipment: small hydro-cleansing unit (portable or on the back of a pick-up, for example) 	Monthly
	Remove small blockages (corrective maintenance)	THE OPERATOR	The operator (or one of their providers)	<ul style="list-style-type: none"> • Hand tools: picks, brushes, flexible rods, spades, cleaning balls • Mechanical equipment: small hydro-cleansing unit (portable or on the back of a pick-up, for example) 	Whenever a blockage is detected during an inspection or during investigation of a user complaint
	Settled sewerage with shared settling tank: check the level of sludge in the tank and arrange for the sludge to be removed	THE OPERATOR	The operator (or one of their providers)	Vacuum truck	Monthly inspection

	TASK DESCRIPTION	WHO IS RESPONSIBLE FOR THIS TASK?	WHO CARRIES OUT THIS TASK?	EQUIPMENT AND TOOLS REQUIRED	FREQUENCY
THIRD LEVEL	Inspect the secondary sewer lines	THE OPERATOR	The operator	Visual (surface) inspection Inspection camera and other inspection devices	Monthly
	Clean the secondary sewer lines and manholes (preventive maintenance)	THE OPERATOR	The operator (or one of their providers)	Medium to high-pressure hydro-cleansing tanker	Monthly
	Remove major blockages on the secondary and tertiary sewer lines	THE OPERATOR	The operator (or one of their providers)	Medium to high-pressure hydro-cleansing tanker	Whenever a blockage is detected or during investigation of a user complaint
	Replace broken and cracked pipes and manholes, replace damaged or stolen manhole covers along the entire length of the sewer	THE OPERATOR	The operator or a sub-contractor (a construction company, for example)	<ul style="list-style-type: none"> • Hand or mechanical digging tools, trucks and, potentially, lifting equipment • Spare parts and equipment 	Whenever a problem is detected during an inspection or following a user complaint
	Remove or make legal illegal connections found along the length of the sewer	The operator and municipal hygiene and sanitation department	The operator and the municipal hygiene and sanitation department	Concrete for sealing off the illegal connections and fines imposed as a penalty	Whenever an illegal connection is detected

	Task Description	Who is responsible for this task?	Who carries out this task?	Equipment and tools required	Frequency
FOURTH LEVEL	Monitor the routine operation of the wastewater treatment plant: clean the screen filter and grit chamber at the plant inlet; check sludge levels; by-pass the plant if there is heavy rain; monitor the quality of the treated wastewater discharged	THE OPERATOR	The operator	Either a permanent on-site caretaker or specialist technician that carries out weekly visits Visual inspection Water quality testing tools Electro-mechanical equipment's control panels	Weekly inspection, depending on the type of treatment plant and sludge levels Monitoring the quality of the treated wastewater discharged: every six months Weekly inspection of the lift station
	Inspect the electro-mechanical equipment (if there are lift pumps) Where lift pumps are powered by a generator, check the fuel supply and consumption				
	Empty or clean the wastewater treatment plants and lift stations Ventilate the lift stations			Pumping and cleaning equipment (tanker) Air pump	Every 1 to 5 years depending on the type of wastewater plant and lift station
	Perform wastewater treatment plant maintenance	THE OPERATOR	The operator or one of their providers (company specializing in the maintenance of mechanical equipment, for example)	Specialist technicians Spare parts and equipment	Whenever there are breakdowns or aging equipment needs replacing

The most commonly encountered problems

The table below lists the technical risks and problems most commonly encountered on non-conventional sewers. The majority of these problems can be easily avoided or resolved by an appropriately skilled and vigilant operator.

TABLE 18

The main technical problems and how to prevent them

PROBLEMS OBSERVED	CAUSES & SOURCES	HOW TO PREVENT THEM
Blockages in domestic plumbing installations	<ul style="list-style-type: none"> • Failure to clean the grease trap, screen filter or connection chamber • Disposing of solid matter via the drains 	<ul style="list-style-type: none"> • Awareness-raising (during the kick-off phase then as part of user and operator relations) • Sanctions (hygiene and sanitation controls)
Sludge overflowing into the settled sewer system	<ul style="list-style-type: none"> • Failure to empty settling tanks (settled sewerage) • Illegal connections 	<ul style="list-style-type: none"> • Awareness-raising (during the kick-off phase then as part of user and operator relations) • Sanctions (hygiene and sanitation controls)
Blockages in the sewer	<ul style="list-style-type: none"> • Often caused by a build-up of sediment (sand) around plastic bags or clothes that have entered the sewer • Theft of manhole covers • Damage (vandalism) 	<ul style="list-style-type: none"> • Awareness-raising (during the kick-off phase then as part of user relations) • Sanctions (hygiene and sanitation controls) • Consultation (willful damage is often a sign of dissatisfaction with the service, which must be analyzed and dealt with)
Flooding of the sewer (which sometimes backs up into homes) and flooding of the wastewater treatment plant	Residents discharging stormwater into the sewer	<ul style="list-style-type: none"> • Awareness-raising (during the kick-off phase then as part of user relations) • Sanctions (hygiene and sanitation controls)

PROBLEMS OBSERVED	CAUSES & SOURCES	HOW TO PREVENT THEM
Difficulties accessing the sewer	<ul style="list-style-type: none"> • No right-of-way or refusal to allow the operator right-of-way • Construction or extension of private buildings on public land 	<ul style="list-style-type: none"> • Urban planning inspections • Sanctions (hygiene and sanitation and urban planning controls)
Lift station breakdowns	Lack of technical monitoring or, sometimes, lack of fuel to run them	<ul style="list-style-type: none"> • Operator capacity-building • If problems persist: sanctions or change of operator
Significant deterioration of the wastewater treatment plant's treatment capacities	Discharge of prohibited industrial waste	<ul style="list-style-type: none"> • Craftsmen and industrial users' awareness-raising (during the kick-off phase then as part of user relations) • Sanctions against the polluters (hygiene and sanitation controls)
	Lack of treatment plant maintenance (particularly cleaning and sludge removal)	Operator capacity-building or, if problems persist: sanctions or change of operator

ILLUSTRATION 24

A manhole that has been punctured to allow stormwater into the sewer in Ramagundam, India

**Controls and sanctions**

The table above shows that a number of problems are caused by improper practices on the part of service users and local residents.

To prevent, and potentially sanction, these poor practices, the operator needs to work 'hand-in-hand' with the residents' representative bodies (neighborhood committees), as well as with the municipal hygiene and sanitation and urban planning departments, which have the authority to remind users of the regulations and impose sanctions if required (hygiene and sanitation and urban planning controls).

ACTIVITY 4.2.

Undertake financial management of the service

The tasks to be carried out

There are three types of task to be carried out when undertaking financial management of the service:

- **Collect and record revenues**

The revenues to be collected and recorded by the accountant generally include:

- the **sanitation fee** from users of the service, either paid directly to the operator or transferred by the water operator if the ‘non-conventional sewerage service’ fee is included in the water bill;
- the **new users’ contribution** to the cost of their connection, which may be paid in installments;
- **any additional financial resources**, such as an operating grant from the municipality, for example.

The accountant should identify unpaid sanitation fees, issue (or request the issue of) payment reminders and then take action to recover the monies owed, if necessary.

- **Implement expenditure**

Details of expenditure required for maintenance are submitted by the sewer technicians. The procedure to then be followed depends on the amount requested:

- for small amounts that can be covered by cash on hand, the accountant approves the request;
- for larger amounts, financial approval from a designated member of the operator’s management team is required;
- for purchases over a defined financial threshold, the law or operator status (for public operators or associations) may require the use of competitive tendering procedures.

Where the sewer is operated by an association, the signature of both the association treasurer and president is required for major expenditure requests. Any ‘extraordinary’ expenditure should be discussed and approved by the association management committee.

- **Monitor the operating income**

Each month, the accountant calculates the operating income by subtracting the operating expenses from the revenue received to determine the financial health of the service. If the service has made a loss, the accountant must alert their manager and the operating team. They will then work together to ascertain the reason for this loss: poor bill recovery rate, too few connections installed, extraordinary expenditure due to technical problems, poor financial management, etc. Once the cause has been identified, the appropriate solution can be put in place: marketing to improve the connection rate, awareness-raising to explain the importance of paying the sanitation fee, etc.

Where the operating income shows a profit, the operator, in agreement with the contracting authority, may either deposit some of this income in a savings account for future infrastructure renewal or immediately spend it on extending the sewer or improving its quality.

The tools to be used

There are a number of accounting tools that the operator can use to ensure proper financial management of the service:

- cash on hand for small, recurring expenses and a cash book for recording cash income and expenditure;
- a bank account in which to deposit revenue, and from which to pay out the largest expenses;
- a journal for recording all income and expenditure by date, amount and source/purpose;
- a general ledger to check the balance of the operating account on a regular basis, present

the consolidated balance sheet for each financial year and maintain a clear overview of all expenditure items (cost accounting).

There is also a range of other tools available for monitoring collection of the sanitation fee and user relations:

- customer records that contain the names of all users, their contact details and other relevant information (such as whether their connection cost contribution payment has been received);
- payment records that list the status of each customer's sanitation fee payments ('up-to-date', 'payment owed' and the total amount owed, where applicable);
- a receipt book for issuing sanitation fee payment receipts to users. Information listed on the receipt stub is used to update the customer records.

The journal, customer records, payment records and general ledger must all be computerized and regularly backed-up in different locations.

ACTIVITY 4.3.

Manage user relations

As customers, the users are entitled to demand that the service meets their expectations, i.e. that it is of good quality, sustainable, fair and a reasonable price. In turn, the operators expect users to uphold their contractual obligations to pay their sanitation fees and respect equipment and facilities.

The non-conventional sewerage service operator must therefore work closely with the users:

- to deal with customer complaints if there is a problem with the service. The technician either advises the user to help them resolve the problem (if it is an issue with the user's own domestic plumbing installations) or carries out major repair work on the sections of the sewer under their responsibility (in the event of broken pipes or serious blockages, for example);
- to collect the sanitation fee from customers (if this is paid directly to the operator) and chase up monies owed;

**BOX 13**

The private operator's user information kiosk in the Asafo district of Kumasi (Ghana)

To manage relations with the users of the non-conventional sewerage service in the Asafo district, the private operator, Environmental Engineering Limited, has opened a user information kiosk that is open every day from 7am to 5pm. The kiosk is staffed by a multi-skilled technician, who handles user requests, collects sanitation fee payments and helps the users to resolve any problems they may have (see the photo opposite).

If a user reports a problem on the sewer, the technician will carry out an on-site diagnostic. The technician will then decide if it is something they can repair themselves or if a more qualified technician and mechanical equipment is required (a hydro-cleansing tanker to clear major blockages or the maintenance team, for instance).

The kiosk is also equipped with a telephone line. According to the operator, all requests are handled within 24 hours.

Source: Lukman Y. Salifu, WasteCare Associates

- to remind users of the proper sewer maintenance procedures and continue to carry out the awareness-raising activities initiated during the kick-off phase. These daily activities involve reiterating to users that non-conventional sewers

are not as robust as conventional sewerage and more likely to become blocked if users throw solid waste into the sewer. If poor practices continue to be observed, sanctions can be imposed on the offending customers or local residents;

- to encourage residents to apply for connections, handle new applications in a timely

manner and update the customer records (in conjunction with the accountant).

In order to fulfill their role effectively, the operator has a team of trained staff (see p.61, Activity 2.2.: Assign roles for operation of the service) and a customer contact point and telephone number.

ACTIVITY 4.4.

Monitor and audit the quality of the service

What is monitoring?

The aim of monitoring is to ensure that, from a technical, economic and social perspective, the service provided is of good quality, fair and sustainable. It also provides the transparency required of all operators running a public service.

However, this vital aspect of the service is too often overlooked by non-conventional sewerage service projects, hence their sometimes poor sustainability.

The process involves two distinct activities:

- **monitoring**, which involves monitoring the quality of the service using objective indicators;
- **auditing**, which consists of verifying whether service objectives have been met and taking corrective action, or imposing corrective action, along with sanctions if required.

What tasks are to be carried out and by whom?

There are several levels of monitoring and auditing and these are carried out at different levels and times and by different stakeholders:

- **daily monitoring by the operator** using technical, financial and social indicators (see Activities 4.1, 4.2 and 4.3). The operator reviews the results of these indicators to identify any corrective action to be taken, such as clearing a blockage, replacing a broken pipe or organizing user awareness-raising activities;
- **monitoring by the users** who report any problems to the operator, as well as directly to the contracting authority (should the operator fail to take the appropriate action);
- **auditing by the contracting authority** to ensure the required service quality and contractual

objectives are being met by the operator. The contracting authority will periodically request the operator to send them analysis reports of the technical, financial and social aspects of the service. The contracting authority can then continually or periodically review the information submitted (or have this checked by a consultancy firm or specialist government department). If the operator has failed to fulfill their obligations, the contracting authority can impose corrective action, such as sanctions or revision of the contract;

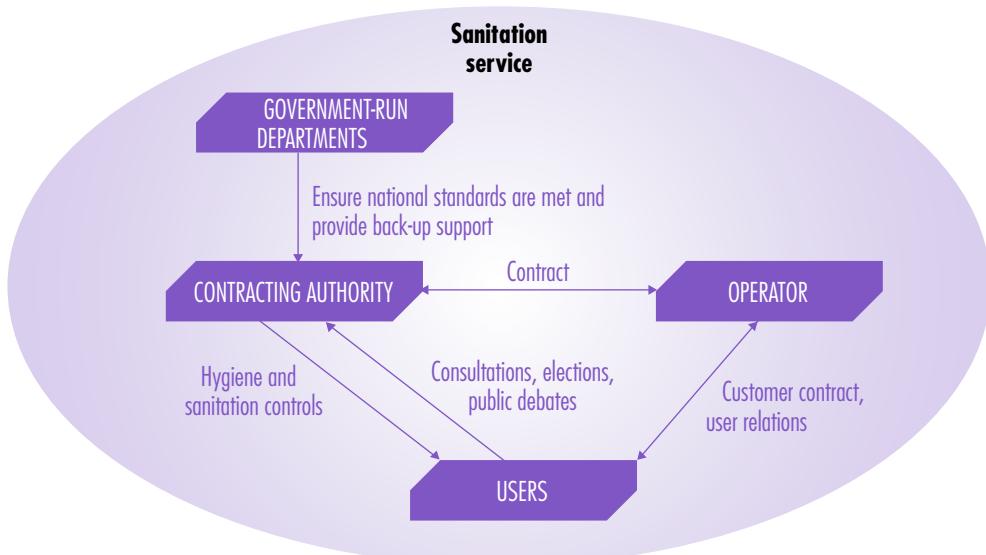
- **government departments** (the regional directorate of water, health or the environment, for

example)¹, which have specialist teams and equipment, also have a monitoring or back-up support role to play. As representatives of the public authorities and having no stake in the service, they are in a prime position to help resolve any disputes that may arise between the contracting authority and operator, for example;

- lastly, **legal and control bodies** have the power to impose sanctions in the event that contractual engagements are not upheld or there is a dispute between the operator and the users or the contracting authority and the operator.

ILLUSTRATION 25

Sanitation service monitoring by the various stakeholders



1 Some countries, such as Brazil, have an independent public body in charge of regulating water and sanitation services.

Set up monitoring review and consultation meetings

Consultation meetings will help ensure transparency in service delivery and that the contracting authority and operator are held accountable to the users. Participants will give feedback on the service, jointly validate the monitoring results and discuss corrective measures, as well as resolve any areas of conflict.

When possible and in order to avoid planning overly frequent meetings with the users (which could result in poor attendance or meeting fatigue), these monitoring review meetings should be combined with those held to discuss other public services, such as water supply, solid waste and electricity, etc.

Monitoring costs and funding

Successful monitoring requires:

- **technical resources:** monitoring equipment (computer, camera, water quality tests), means of transport for the staff responsible for collecting monitor indicator data;
- **human resources:** the contracting authority must allocate one to two employees to monitor the service. Operator and state technical department staff should also be involved.

Monitoring thus has an associated cost, which can either be charged to the operating account and covered by the revenue received from the sanitation fee or be included in the operating budget of the local authority or relevant state technical department.

ACTIVITY 4.5.

Support service operation over the first few years

In order to ensure sustainability of the non-conventional sewerage service, it will be necessary to provide support to both the operator and contracting authority over the first few years of operation. This will involve responding to their questions, correcting any management errors observed and continually building their capacities (by training staff to cover any specific needs identified, for instance).

This support should be provided by specialists with a thorough understanding of the technical, financial and social, and legal and institutional aspects of water and sanitation services. These are the partners (or contractors) who provided support to the contracting authority or acted as project supervisors during the previous design and construction phases. The cost of this support should be included in the investment budget.

TABLE 19

Monitoring indicators and corrective measures

	MONITOR WHAT?	USING WHICH INDICATORS?	WHERE IS THE INFORMATION HELD?	HOW OFTEN SHOULD IT BE MONITORED?	WHEN SHOULD THE ALERT BE RAISED?
FINANCIAL MONITORING & AUDITING	The financial sustainability of the service	Increase in the bill collection rate	User payment records	Monthly	When late payment becomes frequent and when the proportion of unpaid bills exceeds 20%
		Balance of the operating account	Operating account (general ledger)	Twice-yearly	When the operating account balance is below the target set out in the business plan (and before it becomes negative)
		Balance of available reserves	Operating account (general ledger)	Annually	When the available reserves are below the target set out in the business plan
TECHNICAL MONITORING AND AUDITING	The technical and environmental sustainability of the service	Number of blockages on the sewer	Activity log	Monthly	When there is a significant increase in blockages on a certain section of the sewer
		Number of leaks and broken pipes and manholes	Activity log	Quarterly	When there is a significant increase in leaks and broken pipes/manholes on a certain section of the sewer
		Quality of the treated wastewater discharged from the wastewater treatment plant	Water quality tests	Twice-yearly	When there is an anomalous drop in treatment quality (outside of acceptable seasonal variations) And before the quality falls below the set service targets

USER SATISFACTION MONITORING & AUDITING	Ownership of the service by the users or 'social sustainability'	MONITOR WHAT?	USING WHICH INDICATORS?	WHERE IS THE INFORMATION HELD?	HOW OFTEN SHOULD IT BE MONITORED?	WHEN SHOULD THE ALERT BE RAISED?
		Number of complaints received		Activity log	Monthly	When there is a large increase in the number of complaints received. This indicates that either there is a technical problem, or users are failing to maintain their domestic plumbing installations correctly or have damaged the sewer
		Complaint handling time		Activity log	Monthly	When users complain the process is taking too long
		Group meeting attendance rates (awareness-raising and/or monitoring results presentation meetings)	Meeting attendance records		Quarterly	When attendance at awareness-raising meetings is too low for activities to have an impact When there is no longer any user representation at monitoring results presentation meetings
		Use of poor/good practices at the household level	Activity log and daily user relations		Quarterly	When the poor practices employed start to affect other users and jeopardize the quality of the service for all
		Number of observed cases of poor practices and damage to the sewer (public land)		Visual inspection of the sewer	Monthly	This technical indicator is also an indicator of the users' sense of ownership towards the service (social sustainability)

Bibliography

- BAKALIAN A., WRIGHT A., OTIS R., NETTO J., 1994, Simplified sewerage: design guidelines, UNDP-WSP
- COLLECTIF, 2010, Maîtrise d'ouvrage locale manuel pratique, Protos
- DESILLE D., LE JALLE C., VALFREY B., TOUBKISS J., 2010, pS-Eau Guide n°6. Financing sanitation in sub-Saharan Africa, pS-Eau
- DESILLE D., RANGAMA J., 2013, Concevoir et mettre en œuvre une stratégie de sensibilisation à l'hygiène et de promotion de l'assainissement, pS-Eau
- DESILLE D., FAGGIANELLI D., 2012, Supplying piped water services in small towns in developing countries: Regulating and monitoring the technical and financial performance of small systems, pS-Eau
- DEVINE J., KULLMANN C., 2011, Introductory Guide to Sanitation Marketing, WSP EALES K., BLACKETT I., SIREGAR R., FEBRIANI E., 2013. Review of Community-Managed Decentralized Wastewater Treatment Systems in Indonesia, WSP
- EVANS B., MARA D., 2011, Sanitation and water supply in low-income countries, Ventus publishing, University of Leeds
- FOLEY S., SOEDJARWO A., POLLARD R., 2000, Case Study. Of the people, by the people, for the people: Community-Based Sewer Systems in Malang, Indonesia, WSP
- FOSTER V., 2001, Condominium water and sanitation system. Costs of implementation of the model. El Alto-Bolivia/Pilot Project, WSP
- GABERT J., DESILLE D., LE JALLE C., MONVOIS J., FRENNOUX C., GUILLAUME M., 2010, pS-Eau Guide n°4. How to select appropriate technical solutions for sanitation, MDP/pS-Eau
- GAYE M, 2011 Guide pratique pour la mise en place de systèmes sociaux alternatifs d'assainissement condominium en milieu urbain et périurbain, ENDA
- GUTTERER B., PANZERBIETER T., RECKERZGULT T., SASSE L, 2008, Decentralised Wastewater Treatment Systems (DEWATS) and Sanitation in Developing Countries: A Practical Guide, BORDA, WEDC
- LE JALLE C., BAERHEL C., NGNIKAM E., DESILLE D., ILY J-M., 2010, pS-Eau Guide n°1. How to develop a concerted municipal strategy for water and sanitation in large towns in Africa, MDP/pS-Eau
- LUTHI C., MOREL A., TILLEY E., ULRICH L., Community-Led Urban Environmental Sanitation Planning: CLUES, Complete Guidelines for Decision-Makers with 30 Tools, EAWAG-Sandec, WSSCC, UN-HABITAT

- MARA D., SLEIGH A., 2001, PC-Based design of simplified sewers, DFID
- MELO J.C., 2008, Sistema condominial: Uma resposta ao desafio da universalização do saneamento, Ministério das Cidades
- MELO J.C., 2005, The experience of condominium water and sewerage systems in Brazil. Case studies from Brasilia, Salvador and Parauapebas, WB, BNWP, WSP
- OTIS R. J., MARA D., 1985, The design of small bore sewer systems, UNDP-World Bank
- REED R., 1995, Sustainable sewerage, Guidelines for community schemes, WEDC
- ROGER G., 2010, pS-Eau Guide n°3. How to analyze the demand of current and future users for water and sanitation services in towns and cities in Africa, MDP-pS-Eau
- TOUBKISS J., 2010, pS-Eau Guide n°5. How to manage public toilets and showers, MDP/pS-Eau
- TILLEY E., LUTHI C., MOREL A., ZURBRUGG C., SCHERTENLEIB R., 2008, Compendium of Sanitation Systems and Technologies, EAWAG-Sandec, WVSSCC
- TREMOLET S., BINDER D., 2010, La régulation des services d'eau et d'assainissement dans les PED, revue de littérature, éclairages et pistes de recherche, AFD, 2010
- UNCHS, 1986, The design of shallow sewer systems, UN-Habitat
- VINCENT I., 2001, Pratiques recommandées pour l'implantation de projets pilotes d'assainissement condominial, Suez Environnement, Paris
- WATSON G. 1995, Good sewers cheap? Agency-Customer interactions in low-cost urban sanitation in Brazil, World Bank

Case studies conducted in preparation for the development of this guide

- ILY J.M., 2013, Choosing and implementing non-conventional sewerage services: Senegal Case Study, pS-Eau
- ILY J.M., MIRANDA NETO A., 2013, Choosing and implementing non-conventional sewerage services: Brazil Case Study, pS-Eau
- NEMA A., 2013, Choosing and implementing non-conventional sewerage services: India Case Study, pS-Eau
- SALIFU L.Y., 2013, Choosing and implementing non-conventional sewerage services: Ghana Case Study, pS-Eau
- WSA Mali, 2013, Choosing and implementing non-conventional sewerage services: Mali Case Study, pS-Eau (available only in French)

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- N° 6. How to finance sanitation in sub-Saharan Africa
- N° 7. Non-conventional sewerage services. When to choose this option,
how to implement this solution

The aim of the pS-Eau Methodological Guides series is to provide aids and tools to address water and sanitation service-related issues to best meet the needs of sector stakeholders. These guides are designed to evolve over time and be regularly updated. To assist with this process, please send any feedback or suggestions for improving this publication to the following address:

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Non-conventional sewerage services

When to choose this option, how to implement this solution

There are two main types of sanitation system that can be used to meet household demand for sanitation services in developing countries: on-site sanitation, whereby individual facilities are built for each household; and conventional sewerage, such as that used in many towns and cities.

However, in some areas, installing these types of sanitation is not always possible and alternative sewerage systems have had to be developed. These systems, called 'non-conventional sewerage' in this guide (and which include both simplified and settled sewers), overcome some of the constraints associated with conventional sewerage (smaller diameter pipes, which are laid at shallower depths, and simplified connections, etc.), which results in a lower investment cost. Non-conventional sewerage services also differ from conventional sewerage by virtue of their scope (covering a residential area rather than the whole town), allocation of responsibilities and the management method used.

Consequently, non-conventional sewerage is an option that is only suitable for specific types of urban area. Before embarking on a non-conventional sewerage project, it is important to be fully aware of the complexities of managing a non-conventional sewerage service and ensure that all the necessary conditions for launching such a service are in place.

This guide is based on a number of case studies of non-conventional sewerage services around the world. Its aim is to support contracting authorities, local decision-makers and their partners to develop their sanitation service by providing them with decision-making tools and practical methodological approaches. This guide will help these stakeholders determine whether non-conventional sewerage really is the most appropriate option for the area concerned. If this option is selected, it will also help them coordinate their project effectively and provide them with a clear understanding of the management methods that can be used and of the skills and know-how required.

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