

A Guide to Simplified Sewer Systems in Kenya

November 2022



Executive Summary

This technical guide presents an overview of the key steps involved in planning and implementing Simplified Sewer Systems (SSS) as a sanitation option for low-income urban communities.

What are Simplified Sewer Systems?

Simplified sewer systems (SSS) provide a low-cost, flexible alternative to conventional sewers, and are suitable for densely populated low-income urban settlements. Relative to conventional sewers, SSS cost less, and can be laid in very close proximity to the property of the users, enabling higher household connection rates to be achieved. SSS are used widely in Brazil and other Latin American countries, and have also been trialled in Tanzania and Namibia, underpinned by the rationale that SSS can enable major cost savings without affecting the performance of the system. Figure 1 on the next page presents an illustration of SSS in the context of city-level sewered services provision.

Who is this Guide aimed for?

The Guide has been developed as a resource for WASH sector professionals involved in sanitation service planning and sanitation services provision. The Guide will be useful for managers within water and sanitation utilities, local governments and community-based organisations, and for decision-makers within regulators and relevant ministries. The Guide aims specifically to support scale-up of SSS in Kenya, and is aimed primarily at Kenyan stakeholders; however, much of the guidance included will be relevant to other contexts.

Why Simplified Sewer Systems in Kenya?

The Guide draws extensively on the experience of WSUP and our partners in Kenya — including Nairobi City Water and Sewerage Company (NCWSC), Nairobi Metropolitan Services (NMS), and Akiba Mashinani Trust (AMT) — in piloting SSS in the low-income settlement of Mukuru, Nairobi, as part of a wider slum development programme (see Annex 1). The pilot has been

independently evaluated, with positive findings relating to sustainability, affordability and customer satisfaction with the model, documented in a parallel WSUP publication.¹ Evaluation findings support WSUP's view that the prevalence of trunk sewer networks in informal settlements in Nairobi, and other Kenyan cities, provides genuine potential for scale-up of SSS in the Kenyan context.

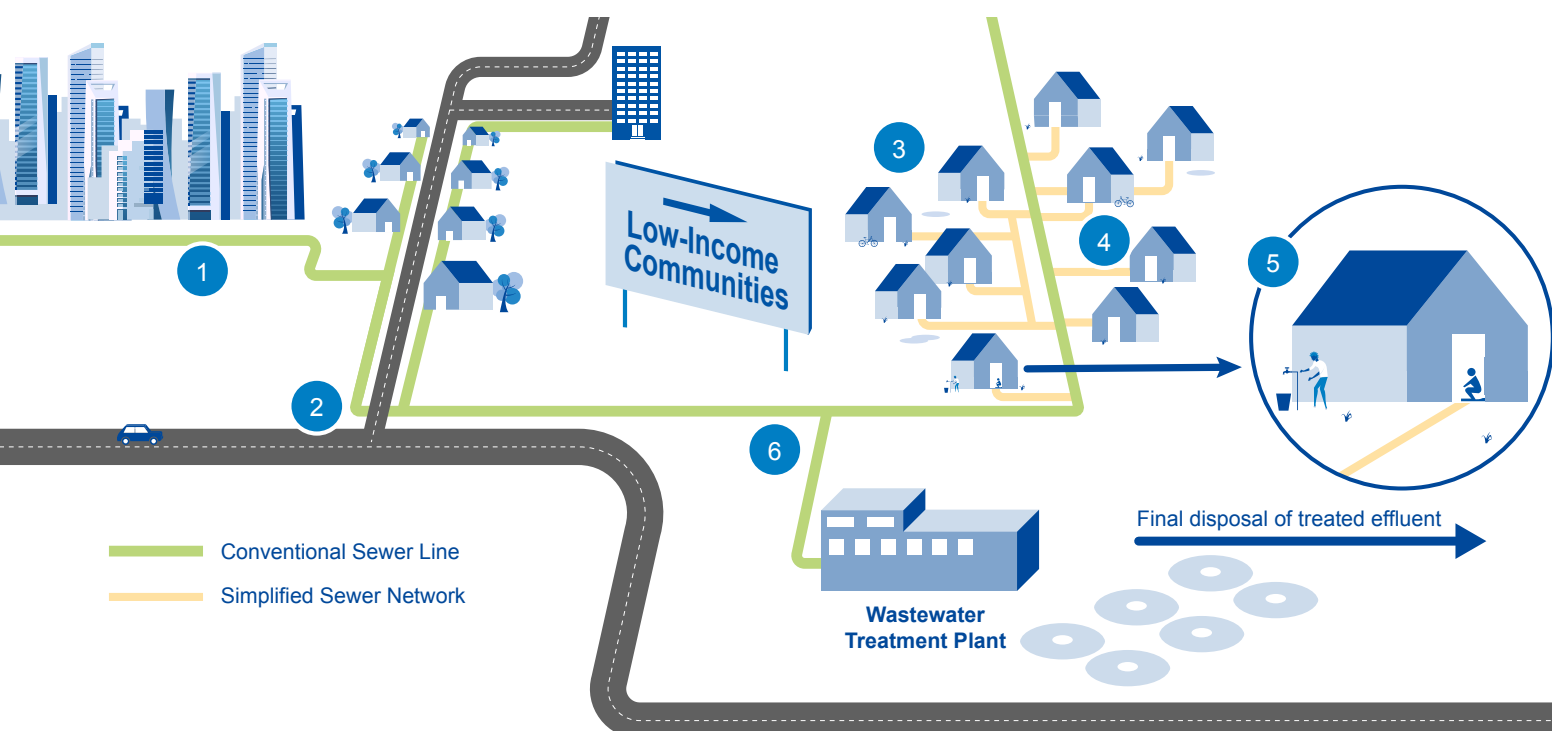
How is the Guide structured?

The Guide aims to provide an overview of key considerations in implementing SSS at scale, from policy and urban planning to operations, maintenance and long-term sustainability. The Guide is structured as follows:

- **Section 1** introduces urban sanitation in Kenya
- **Section 2** outlines the rationale for introducing SSS in Kenya
- **Section 3** aims to place SSS within the wider context of Citywide Inclusive Sanitation, as one of a menu of services required to serve everyone in the city
- **Section 4** outlines the key steps involved in design and construction of SSS
- **Section 5** outlines how SSS can be integrated with wider urban development programmes
- **Section 6** outlines the policy, legal and regulatory frameworks required to underpin scale-up of SSS
- **Section 7** presents the key stakeholders involved and the coordination mechanisms required to support SSS in the Kenyan context
- **Section 8** presents financing options to support provision and scale-up of SSS
- **Section 9** is focused on management structures and operations and maintenance of SSS
- **Section 10** introduces potential business models available to support SSS
- **Annex 1** provides further information on the pilot of SSS in Mukuru, Nairobi

¹ WSUP (2022) Are Simplified Sewer Systems a viable option for informal settlements in Kenya? Results of a pilot project in Mukuru, Nairobi.

Figure 1: Illustration of Simplified Sewer System in the context of city-level sewer services provision.



1. In wealthier parts of the city, including business districts and planned residential neighbourhoods, a network of deep sewers remove waste from each building and dwelling. These buildings have piped water too.
2. Both water and sewage pipes tend to be laid in line with roadways so they are easier to maintain. Smaller sewers discharge into large trunk sewers which take the waste to the wastewater treatment plant.
3. The informal settlements where people with lower incomes live are often not planned. Homes tend to be crowded and occupied by many people. There are few formal road networks, piped water is not common, and sewers very rare. Most people use pit latrines which need emptying, and human waste is often washed into open drains and from there into the rivers.
4. Here, a simplified sewer network has been laid. Small, flexible pipes are used that can go around corners and are better at reaching toilets in the jumbled housing. They are laid at a shallow depth so not too much digging is required, and inspection chambers are installed at intervals to allow for regular maintenance.
5. The toilets are not directly connected to the water network. Users need to flush their waste through the system with a bucket of water. In areas where SSS are to be used, it is a requirement that households be supplied with at least 60 litres per person per day, which could potentially be supplied through communal plot-level yard taps or prepaid water dispensers.
6. The simplified sewers take the waste into a nearby secondary sewer, and from there to the trunk network which transports it to the wastewater treatment plant.

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1. Introduction: sanitation in Kenya

With an urbanisation rate of 4.5% per annum (double the global average), Kenya is one of the most rapidly urbanising countries in the world. Growth is skewed towards the country's informal urban settlements, where low-income earners are concentrated in crowded, semi-permanent structures. Access to improved sanitation facilities remains low at 31% in urban areas, with access to safely managed sanitation estimated at 16%. Sewer coverage is estimated at 16% with 84% of the Kenyans depending on onsite sanitation.² Over half of the population are at heightened risk of diseases and death due to poor access to safe water, sanitation and hygiene, which is responsible for over 75% of Kenya's total disease burden.

To meet the SDG 6.2 and Kenya Vision 2030 sanitation targets, about \$3.4 billion would be required to fund urban sanitation.³

According to the National Water Master Plan 2030, to increase the conventional sewerage coverage to at least 80 per cent by 2030, 96% of the required resources of US\$ 5.2 billion will be needed for new urban sewerage infrastructure development, with the remaining 4% required for rehabilitation of existing dilapidated systems. Furthermore, the construction of new sewer systems can be expected to generate additional operation and maintenance costs, bringing the total financing needs to about US\$5.4 billion.⁴ To realise these investment targets, the National Water Master Plan 2030 estimates an annual investment of US\$ 1 billion (KES 100 billion) is required. This funding shortfall excludes onsite sanitation services that serve the greater urban population, while budget allocation to sanitation has remained negligible both at county and national levels.

The WHO/UNICEF Joint Monitoring Program (JMP) estimates that only 31% of urban residents in Kenya have access to improved facilities. About 48% use shared facilities, including public toilets as well as facilities shared by defined groups of households.



Image: Project signage for Githima sewer line, Nakuru County. **Credit:** Brian Otieno

While 18% of urban dwellers use unimproved facilities, 3% still practice open defecation. Onsite sanitation is the norm for most urban residents, as less than 20% have access to sewerage services. Transportation and treatment services are very poor across all kinds of facilities. Nationally, only 5% of sewage is effectively treated due to failures of the sewerage system and inadequate wastewater treatment processes. Access to sewerage services has been declining over time from a figure of 19% coverage recorded in 2010 to 16% sewerage coverage in 2022.⁵ This decline is attributed to the rapid increase in population, with slower sewerage services development. To achieve safely managed sanitation services as per Sustainable Development Goal 6.2, sanitation practitioners and service providers are adopting Citywide Inclusive Sanitation (CWIS), which seeks to ensure that everyone benefits from adequate sanitation service delivery outcomes, while embracing the principles of safety, equity, and sustainability.

² Water Services Regulatory Board (WASREB) (2022) Impact issue No 14.

³ Draft Water Sector Investment Program prepared in 2011.

⁴ Republic of Kenya (2013), National Water Master Plan 2030.

⁵ WASREB (2022)

2. Rationale for introducing simplified sewer systems

In recent decades in Kenya, focus on trunk sewer infrastructure has resulted in expensive investments in sewer networks and wastewater treatment plants, which have often remained under-utilised, as the last-mile sewer networks and connections and the necessary household installations are never actually realised.

Currently in Kenya, the use of HDPE double walled corrugated (DWC) sewer pipes is gaining popularity. Historical use of PVC pipes, concrete pipes, culverts and manholes has been costly in terms of installation and maintenance. HDPE sewer pipes and inspection chambers are over 50% more cost-effective compared to concrete sewer pipes. Composite material assets are also preferable as they are durable and easy to fix and replace.

Simplified sewer systems (SSS) adopt conservative design standards and design features that are better adapted to the local situation. This could be use of locally available and affordable floor tiles or material for the toilet upgrades, plastic basins for the pour flush and simple wash taps for hygiene. Because simplified sewers are laid on, or in very close proximity to, the property of the users, higher connection rates can be achieved, fewer and shorter pipes can be used, and less excavation is required as the pipes will not be subject to heavy traffic loads.⁶ Additionally, SSS utilise local labour in both construction and maintenance making them affordable to low-income populations.

Suitable areas for SSS are mostly found in urban and peri-urban settlements with population density exceeding 150 persons per hectare. Simplified sewerage should be constructed in areas where there is a minimum availability of 60 litres per person per day. Where this is unavailable water supply mitigation measures should be incorporated.



Image: Open sewer in Githima, Nakuru County. **Credit:** Brian Otieno

Table 1: Summary of key benefits of Simplified Sewers.

Suited to densely populated but well-structured settlements
Inspection chambers are provided every 30 Metres to support network maintenance
Easily adapted to low-income area (LIA) sanitation governance systems e.g. CBOs
Easily adapted to LIA technologies e.g. pour-flush latrines
Provide incentives for CBOs and communities who may be engaged as caretaker managers
Enable improvisation and the use of locally available materials, unlike conventional sewers
Enhance utility and government visibility through comprehensive participatory approaches
Reduced connection costs relative to conventional sewers
Facilitate local innovation and skills transfer, providing easy integration of FSM options

⁶ Mara, D, et al (2001) PC Based Simplified Sewer Design. London: University of Leeds.

3. Simplified sewer systems within Citywide Inclusive Sanitation

Simplified sewer systems can be considered as part of the menu of services required to achieve citywide inclusive sanitation. Within this context, the following considerations should be planned for to ensure the systems are viable and sustainable:

Equity and access: Simplified sewer systems are 50–80% less expensive than conventional gravity sewerage. The lower cost of investment means lower connection fees and tariffs that poor households can afford.

Functional sanitation service chain:

Simplified sewers should be designed taking into account the complementary provision of other services. The system should not be regarded as a standalone solution, but as an option that enhances the capability of other non-sewer alternatives to serve everyone. The SSS should consider the safe delivery of faecal waste from various sources to the trunk sewers, treatment and reuse facilities.

Urban planning and renewal: The SSS should be designed to conform to urban planning requirements, and to promote livable and sanitary environments. Systems must be designed with the long-term development and sustainability of the city and its residents in mind.

Partnerships and stakeholder engagement:

Designing, implementing, and sustaining SSS is a highly collaborative process. Wide-ranging partners are required to play a critical role in all stages of the project cycle. Institutions adopting this system must make adjustments to bring all stakeholders on board, particularly the users; and avoid the top-down approaches which characterize the planning and implementation of conventional sewer systems.

Enhanced customer experience: Despite challenges associated with sanitation in low-income areas, utility planners, designers and managers should ensure that a proactive customer experience is maintained to avoid customer frustration, which in turn can damage the overall sustainability of the system.

Community participation: Owing to the consultative nature of SSS, communities need to be aware of their involvement across all phases of project development. Community sensitisation is required to enhance ownership, and to create a platform through which communities can identify and access service providers. A space must be provided for the community to voice historical, cultural, and religious considerations, paving the way for inclusive and consultative project implementation.

Resources and capacity: Service providers should be equipped with human resources, skills, and materials to facilitate last-mile connectivity within the shortest turnaround time possible. A skilled workforce is critical, because pipe networks are laid close to the surface and risk being punctured if standards are not observed. To address this, the regulator and service providers should set minimum standards, guidelines and develop sewer connection manuals outlining procedures for installation and maintenance of SSS.

Marketing and demand creation: To maximize utilisation of the SSS, effective strategies must be put in place to ensure uptake of connections in the intervention area. Marketing and demand creation is not one-size fits-all: service providers should conduct an analysis of their customer segments to inform strategy in this area.

4. Framework for design and construction of simplified sewer systems

In this section we present an overview of the key steps involved in designing and constructing simplified sewer systems.

1. Socio-economic aspects

Successful planning, implementation, operation and maintenance and sustainability of the SSS is highly dependent on stakeholder engagement, sensitisation, and participation. This entails continuous engagement between service providers, private sector players, policy, and regulatory bodies, as well as end-users.

2. Community needs assessment on WASH

Planning and designing of SSS should build on the community's perception of what their needs are for water, sanitation and hygiene. A community needs assessment seeks to gather accurate information representative of the needs of a community. The process brings out the thoughts, opinions and attitudes the communities have towards the proposed SSS intervention. It will form a basis through which service providers can tailor messaging during the sensitisation phase.

3. Location mapping

The first task in the planning process is to collect all available information on the area to be sewered. Existing topographical maps and any maps showing the routes of existing drains and sewers should be collected, as these are needed to define the area to be sewered and determine the overall SSS layout. Data on existing onsite sanitation facilities should also be collected to guide future integration. Field reconnaissance during the planning and designing phase will shed light into the general layout and terrain of the project site. Designers should seek to maintain and preserve existing infrastructure and structures of the target location.

4. Physical surveys

Physical surveys are required to determine sewer routes and levels. If existing plans exist, it may be possible to use them, at least for preliminary design. However, checks on their accuracy should always be made, and they must



Image: Upgrading pit latrines to pour-flush toilets connected to the simplified sewer system, Mukuru, Nairobi.

be updated to include any developments that have taken place since they were produced. Where plans are non-existent or insufficiently detailed, additional surveys will be required to provide information on the overall layout of the area.

5. Social surveys

Social surveys should be used to provide information on household sizes and incomes, existing sanitation and water supply facilities, attitudes to sanitation and user preferences. Questionnaire surveys are useful for providing quantitative information. Semi-structured interviews and focused group discussions (FGDs) are more likely to provide information on attitudes and preferences. The options for operations can be explored in community meetings, but should be backed-up by smaller meetings with groups, as minority viewpoints may not emerge in open community meetings.

6 Technical design planning

During this stage, technical options for the best SSS option are considered, including possibility of access to a trunk sewer, and water availability (preferably 60 litres per person per day, but in cases where this is not met, mitigation measures should be taken including provision of settling tanks or introduction of multiple rodding

eyes in the sewer systems). Additionally, the design should ensure a minimum flow of 1.5 litres per second. Factors to consider include population density (at least 150,000 people per hectare), the arrangements for effluent disposal and the preferences of the local population. While evaluating onsite sanitation options, the plot size, infiltration capacity of the soil and the potential for groundwater pollution should also be considered.⁷

7 Detailed technical design

The design of simplified sewers applies the same principles of hydraulics. However, there are a few differences with the principles applied in conventional sewer design. The main difference is the reliance on tractive force as opposed to self-cleaning velocity. The advantage of this approach is that it allows for lower minimum sewer diameters and also emphasizes on initial wastewater inflow rates and final wastewater conveyance flow rates in sizing of sewer pipelines.

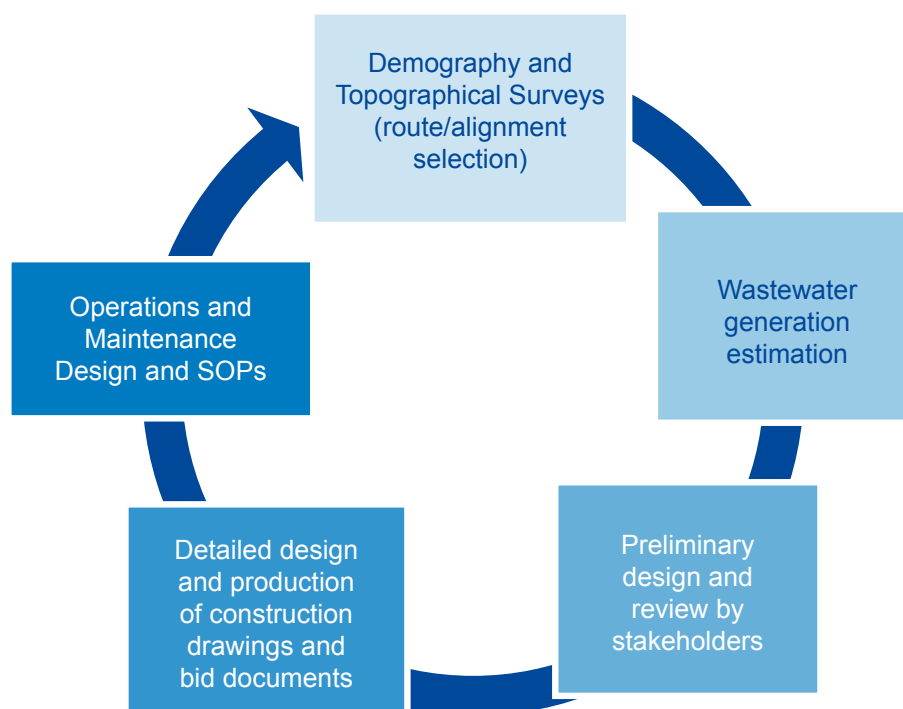
8 Development of a draft sewerage plan

A draft sewer plan is then developed, to cover a local system, or the sewerage needs of a wider area. Sewers should be routed as close as possible to natural drainage routes and aligned to existing land development and ownership patterns. In general, collector sewers should be routed in public rights of way.

9 Final sewer routes

Once good survey information has been obtained, detailed design of the system can commence. Minor changes to the routes of collector sewers may be required because of improved survey information. More substantive changes may be necessary in condominium systems as a result of the findings of both the physical and social surveys. The preferred options for condominium sewers should be decided in consultation with the community, bearing in mind the management arrangements to be adopted.

Figure 2: The Design Process for Simplified Sewers.



7 GHK Research and Training (2000) Strategic Planning for Municipal Sanitation. First Edition.

10 Construction materials and approach

Unlike conventional sewers, SSS embrace innovative construction methods that are suitable for adaptation without adverse effects on performance. These innovative methods include laying sewers in shallow depth, the use of HDPE inspection chambers as much as possible, and optimising number of people served per conduit length of SSS by aligning sewers networks to block unit boundaries.

11 Utility and community operations and maintenance

While simplified sewers are considered an affordable solution for informal settlements, they also present a challenge in terms of operation and maintenance. Sewer services are usually billed as a charge levied on the water customer's periodic bill obtained from set tariffs and volume measures at a consumer meter. In many informal settlements, individual connections are rare, and the management of consumer meters is greatly hampered by commercial water losses related to meter malpractices. This has led many water utilities to be reluctant to offer individual connection services for water and by extension sewer systems in these areas.

Because SSS uses smaller diameter pipes than conventional sewers, the likelihood of blockages may be higher. It is prudent to provide adequate rodding eyes and grease traps for SSS systems where frequent blockages are likely. Additionally, flush tanks may be introduced to flush any troublesome sewer pipe at least once per day. This is recommended for sewers that may not achieve self-cleaning capability.

Sustained community sensitisation is necessary, especially in relation to:

- solid waste disposal in designated locations;
- maintenance of household grease or storm water gully traps;
- reporting of blockages and leaks

It is helpful if there is a well-organised Residents' Association which can act as the primary point of contact between the sewerage authority and the community.



Image: HDPE Inspection chamber installation for SSS.

Table 2: Typical design and construction standards applied in SSS systems.
Source: Mara, 2001.

DESCRIPTION	STANDARD
Depth of sewers	>400 mm
Minimum flow per sewer line conduit	≥ 1.5 l/s
Diameter size	≥ 100 mm
Material	Normally PVC and Concrete
Minimum Tractive force (τ) in sewer pipe (Boundary Shear stress). NB. The value is purely for separate simplified sewer systems	$1 > \tau < 2$ Pascal
Minimum sewer gradient	1;200
Design Peak Factor	1.8
Return Factor	0.85 (This may vary depending on site)
Limit Ratios of depth of flow to Diameter of pipe d/D . (The limits prevent deposition as well as adequate ventilation in the sewer pipes respectively)	$0.2 < d/D < 0.8$

5. Integration of simplified sewer systems with wider urban development

To be effective, simplified sewer systems must be designed in a way that supports integration with wider urban development and basic services. Below we present an overview of key points for consideration within this integrated approach.

Solid waste management: One of the major challenges in SSS management in informal settlements is poor solid waste management. Solid waste often finds its way in manholes causing blockages in sewer pipes. Part of the solution involves provision of solid waste management bins that are collected regularly in areas with SSS - this has worked in various parts of Kenya, where the County government collects garbage or subcontracts solid waste management services to CBOs. This needs to be complemented by strong stakeholder engagement and awareness campaigns through community mobilisation and sensitisation.

Upgrading of pit latrines to pour-flush: Upgrading of existing pit latrines to pour-flush standards is necessary in order to make connections to the SSS network. Pour-flush latrines ease use, maintenance, and construction of the SSS. They will normally require about 1.5 litres of water for every flushing event. It is preferable that the pour flush be fitted with a water trap to control odour and flies. The SSS target area should also have consistent water supply.

Public toilets integration: Public toilets can be integrated with the network via normal sewer connection processes, or where a septic tank was in use previously, the outlet leading to a soak point or percolation/gravel bed can be connected to a SSS, leading to the wider sewer system connected to a wastewater treatment plant.

Sludge handling integration: If space and costs do not permit the construction of a wastewater treatment plant, an alternative solution is a sludge handling facility. Waste from a network of SSS is collected and deposited at the sludge handling facility, which then facilitates

decomposition of organic waste and other suspended solids. The quiescent wastewater is discharged to a nearby soak pit/percolation field while sludge settles in the sludge handling facility. As sludge accumulates the sludge handling facility will need to be desludged. Sludge could be carted off to sludge drying beds in a nearby wastewater treatment plant to be converted to raw material for charcoal briquettes/ organic fertilisers.

Integration with conventional sewers: SSS can be connected to conventional sewers as they perform similar functions and are based on similar hydraulic principles. The SSS primarily use inspection chambers, but may be connected via typical manholes at connection terminals, as is the case with conventional sewer systems.

Integration with future slum upgrading and infrastructure improvements in informal settlements: The SSS should be designed to enable flexibility and integration with potential or planned developments. This should involve review of existing cadastral maps, official slum upgrading proposals, spatial plans and demographic trends. Where disruptions to existing SSS are unavoidable, alternative stop-gap measures should first be considered before decommissioning through a joint task team with the utility and community.

Housing and water supply: Every simplified sewer-connected pour-flush toilet will require at least 1.5 litres of water per flushing event to avoid operational challenges. Ensuring utility water piped to individual households in informal settlements can be challenging, with some utilities preferring to have last-mile connectivity in areas with better land use and planning as well as ease of access and formalized metering and billing systems. However, in areas where SSS are to be used, it is a requirement that households be supplied with at least 60 litres per person per day, which could potentially be supplied through communal plot-level yard taps or prepaid water dispensers.

6. Policy, legal and regulatory basis for simplified sewer systems

The policy, legal and regulatory framework for the sanitation sector in Kenya is governed and regulated under the Water Act 2016. Other policy and legal frameworks complement the Water Act, including the Urban Areas & Cities Act, Land Act, National Environment Management and Coordination Act, and Public Health Act. All of these frameworks draw their mandates from the Constitution of Kenya, 2010. For sanitation, of which sewerage is one part, the driving policy emanates from article 43 (1) b of the Constitution (under Economic and Social rights), which stipulates “Every person has the right to accessible and adequate housing and to reasonable standards of sanitation”. In this connection, the planning, design, operation, and maintenance standards of the SSS must address the needs of beneficiaries.

SSS provision is further underpinned by the Kenya Environmental Sanitation and Hygiene Policy (KESHP) 2016-2030, the National Sanitation Management Policy 2030, and the National Water & Sanitation Services Strategy 2019-2030. These frameworks provide for the promotion of appropriate technology options which are cost-effective, affordable, socially acceptable and adaptable to the needs of vulnerable population groups. Such technology choices shall include a variety of alternatives including sewerage and onsite, centralised and decentralised systems.

For SSS to be embedded, standards shall require technical and stakeholder input and acceptance. National and county-level government and utilities, in collaboration with the Engineers Board of Kenya and Kenya Bureau of Standards, shall adopt the standard specifications for the SSS as a sanitation technology option.



Image: Upgrading pit latrines to pour-flush toilets connected to the simplified sewer system, Mukuru, Nairobi.

The SSS standards must meet the requirements for:

- i. Safe sanitation
- ii. Practicality in operational and maintenance
- iii. Sustainability requirements for wider adoption and scale-up
- iv. Alignment to national guidelines on equipment and supplies to be procured for use by service providers at various levels
- v. Adherence to environmental protection standards
- vi. Be within legal frameworks of respective governments

For the above to happen, there is a need to initiate and sustain discourse through forums, publications and information dissemination with key stakeholders who could review the legally acceptable codes and include SSS in the sanitation services building codes. This would, in turn, trigger adoption and financing for SSS systems to be scaled-up.

7. Stakeholder coordination for simplified sewer systems

The provision of SSS must be strategically coordinated and adequately address the concerns of professional bodies, local and national authorities (statutory bodies mandated with sewerage/sanitation services provision), NGOs, utility managers, area community leaders and the public. Among the key stakeholders in the SSS development processes are:

- i. **Policy institutions** – ministries, regulators, county governments
- ii. **Mandated service authorities** – utilities and other institutions with mandate to provide services
- iii. **Financial Institutions** – development financing institutions, commercial banks, micro-lenders, waterworks development agencies
- iv. **County governments departments** – water, public health, housing, and planning departments
- v. **Small & Medium Enterprises (SMEs)** – masons, plumbers, FSM/SWM enterprises, hardware stockists
- vi. **Households** – tenants in single and multiple dwelling units
- vii. **Landlords** – present or absentee
- viii. **Landowners** – legal owners and temporary land occupants
- ix. **Local administration** – village elders, women and youth leaders, ward administrators, assistant chiefs, chiefs
- x. **Development organisations** – NGO/ community-based organisations, women and youth self-help groups

The levels of commitment, capacity and the relationships between these institutions will have a significant bearing on the planning process. Coordination between different stakeholder institutions, each of whom has a related mandate and jurisdiction, is crucial. There is therefore a need for strong political will to drive a coherent strategy to bring all major actors to the table and set the functions and specific objectives of the improved services. Civic society, user communities, NGOs, and other relevant actors, must also be adequately



Image: Stakeholder workshop for the simplified sewer system project, Nairobi.

represented, informed and consulted throughout the process.

Current national standards in Kenya mostly cover conventional sewer systems and leave out innovative SSS methods. To initiate a paradigm shift from business as usual to SSS, there must be nationally designed standards complete with a design manual for simplified sewerage that aligns to other standards like building codes. In drafting the manual, a multi-sectoral technical committee from the relevant institutions should be formed to deliver a well-aligned and comprehensive document.

8. Financing framework for simplified sewer systems

National and County governments commitments for sewerage require large investments. A financing gap of USD \$3.4 Billion has been identified as one of the greatest barriers to achieving the 2030 target for Kenya of 80% sewerage coverage. The construction of the new sewer systems will also generate additional operation and maintenance costs, bringing the total financing needs to about US\$5.2 billion.⁸ This investment does not include onsite sanitation and household connections which, if added, take the financing gap higher.

Below we set out potential financing streams which can support SSS provision:

Connection fees: While the network for SSS may be available, procuring materials for the connection - plus charges payable to the utility for the connection - could be prohibitive for most property owners. An affordable connection fee with payment spread over a long period on a monthly basis should be explored.

Tariffs or levies: The SSS funding can be bridged through development levies or surcharges that can be institutionalised for improving access to safe sanitation in non-sewered areas and low-income communities. Cross-subsidies could levy higher charges for conventional sewerage so that providers can charge less in poor areas served by simplified sewerage. Initial connection fees are likely to cause payment problems in poor areas, and these should be subsumed into the monthly charges.

Social connection fund: SSS can be financed sustainably through a utility social connection fund or revolving fund. Any bilateral, multilateral, and private foundations that raise resources could complement government funding for social connections and such resources can be coordinated and aligned within the County integrated and sector planning/budgeting framework.

Financing from Public Benefit

Organisations: County governments can actively leverage funds from public benefit or not-for-profit organisations including international and local NGOs to advance household connections and promote last-mile connections through lateral extensions.

Households and property owners' financing:

Households and landlords in peri-urban and informal settlements could bear the cost of providing, improving, and maintaining sanitation facilities including the costs of operation and maintenance of the chosen technology. The costing of the SSS capital and maintenance requirements can be provided in easy-to-understand manuals which assist householders in making informed investments. To support households and access the financial resources required for sanitation development and improvement, microfinance institutions and other credit schemes should be promoted for uptake. Property developers in un-sewered urban areas in the informal settlements could be encouraged to create awareness through sanitation marketing.

Private sector financing: The private sector can be encouraged and incentivised to actively participate in the planning, design and contract supervision; carrying out large and small-scale construction works and installation of equipment; product development and production of appropriate sanitation and hygiene materials and equipment; provision of finance to support capital development and delivery of sanitation and hygiene services; carrying out sanitation marketing and campaigns and demand creation; and equipment leasing and maintenance/workshop services.

⁸ Republic of Kenya (2013).

9. Sustainable management structure for simplified sewer systems

A simple management structure for simplified sewer systems in a given service area is shown in Figure 3 below. This could be modified depending on geographical characteristics and institutional capacity within a locality.

In practice, household sanitation facilities, sewers and wastewater disposal facilities together form a hierarchical wastewater disposal system. SSS will normally include several streets or lanes that can be sewerred to one connection with a higher-order collector sewer. For the optimal performance of the SSS system, the SSS should be managed by the same utility that manages the higher-order facilities.

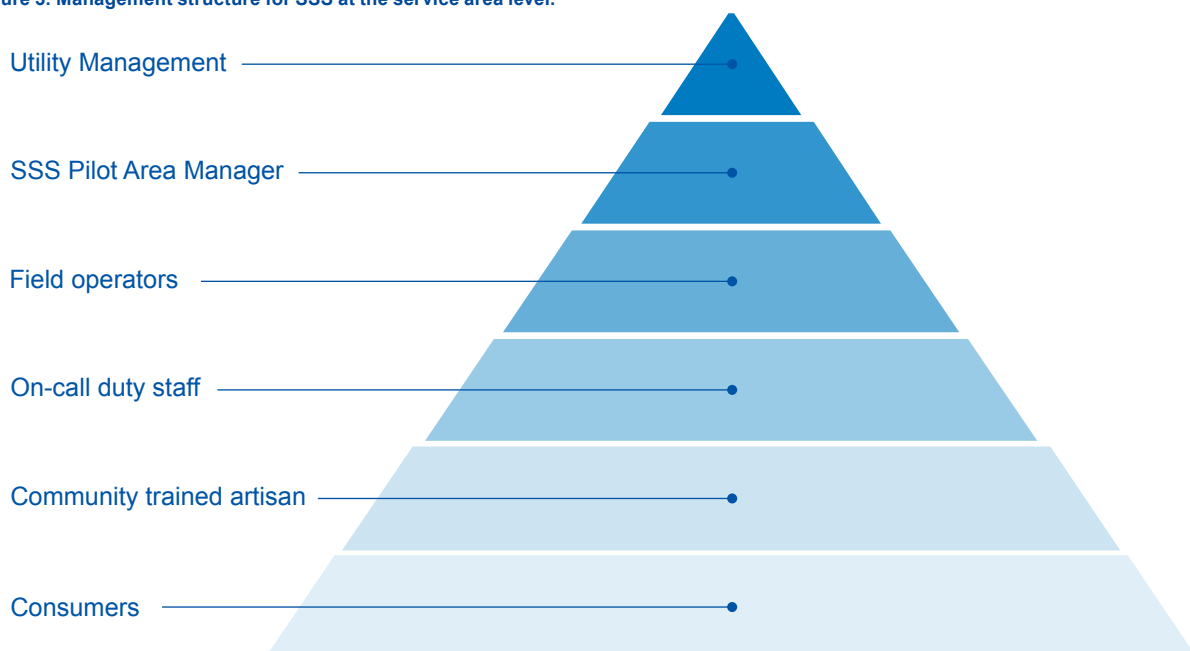
Users/households and local artisans should take full responsibility for providing and managing all internal SSS facilities. The utility/service provider should similarly take full responsibility for managing external facilities, including collector and trunk sewers and wastewater treatment facilities. The exact details of the division of responsibilities should be well-documented to eliminate the risks of emergence of existing cartels posing as community services providers.



Image: Zaituni Kanenje, Manager for the Low-Income Customer Services department at NAWASSCO, Nakuru County, Kenya. **Credit:** Brian Otieno.

Management options for operation and maintenance are very important in ensuring system sustainability. It is critical to evaluate what management arrangements are possible in the local context. Community management should not be considered an option for simplified sewerage systems connected to a municipal system operated by mandated utilities.

Figure 3: Management structure for SSS at the service area level.



10. Business typologies for simplified sewer systems

The utility may choose to operate a system of cross-subsidies whereby it levies higher charges for conventional sewerage so that it can charge less in poor areas served by simplified sewerage. As noted in Section 8, initial connection fees are likely to cause payment problems in poor areas, and these should be subsumed into the monthly charges through a utility social connection policy. Combined water and sewerage charges should not be greater than 7% of household income. Several business models could be adopted by utilities for SSS as summarised in Table 3.

Up-scaling and long-term sustainability of SSS can be ensured by:

- Strong partnership between the communities served by SSS and the utility
- Good design and quality construction
- Good maintenance
- An adequate, but affordable, tariff structure
- Ensuring lessons are applied for future self-improvement, in areas including community engagement efficiency, wayleave acquisition, billing and collection, tariff structures, technical training needs, service levels, etc

The lack of key skills and the capacity gaps in the Kenyan sanitation sector remains a challenge which may undermine the provision of SSS services. To mitigate this, a utility skills development strategy on SSS should be developed, considering the capacity gaps and the need to accelerate and expand formal and structured training programs related to planning, implementing, operating, and maintaining SSS. NGOs, development partners, governments and other key players should invest in capacity building of the roles outlined in the stakeholder engagement forum. This could involve (for example) on-the-job training, seminars and workshops, scholarships, building financing capacity, information dissemination, and advocacy.

Table 3: Potential business models for SSS provision.

	CONTRACT	APPLICATION	INCENTIVES
1	Service	Water meter reading and billing (including wastewater) and collection as well as O&M in the target area	May trigger competition among CBOs, each with short and specific contracts, leading to service improvements
2	Delegated Management Models	O&M of SSS in informal settlements	May be implemented based on performance-based contracts e.g. revenues collected from SSS connections, improved sanitation, frequency of complaints, and response time to customer complaints
3	Lease	Extended operational contract	A private enterprise may lease the SSS network from the water utility for a medium-term period and collect revenue, as well as maintain the system, including infrastructure ownership for this period
4	Concession	Same as lease but in this case the private entity may inject capital into the development of SSS in an informal settlement and have a long-term contract with the local water utility	This is long-term engagement and the risk is diversified to the concessioner by the water utility

Finally, utility business planning for SSS should ensure robust data collection of current practices, including socio-cultural, economic and environmental aspects.

Annex 1: The Mukuru Mosque Road pilot SSS project

Mukuru, one of the largest informal settlements in Nairobi, was declared a Special Planning Area (SPA) in 2017. This step was taken to address high levels of poverty and poor living conditions in the area, including lack of access to basic infrastructure such as water and sanitation, and lack of planning and management. Before 2021, water, sanitation and solid waste management services in Mukuru were highly dominated by informal suppliers. Water was previously sold by water vendors that are illegally connected or provided by door-to-door distributors using hand carts. Sanitation was characterised by pit latrines, pour-flush toilets and portable toilets provided by non-profit agencies. The residents were charged high rates to access unreliable water and sanitation services, and there were no proper methods of solid waste disposal, resulting in haphazard dumping.

Residents in the settlements of Mukuru must cope with entrenched poverty, gender inequality, and frequent threats to their dignity that stem from inadequate housing, water and sanitation. Households typically rent tiny iron shacks with only minimal infrastructure and face a range of major health concerns. Inadequate shelter has resulted in severe health risks and threats to well-being. According to surveys of Nairobi's slums, the under-5 mortality rate in Mukuru was 83 per 1000. This under-5 mortality rate exceeds the Nairobi slum average of 80 per 1000 and the city's overall average of 52 per 1000 (ibid.), underscoring the particularly acute health concerns in Mukuru and multiple burdens linked to poor housing and poor sanitation.

The SSS pilot project along Mosque Road in Mukuru Kwa Reuben was implemented by Nairobi City Water & Sewerage Company (NCWSC), Nairobi Metropolitan Services (NMS) and WSUP in 2020-2021. Its target was to reach 100 plots (1,000 households with a population of about 4,000 persons) through laying of 1,800 metres of simplified sewer service lines with 75 inspection chambers. The pilot project also



Image: Slum conditions in Mukuru, Nairobi.

entailed the installation of ten prepaid water dispensers (PPDs) and upgrading of toilets by landlords' own investments, to connect to the SSS. Demand creation also facilitated NCWSC's sewer connections at plot-level and accelerated the upgrade of the pit latrines to pour-flush standards with technical support by trained local artisans. The project cost was US\$ 140,000 which improved sanitation access to a population of approximately 4,000 people. This represents a per-capita cost of about US\$ 35 for last-mile sewer connection.

NCWSC's pilot SSS design is premised on the World Bank Simplified Sewers Design Guidelines⁹ and DFID/University of Leeds Design Manual.¹⁰ A 2021 qualitative study by WSUP on stakeholders' perspectives on the Mukuru pilot SSS project has offered seamless adaptation of these guidelines and manuals. Validation of the WSUP qualitative study was led by NCWSC and NMS, and has helped to move forward the enhancement of design specifications, operations and maintenance, planning for a return to paid services and sharing of roles amongst key stakeholders. The validation has yielded resolutions on the project's next steps, including planned review of

⁹ Bakalian et al (1994).

¹⁰ Mara et al (2001).

Nairobi City County Sanitation Policy and Draft Bill to incorporate SSS, capacity building of the NCWSC and NMS teams on O&M, and development of a monitoring and evaluation tool to be administered jointly by the stakeholders. At national level, WSUP is using learnings from the pilot to inform the basis for influencing review of the policies, regulations, laws, building codes and NCWSC's sewer policy and manual, so as to provide a platform for scaling project in the city.

The key lessons learnt from the Mukuru pilot scheme are:

- In the pilot SSS project implemented along Mosque Road, water and sanitation access, reliability, affordability and quality have significantly improved in comparison with other areas/villages in the wider Mukuru informal settlement with no SSS intervention.
- The SSS elements including shallow trenches and manholes, and easy maneuverability following existing footpaths, offer a cheap technical solution to access of waterborne offsite sanitation services in densely populated areas which were previously difficult to sewer without displacement and interrupting livelihoods.
- Most structure owners and tenants consider the overall costing for the SSS model to be affordable compared to alternative forms of sanitation, and were even willing to pay higher rent for plots with toilets upgraded to pour-flush standards.
- The strategy of directly working through NCWSC with the structure owners and continued sensitisation of users on responsible use of the SSS continues to be key to the sustainability of the project.
- There is need for NCWSC Partners and the Government agencies to deliberate further on future financing arrangements for trunk sewer expansion to include a component of construction of sewer laterals.

- The NCWSC sewer policy should be updated to ensure future sewer expansion/extension, including a mandatory financing for last-mile connectivity.

The SSS pilot in Mukuru has been subject of two independent evaluations commissioned by WSUP, with positive findings relating to sustainability, affordability, customer satisfaction and scalability. For a summary of key evaluation findings, see WSUP (2022) “Are Simplified Sewer Systems a viable option for informal settlements in Kenya? Results of a pilot project in Mukuru, Nairobi”.

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Credits and acknowledgements

The WSUP project activities in Mukuru on which this Guide is based were funded by The One Foundation. WSUP is grateful to the residents of Mukuru and our wider partners in the Mukuru Integrated Development Plan: Nairobi City Water and Sewerage Company (NCWSC), Nairobi Metropolitan Services (NMS) and Akiba Mashinani Trust (AMT). Evaluations of the SSS model in Mukuru were conducted by Armitech Consulting Engineers and Maureen Musya.

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Version 1: November 2022.

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Series editor: Sam Drabble.