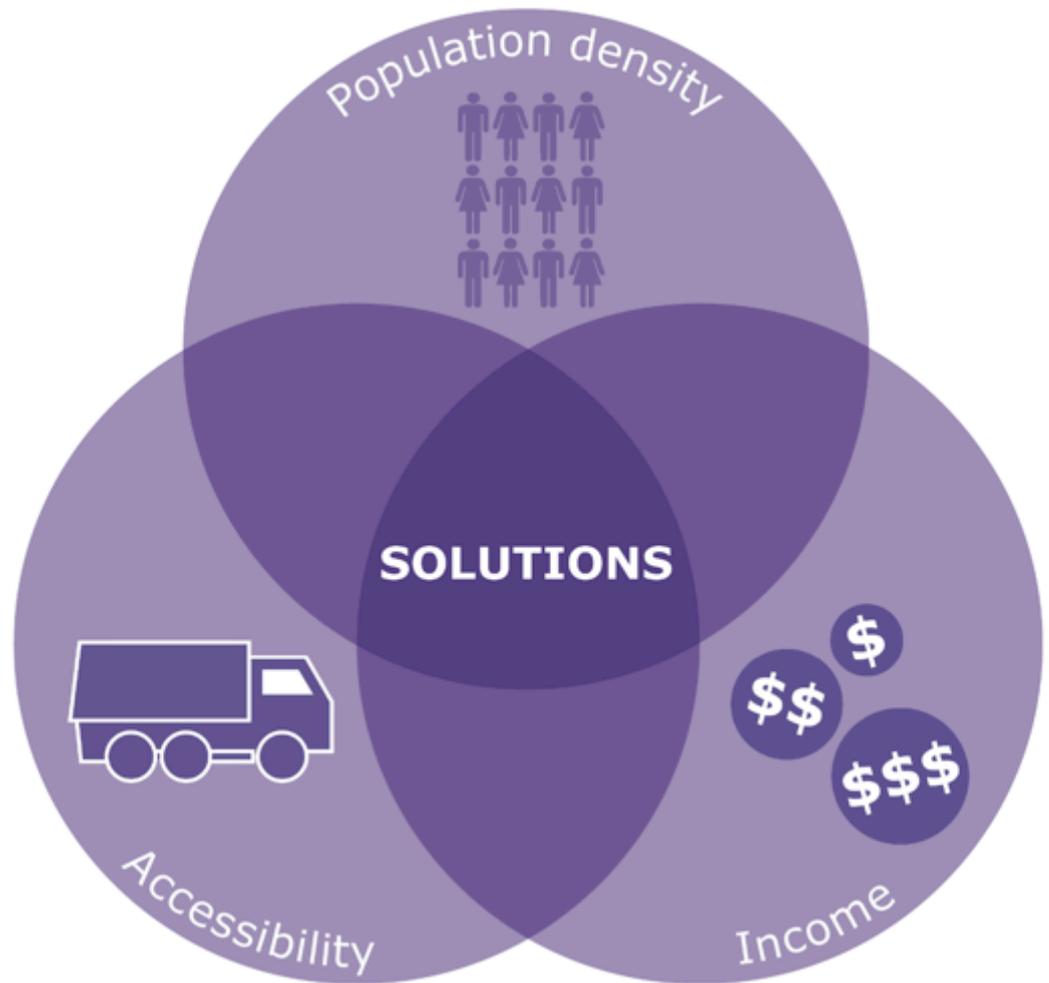
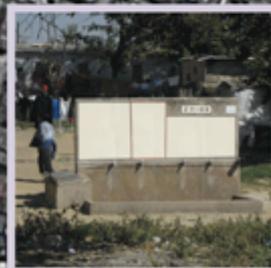


## 5 step planning guide *Which solutions go where?*



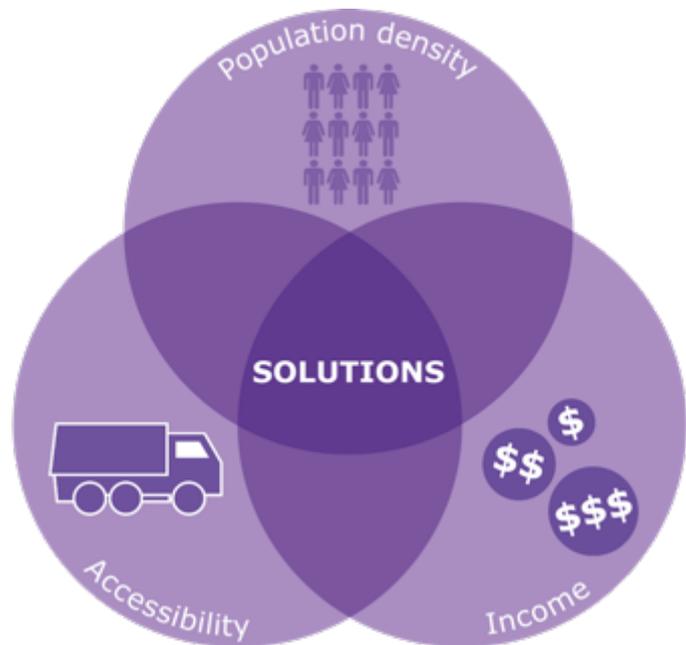
**Case Study: Dar es Salaam, Tanzania**  
Solutions for residential & commercial areas





## *5 step planning guide* *Which solutions go where?*

We welcome any  
feedback or constructive  
comments



### **Case Study:** Dar es Salaam, Tanzania For residential and commercial areas

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Andreas Schmidt  
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Faraja Mbuduka

Produced by



With support from



Bundesministerium für  
wirtschaftliche Zusammenarbeit  
und Entwicklung



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# About this planning guide

This planning guide is the second part of a 3-part City Sanitation Planning package, and will present a selection of options for improving environmental sanitation in urban areas, with a focus on decentralised options as an alternative to conventional systems. Dar es Salaam will be used as an example, as the city (like many rapidly urbanising cities in developing countries) is struggling to provide adequate service coverage to all citizens.



## Who is this guide for?

This tool has been designed to assist all decision-makers and practitioners involved in urban environmental sanitation planning, such as:

- Municipalities
- Water / wastewater utilities
- Sector regulators
- Service providers
- City council / local governments
- Urban planners
- Urban developers
- Donors
- NGOs

# Understanding the existing urban context

When it comes to planning for urban environmental sanitation improvements, there is no “one size fits all” solution for the whole city.

In cities like Dar es Salaam, the urban fabric contains a patchwork of different land uses and settlement structures, each with specific challenges in terms of environmental sanitation. It is therefore helpful to categorise these areas according to their physical and socio-economic characteristics, to better understand the various scales and types of interventions available. This process of categorisation also helps to streamline the process of identifying and implementing the most suitable solutions for each area.



Figure 1: Various land use categories in Dar es Salaam

The planning steps in this guide will only cover recommendations for **residential** and **commercial areas**, These areas often in close proximity (or co-exist), and have similar physical characteristics and sanitation requirements. Other land use categories such as industry, institutions and public places require a separate planning approach. Likewise, military areas have different rules and fall under another jurisdiction.

## Various options for service delivery

Recommendations for environmental sanitation service delivery in residential and commercial areas might include **decentralised** (on-site) services for some areas, as well as **centralised** (off-site) systems for other areas.

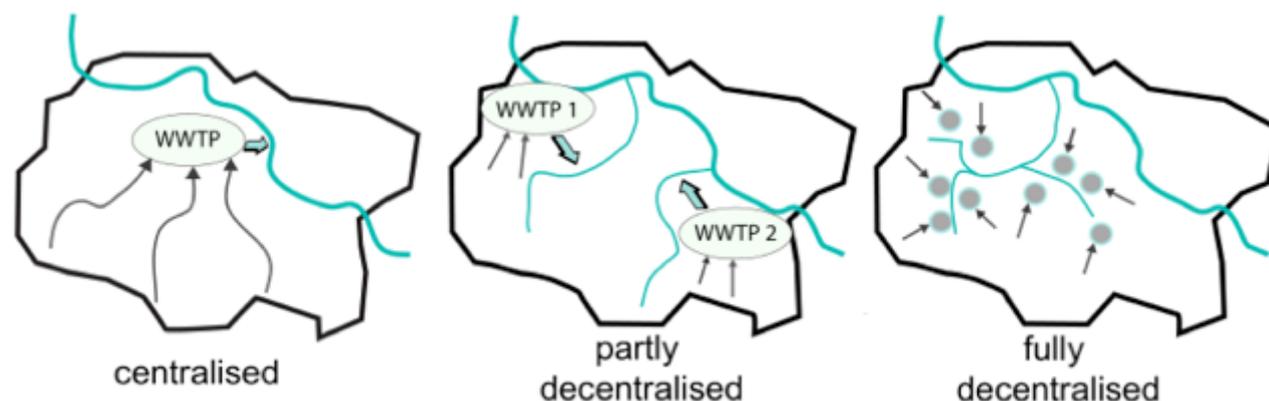
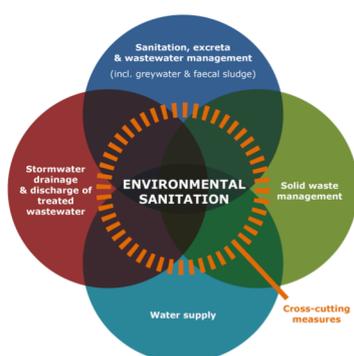


Figure 2: The range of different models for service delivery (IWA 2014)

## Defining environmental sanitation

Environmental sanitation can be understood as a set of activities required to achieve a sanitary physical environment. Based on the *Bellagio Principles for Sustainable Sanitation*, environmental sanitation was developed by a team of WASH experts in 2000 in response to the shortfalls of conventional sanitation policies and practices in meeting the needs of the developing world (WSSCC 2000).

Environmental sanitation goes one step further than the traditional notion of “sanitation” which is limited to the immediate aspects surrounding human excreta and/or the provision of toilets. A holistic approach to achieving a sanitary urban environment considers all aspects related to hygiene, notably those aspects directly linked to human health and quality of life:



- **Sanitation, excreta & wastewater management (including grey water and faecal sludge)**
- **Solid Waste Management (SWM)**
- **Water supply**
- **Storm water & discharge of treated wastewater**
- **Cross-cutting measures**

**NOTE: Understanding environmental sanitation and implementing long-lasting solutions requires a paradigm shift from thinking of “used” water as “waste” water (something to discard) to thinking of it as a valuable resource. The familiar term “wastewater” will be used within this guide, however it is crucial to acknowledge the value of “used” water, as more than simply “waste” water.**

### Decentralised options might include the following:



#### **Sanitation, excreta & wastewater management (including grey water and faecal sludge):**

Pit-latrines (lined or unlined), double-leach pits, on-site septic solutions, or ‘decentralised wastewater treatment solutions’ (DEWATS) with French drain. Faecal sludge management (FSM) goes hand-in-hand with on-site sanitation systems.



#### **Solid Waste Management (SWM):**

Household solid waste separation, ‘decentralised solid waste management’ (DESWAM) facilities: compost facilities (CF), material separation facilities (MSF), recycling depots (RD).



#### **Water supply:**

Borehole connections (individual or communal), delivery via human-powered carts, small 3-wheel transporters or trucks.



#### **Storm water & discharge of treated wastewater:**

Groundwater recharge via French drain, re-use in agriculture or aquaculture

### **Centralised options might include the following:**



**Sanitation, excreta & wastewater management (including greywater and faecal sludge):**  
Connection/extension to public sewer networks



**Solid Waste Management:**  
Collection via truck to central landfill site



**Water supply:**  
Connection/extension to public water-supply networks



**Stormwater & discharge of treated wastewater:**  
Connection/extension to public stormwater drainage networks

### **Partly-decentralised options:**

There are also many areas where **party-decentralised** can be recommended, which means they employ a combination of both on-site and off-site sanitation solutions. For example, FSM can be considered a partly-decentralised solution, where sludge from individual, on-site pit latrines or septic systems is emptied and transported to an off-site sludge treatment facility

Party-decentralised solutions also include simplified sewers or solids-free sewers, which are well suited for planned communities such as national housing schemes or housing estates. In these areas, numerous households might be connected to one shared facility for treating wastewater.

It is important to note, that in all areas, decentralised and partly-decentralised solutions have the potential to be incrementally upgraded, and connect to future centralised network expansions at a later date.



**Decentralised example:**  
DESWAM compost facility



**Centralised example:**  
Connection to water-supply network



**Partly-decentralised example:**  
FSM



#### **Cross-cutting measures:**

For any of environmental sanitation interventions to be successfully implemented and sustainable, the following cross-cutting measures must be addressed:

- Law enforcement / environmental policies
- Awareness creation and community education (E.g. training workshops, house-to-house education, mobile sanitation exhibition)
- Marketing of sanitation hardware products and services



# 5 step guide to planning city sanitation

## Basis of the planning steps

This planning methodology was created in response to the need for a simple, fast and flexible tool, which can keep up with rapid urban growth. This city-wide mapping and planning tool is based on demographic, physical and economic characteristics, and has the following advantages:

- Fast to update as new data (e.g. satellite imagery, open-street maps, etc.) becomes available
- Broad and inclusive coverage of all areas of the city
- Field surveys are only required for selected areas, saving time and money

### Preliminary steps

#### STEP 1

Obtain satellite image of selected area

#### STEP 2

Map selected area using GIS software

### Planning steps: "Which solutions go where?"

#### STEP 3

This step will result in a list of **all possible solutions** for each area



**STEP 3.1: Map population density** [Demand]



**STEP 3.2: Overlay accessible / inaccessible areas** [Solution logistics]



**STEP 3.3: List solutions according to income category** [Solution affordability]

#### STEP 4

This step will result in a **shortlist of most suitable solutions** for each area

**Define other city-specific conditions and by-laws**  
(E.g. Areas with public health risks, high ground water, flood prone)

### Prioritising "where to start?"

#### STEP 5

Identify where the demand/priority is highest

**Next steps: prior to implementation**

## Preliminary Steps

---

### STEP 1: Obtain satellite image of selected area

To begin with, select an area of interest. This is the area in which interventions are required for improving environmental sanitation. For example, this area of interest could be an entire city, a single municipality, or a group of wards. The size of the area is not important, as long as the boundary is defined according to the project interests. Once an area of interest has been defined, obtain satellite image data<sup>1</sup>.

**NOTE: If digital maps of the area of the area already exist, this initial step can be by-passed.**

As this planning guide was developed for the case of Dar es Salaam, examples from Dar es Salaam will be shown throughout the following pages, to help guide through the planning steps.



**Figure 4: Satellite image of Dar es Salaam showing selected area of interest (Google earth, 2015). See Figure 5 for zoom in area.**

---

<sup>1</sup> The high-resolution satellite images used within this guide have been sourced from the National Bureau of Statistics, Tanzania (2012). Additional satellite images have also been captured from Google Earth (2015).

## STEP 2: Map selected area using GIS software

Import the satellite image data from step 1 into GIS (geographic information systems) mapping software<sup>2</sup> and then overlay additional maps, when this data is available. Useful maps and data to obtain at this stage includes:

- Existing water supply or sewerage networks (including planned network expansions)
- Municipality and ward boundaries
- Landfill sites
- Demographic data (E.g. population per ward)
- Roads
- Economic data (E.g. average income per ward)
- Flood prone areas
- Water-table levels
- Areas prone to disease (E.g. cholera)

Where this data is not readily available for import, it can be extrapolated from satellite images (e.g. roads) or through data input into GIS software (e.g. population, economic data).



For more detailed information on the process of mapping using GIS software, please refer to the BORDA "Sanitation Mapping Guide" which supplements this planning guide.

Figure 5: Satellite image of Dar es Salaam, zooming into an area of interest (Google earth, 2015)

<sup>2</sup> GIS software such as ESRI ArcGIS ([www.esri.com/](http://www.esri.com/)) or QGIS ([www.qgis.org/](http://www.qgis.org/)) open-source and free system.

## Planning steps: “Which solutions go where?”

### STEP 3



**STEP 3.1: Map population density** [Demand]

+



**STEP 3.2: Overlay accessible / inaccessible areas** [Solution logistics]

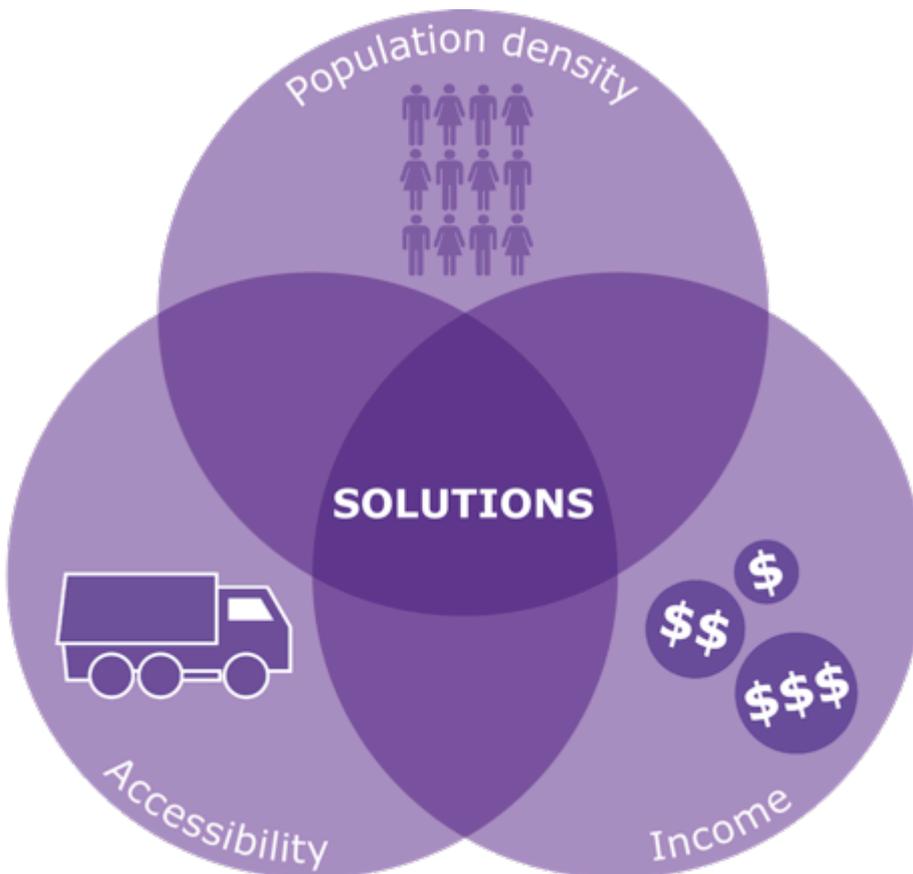
+



**STEP 3.3: List solutions according to income category** [Solution affordability]

This step will result in a list of **all possible solutions** for each area

The third step is to overlay specific parameters onto the map using GIS software. The following demographic, physical and economic characteristics have been selected as the most relevant factors influencing environmental sanitation conditions within urban areas: **population density, accessibility** and **income**:



**Figure 6: These three parameters are the backbone of this 5-step sanitation planning process**

The parameters should be considered in unison, in order to group various areas of the city according to their respective challenges and needs surrounding environmental sanitation (See Page 7). This methodology therefore intends to streamline the process of identifying possible solutions for various areas of the city, resulting in a list for “*which*” solutions could go “*where*”.

### STEP 3

## Case study: Dar es Salaam

On the following pages, the parameters of **population density**, **accessibility** and **income** will be defined and steps 3-1 – 3.3 will be applied to the example of Dar es Salaam.

Within each parameter, each category has been ranked according to how challenging it is to provide environmental sanitation infrastructure/services to these areas. The concept of ranking can help to identify demand and to prioritise interventions, which will be explained in more detail on page 43:

**Most  
challenging  
area**

High  
priority

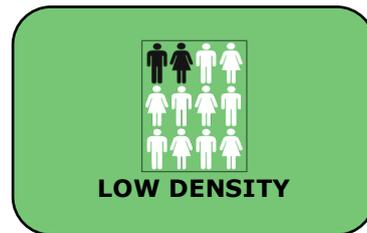
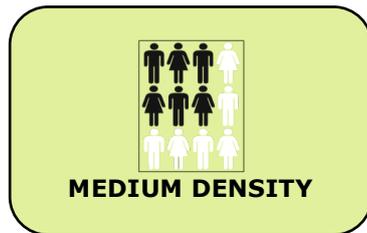
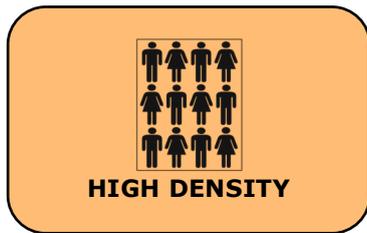
**Area with  
medium  
challenge**

Medium  
priority

**Least  
challenging  
area**

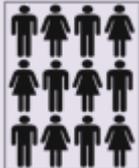
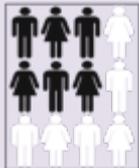
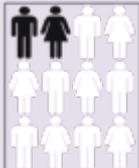
Low  
priority

### STEP 3.1: Mapping population density [Demand]



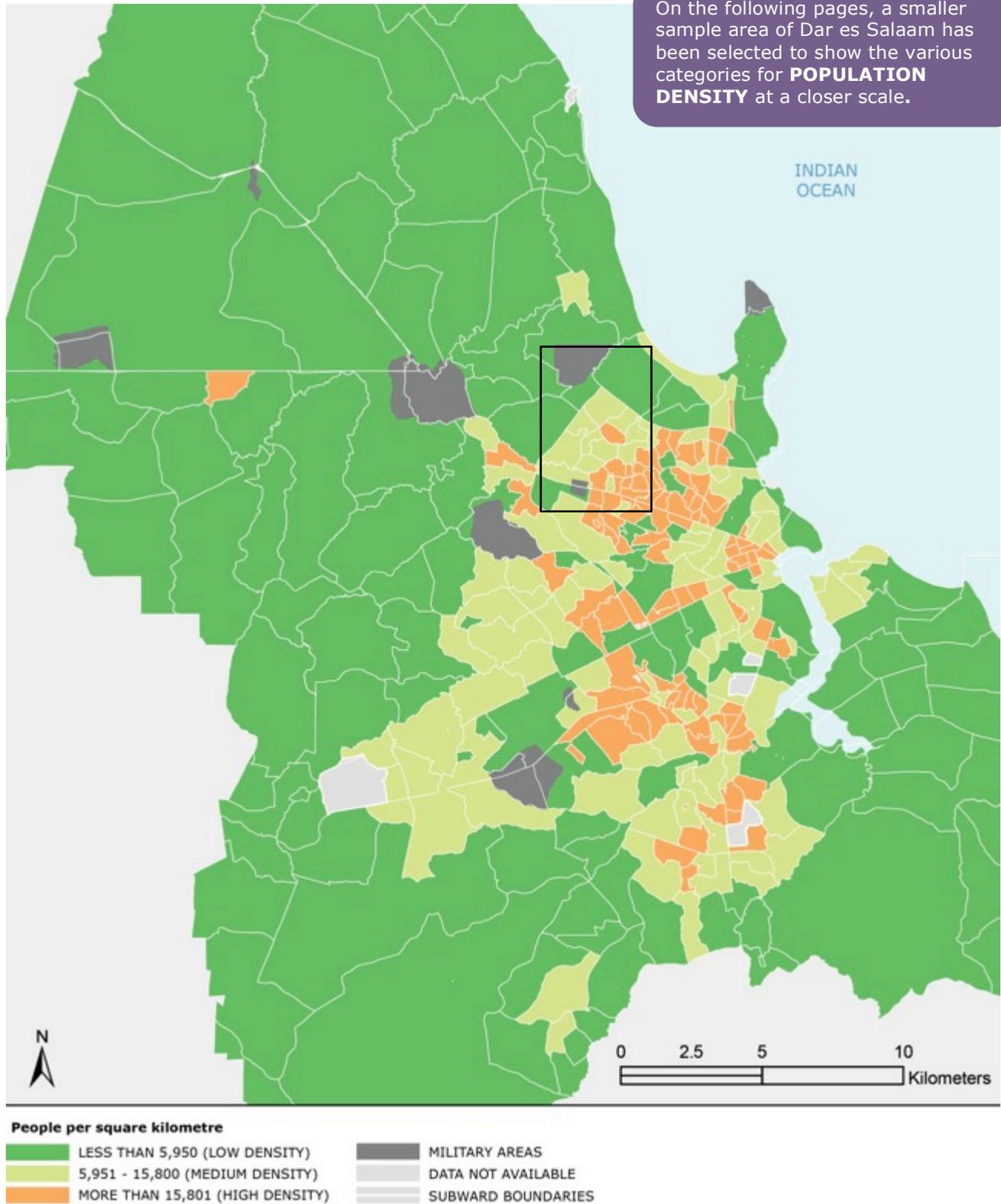
#### Defining: Population density

The average number of people living in each square kilometre determines population density. This has been calculated using population data for each sub-ward (obtained from the Dar es Salaam municipalities), and then dividing the population of each sub-ward by the area (km<sup>2</sup>). The categories of **LOW DENSITY**, **MEDIUM DENSITY** and **HIGH DENSITY** are classified using tertile distribution, where each of the three groups contain one third of the total population of Dar es Salaam.

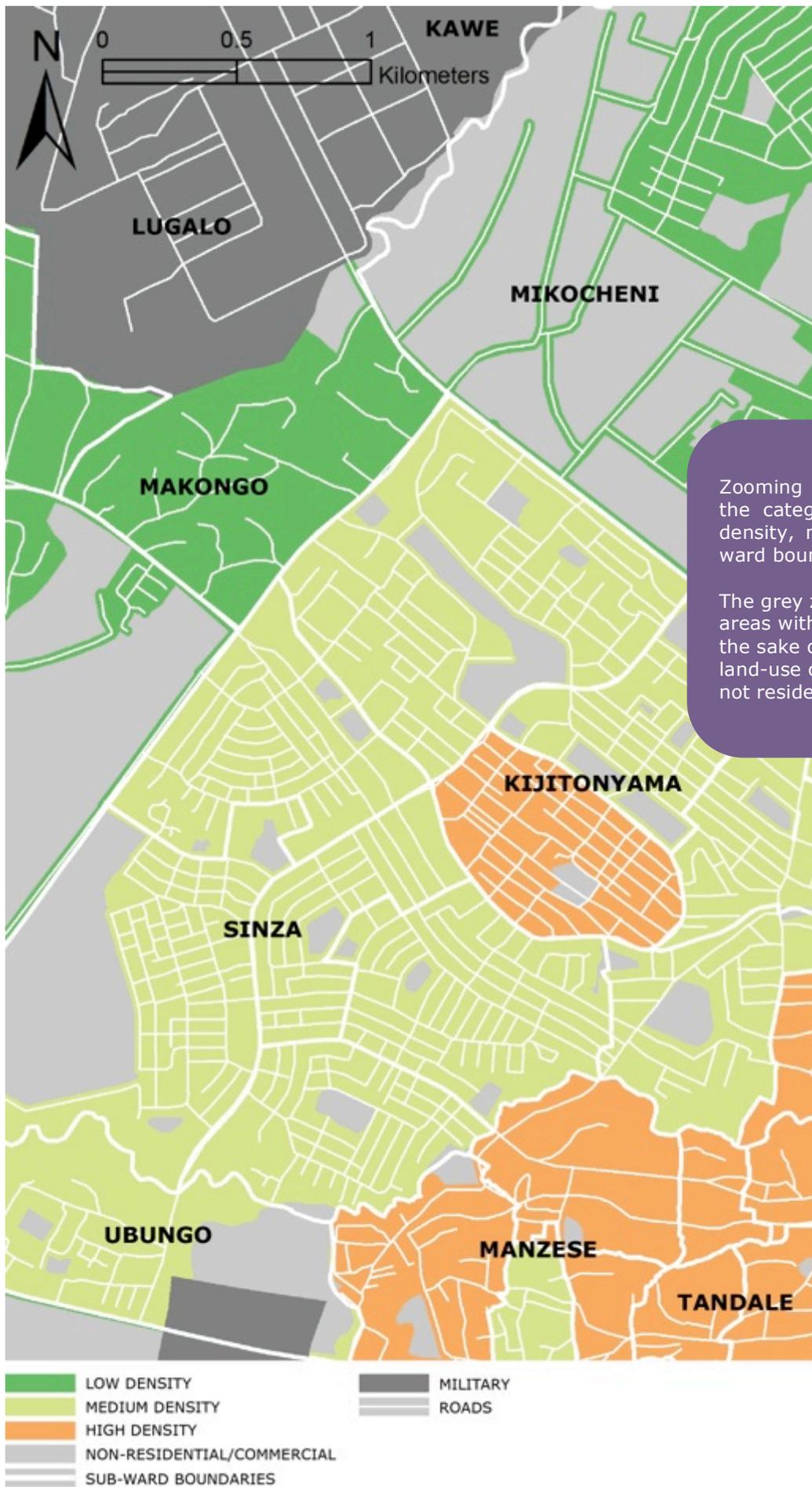
	Parameters	Characteristics
 <b>HIGH DENSITY</b>	<p><b>Average density</b>                      More than 15,801 people/km<sup>2</sup></p>	<ul style="list-style-type: none"> <li>Typically unplanned, low-income areas OR residential towers in the inner-city</li> <li>Prone to vertical growth</li> <li>Due to high population living in a small area and the economy of scale, expanding centralised networks to these areas may be financially viable</li> </ul>
 <b>MEDIUM DENSITY</b>	<p><b>Average density</b>                      5,951 – 15,800 people/km<sup>2</sup></p>	<ul style="list-style-type: none"> <li>Prone to gradual vertical growth</li> <li>Land still available for decentralised solutions</li> </ul>
 <b>LOW DENSITY</b>	<p><b>Average density</b>                      Less than 5,950 people/km<sup>2</sup></p>	<ul style="list-style-type: none"> <li>High investment costs for centralised water &amp; sanitation infrastructure due to distance between settlements and economy of scale</li> <li>Typically clear land-ownership</li> <li>Prone to horizontal growth</li> </ul>
	<p><b>Most challenging area</b></p> <p><b>High priority</b></p>	<p><b>Area with medium challenge</b></p> <p><b>Medium priority</b></p>
		<p><b>Least challenging area</b></p> <p><b>Low priority</b></p>

To help explain step 3 in more detail, the city of Dar es Salaam has been mapped using GIS software (See Figure 7 below) according to the legislative boundaries of sub-wards. Using the sub-ward boundaries to categorise **population density** was the most efficient way to incorporate detailed population data over a large-scale area. It is also reasonable to work within these boundaries, as the ward and sub-ward leaders would need to be involved in any potential interventions.

On the following pages, a smaller sample area of Dar es Salaam has been selected to show the various categories for **POPULATION DENSITY** at a closer scale.



**Figure 7: Wards of Dar es Salaam, categorised according to population density. The black square shows the area, which will be examined at a closer on the following pages**



Zooming into this area shows the categories for population density, mapped according to ward boundaries.

The grey zones represent areas which are excluded for the sake of this exercise (any land-use categories that are not residential or commercial).

**Figure 8: Zooming into a sample area of Dar es Salaam - showing population density (per ward)**

## STEP 3.2: Overlay accessible / inaccessible areas [Solution logistics]



This step is to identify which areas can be considered “**accessible**” and those with “**limited or no access**” to conventional sanitation services. When we talk about accessibility, we are talking about the proximity roads (+/- 20 metres), which is a crucial factor when making decisions regarding solution logistics for the following reasons:

- (1) Service provision can be considerably increased with road access. In areas where a sewer network is not possible, we advise to instead add roads and utility provision to increase accessibility to conventional, affordable services.
- (2) Without access to cost-effective services, service provision to these areas becomes costly and difficult. As a result, the urban poor often pay more for individualised services.
- (3) It is challenging to implement underground water-supply or sewerage pipes to plots without road access, as pipes need to either pass under neighbouring plots, or navigate narrow pedestrian paths

### Defining: Accessibility

Accessibility is determined according to the distance from vehicular access roads (+/- 20m). The distance of 20 metres has been selected as the reasonable distance to provide sanitation services to areas NOT-SERVED by centralised infrastructure, by using a truck (E.g. FSM pit-latrine emptying via vacuum truck, solid waste collection via truck, water supply via tanker). Additionally, as the average plot size in Dar es Salaam is 20mx20m, it can therefore be assumed that any areas located beyond 20 metres from road access would need to pass through other plots in order to reach the road. This influences the type of services available, as well as the feasibility of implementing underground piping for water-supply and wastewater conveyances.

A road with sufficient vehicular access for trucks is defined as being at least 3m wide.

	Parameters	Characteristics
	<p>&gt; 20m from an access road</p>	<ul style="list-style-type: none"> <li>Typically unplanned areas</li> <li>Typical physical constraints include low-lying ground, flood-prone areas, steep slopes, or densely populated settlements</li> </ul> <p><b>No/limited road access suggests that conventional services (i.e. water-supply and wastewater vacuum trucks) are unable to reach these areas. Without adequate access, individualised service provision to these areas becomes costly and difficult</b></p>
	<p>&lt; 20m from an access road</p>	<ul style="list-style-type: none"> <li>Typically planned areas</li> </ul>

Most challenging area

High priority

Area with medium challenge

Medium priority

Least challenging area

Low priority

The distance of **20 metres** has been selected as the maximum distance for conventional sanitation services to reach households via truck (E.g. FSM pit-latrine emptying via vacuum truck, solid waste collection via truck, water supply tanker). A road with sufficient vehicular access for trucks is defined as being at least **3 metres** wide.

**However, it is also essential to consider road access together with topographical data, as trucks cannot navigate roads with a steep slope, sharp corners, poor road quality (e.g. pot-holes) or no-through-roads without turning area.**

To streamline the process of identifying accessible/inaccessible areas, we use GIS to first map the road networks, and then “off-set” all roads by a distance of 20m:



### 3.2.1 Map road networks

As this sample area shows, overlaying the road network in GIS mapping software can be useful for quickly identifying those areas **with access** to conventional services.



### 3.2.2 “Off-set” the roads

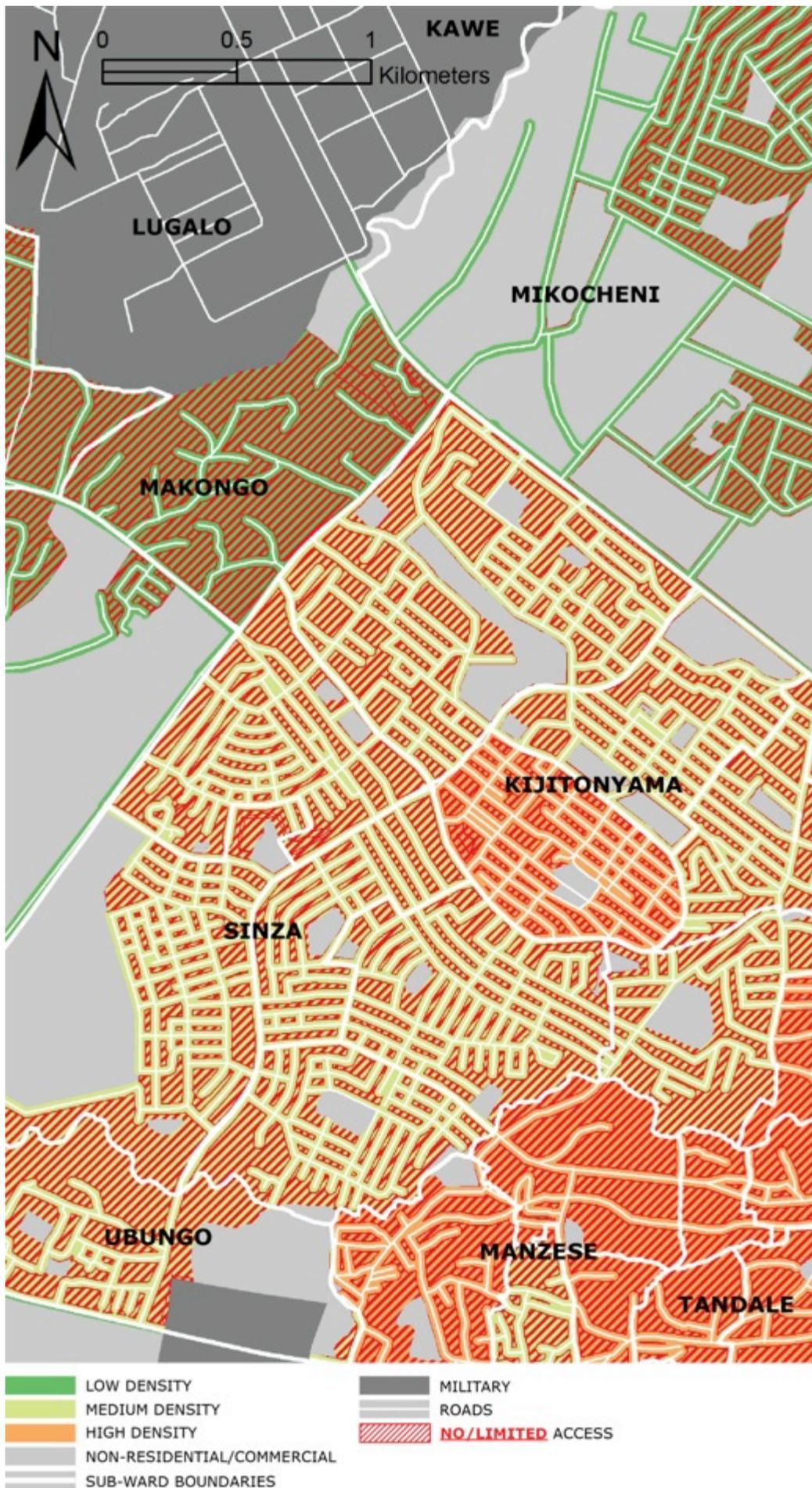
In order to identify areas with **limited or no road access**, all roads have been “off-set” by 20m, creating a buffer zone of 20m on either side.

Where these buffer zones overlap with one another, the larger “accessible” area can be clearly identified.

Meanwhile, areas located beyond this 20m buffer zone are considered to have **limited or no road access**, as shown by the red shading in this image.

**Such large expansive areas with limited or no road access are the most challenging areas for environmental sanitation.**

To help explain this step, we will zoom into the same mapped area as shown on page 17. This map in Figure 9 now shows the categories for **POPULATION DENSITY + ACCESSIBILITY**, overlaid onto the same sample area of Dar es Salaam.



**Figure 9: Zooming into a sample area of Dar es Salaam - showing population density (per ward) + accessibility**

### STEP 3.3: List solutions according to income category [Solution affordability]



The third step is to identify the most suitable set of solutions, which have been listed according to the users' ability to pay for services. Considering income is an important step in determining "solution affordability", and ultimately solution appropriateness.

As household income levels in Dar es Salaam are so varied – and accurate income data is difficult to obtain – it is not possible to map this parameter at ward-level. Assumptions at such a large scale are not helpful, because when we take a closer look at each ward, it is not common to find a range of different income levels at sub-ward and even at household level. Additionally, socio-economic conditions throughout the city are constantly changing, at a pace too fast to keep up with.

The recommendations are therefore presented under the three categories of **low-income**, **medium-income** and **high-income**. At this stage, it is up to the user to make the final decision on which category is most suitable for the area under consideration.

For example, pages 28 – 29:

	Low Income \$	Mid Income \$\$	High Income \$\$\$
<b>Sanitation, excreta &amp; wastewater management (including greywater and faecal sludge)</b>			
<b>Sanitation/excreta/excreta management (DEFEC)</b>			
Basic consumer on-line facilities	✓	✓	
Basic or improved existing latrine (e.g. VIP)	✓	✓	
<b>On-site storage/treatment</b>			
Latrine pit	✓	✓	
Double bucket latrine	✓	✓	
Double bucket latrine or (DUAL) with fresh/dry pit	✓	✓	
<b>TPSL</b>			
Manual emptying ("picking" or "drove") with pullcart or 3-wheel transporter	✓	✓	✓
Manual truck			✓
<b>Excreta for off-site treatment</b>			
Small-scale network connected to public sewer network	04 14 03	04 03 03	03
Composting (e.g. compost)	✓	✓	
Compost to individual crop/soil fertility (e.g. kitchen garden / agriculture)	✓	✓	
Compost to commercial crop/soil fertility (e.g. farm etc)	✓	✓	
Compost to existing wastewater system	✓	✓	
<b>Soil Waste Management</b>	\$	\$\$	\$\$\$
<b>Household-level waste for:</b>			
Transfer/purchase	✓	✓	
Transfer to vehicle	✓	✓	
<b>Door-to-door household collection</b>			
Manual purchase or 3-wheel transporter	✓	✓	✓
Truck			✓
<b>Waste recycling facilities</b>			
Manual recycling facility (MRF), recycling depot or material separation facility (MSF)	MRF	MRF	
Transfer point (e.g. container)	✓	✓	
Transfer station	01 15 15		
<b>Water supply</b>	\$	\$\$	\$\$\$
<b>Networks (Must not be located within 50m radius of unlined pit latrine)</b>			
Individual connection	✓	✓	
Community water standpipes	✓	✓	
<b>Water supply networks</b>			
Manual purchase, Transfer manager	✓	✓	✓
Truck			✓
<b>Related to water supply networks</b>			
Individual connection	04 30	04 04	✓
Community water standpipes	05	01	
<b>Cross-cutting measures</b>	\$	\$\$	\$\$\$
<b>Law enforcement / environmental policies</b>			
Enforcement (sanitation)	✓	✓	
Sanitation marketing	✓	✓	

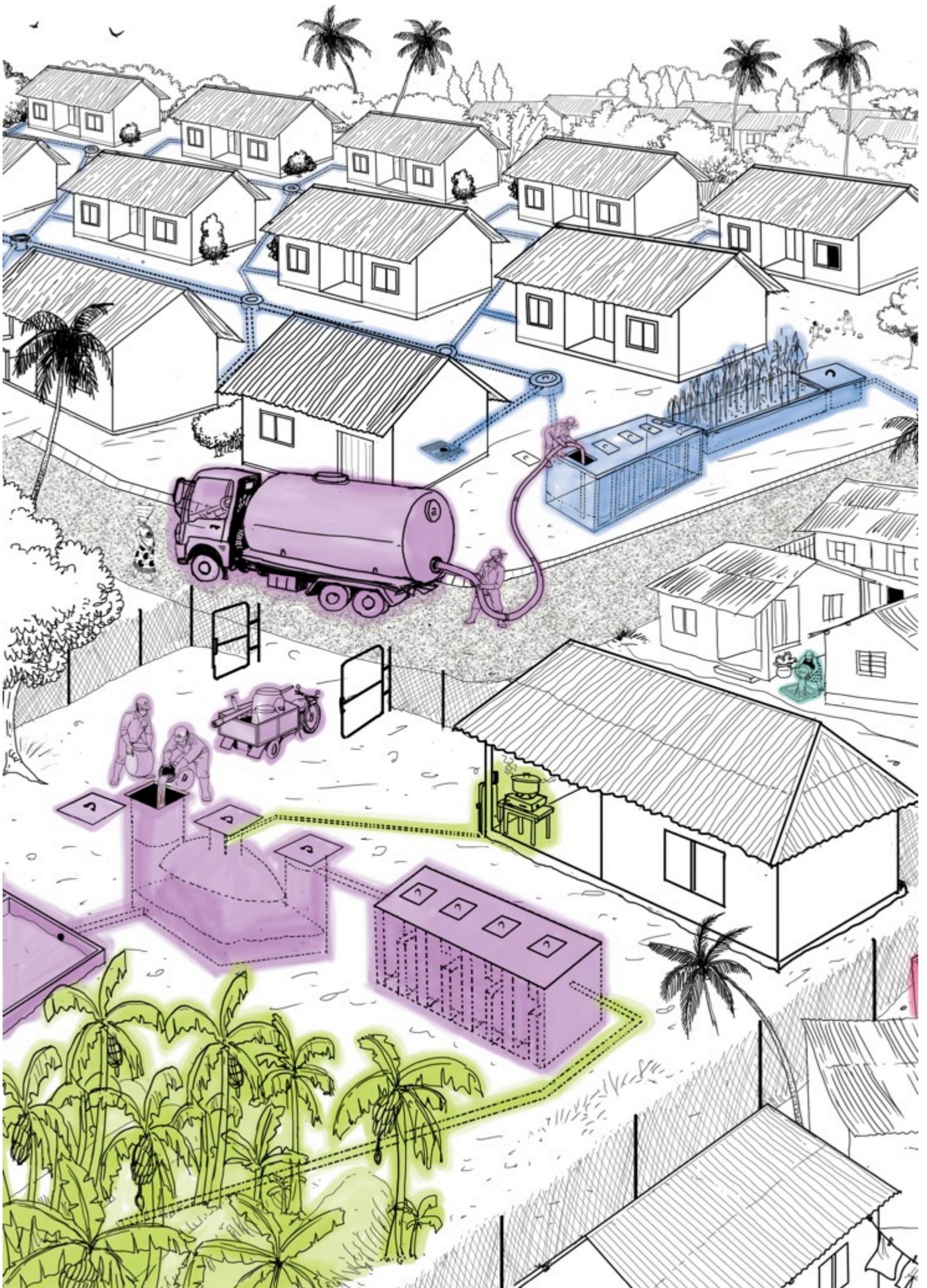
Guidance indicators on how to assess whether an area is low-, medium- or high-income can be found on page 21.

## Defining: Income

In order to assess whether an area is low-, medium- or high-income, some of the following physical indicators may include (but are not limited to) the following guidance:

	Possible indicators (TO PROVIDE GUIDANCE ONLY)	Characteristics related to environmental sanitation
 <p><b>LOW INCOME</b> (\$)</p>	<ul style="list-style-type: none"> <li>Typically with unclear land ownership and mainly short-term tenancy</li> <li>Inadequate (poor quality) or temporary physical structures</li> <li>Use of roofing materials such as corrugated iron, plastic sheeting</li> <li>Smaller sized dwellings</li> <li>Dense housing settlement patterns</li> <li>Hazardous locations (e.g. flood-plains, unstable slopes, industrial zones or railroads)</li> <li>Haphazard, unplanned road networks</li> </ul>	<ul style="list-style-type: none"> <li>Low-cost, temporary solutions and/or subsidies required</li> <li>Unsecured long-term investment and bill payments for water, wastewater and solid waste services</li> <li>Area for high physical water losses</li> <li>Willing to contribute "in-kind" (e.g. labour)</li> </ul>
 <p><b>MIDDLE INCOME</b> (\$\$)</p>	<ul style="list-style-type: none"> <li>Typically with clear land ownership and permanent tenancy</li> <li>Fenced property boundaries (e.g. with barbed wire)</li> <li>Durable housing structure</li> <li>Presence of vegetation</li> <li>Planned road networks, possibly with paved surfaces</li> <li>Presence of green areas</li> </ul>	<ul style="list-style-type: none"> <li>Able to pay for services</li> </ul>
 <p><b>HIGH INCOME</b> (\$\$\$)</p>	<ul style="list-style-type: none"> <li>Typically with clear land ownership and permanent tenancy</li> <li>Fenced property boundaries (e.g. with barbed wire or electric fence)</li> <li>Maintained gardens</li> <li>Planned road networks, possibly with paved surfaces</li> <li>Presence of green or open space</li> </ul>	<ul style="list-style-type: none"> <li>Able to pay for services</li> <li>Willing to pay more for solutions with less maintenance involved</li> </ul>

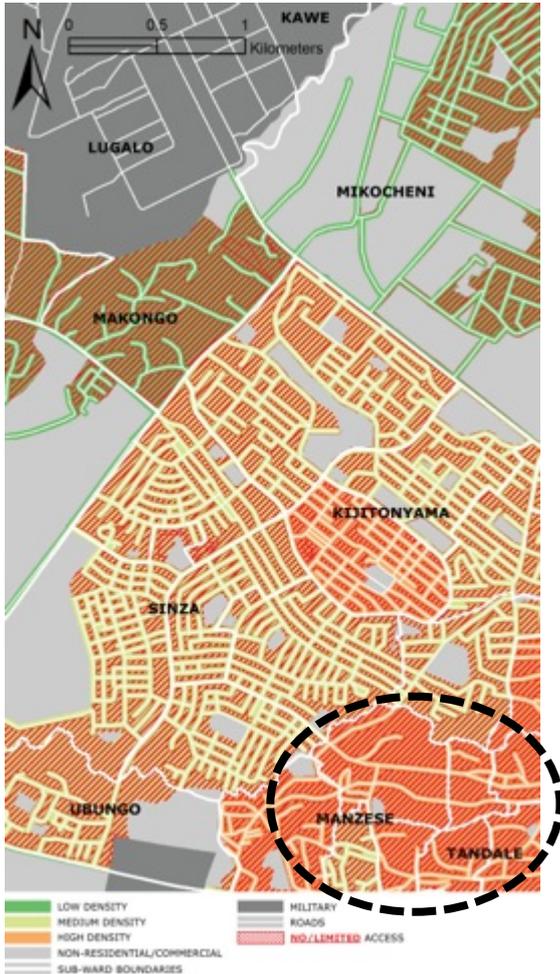




## Outcome of STEP 3: Example 1 from Dar es Salaam



See Page 28 for full details



eg. Tandale



### Sanitation, excreta & wastewater management (including greywater and faecal sludge):

#### On-site storage/treatment:

- Build communal sanitation facilities
- Build or improve existing latrines
- Lined-pit
- On-site septic solution



#### FSM:

- Manual emptying with pushcart or 3-wheel transporter

#### Conveyance:

- Small sewer network extended to public sewer network (if subsidised by government, or as part of a housing scheme). Recommended to build under roads to save space

#### Greywater re-use/disposal:

- Connect to individual or communal disposal facility
- Connect to existing wastewater system



### Water supply:

#### Borehole (Must not be located within 50m radius of unlined-pit latrines):

- Individual connection
- Communal water stands/kiosks



#### Water-supply delivery:

- Manual pushcart, 3-wheel transporter

#### Extend to water-supply network:

- Individual connection (if subsidised by government, or as part of a housing scheme). Recommended to build under roads to save space
- Communal water stands/kiosks (demolition of infrastructure / compensations required)



### Solid Waste Management (SWM):

#### Households carry waste to:

- Transfer point/station
- Truck on schedule

#### Door-to-door household collection:

- Manual pushcart or 3-wheel transporter

#### Waste reduction options:

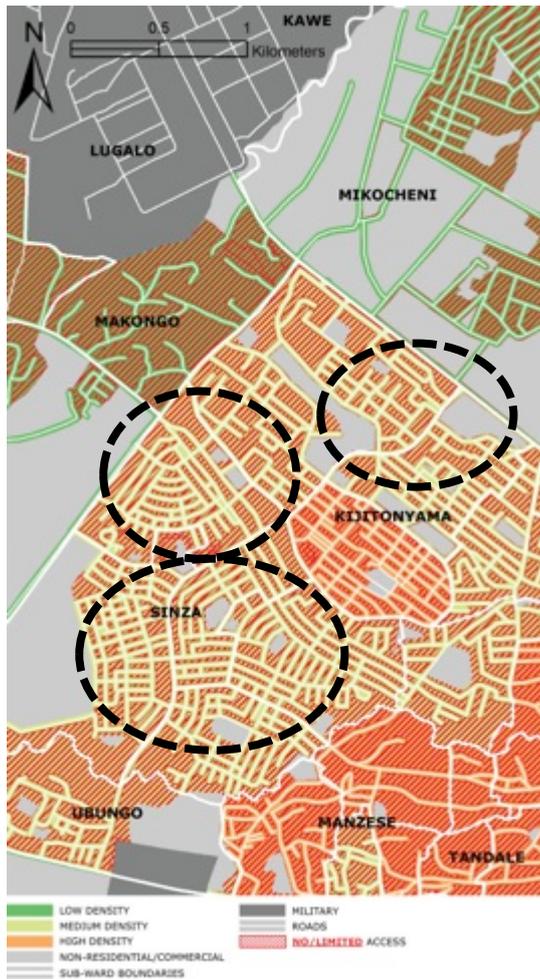
- MSR
- Transfer point
- Transfer station



## Outcome of STEP 3: Example 2 from Dar es Salaam



See Page 30 for full details



**Sanitation, excreta & wastewater management (including greywater and faecal sludge):**

**On-site storage/treatment:**

- Build or improve existing latrines
- Lined-pits
- Double leach-pit
- On-site septic solution



**FSM:**

- Vacuum truck

**Conveyance:**

- Small sewer network with off-site septic solution (if managed by service provider)
- Small sewer network extended to public sewer network

**FSM:**

- Vacuum truck

**Greywater re-use/disposal:**

- Connect to individual disposal facility
- Connect to existing wastewater system

**Water supply:**

**Borehole (Must not be located within 50m radius of unlined-pit latrines):**

- Individual connection

**Water-supply delivery:**

- Manual pushcart, 3-wheel transporter
- Truck



**Extend to water-supply network:**

- Individual connection

**Solid Waste Management (SWM):**

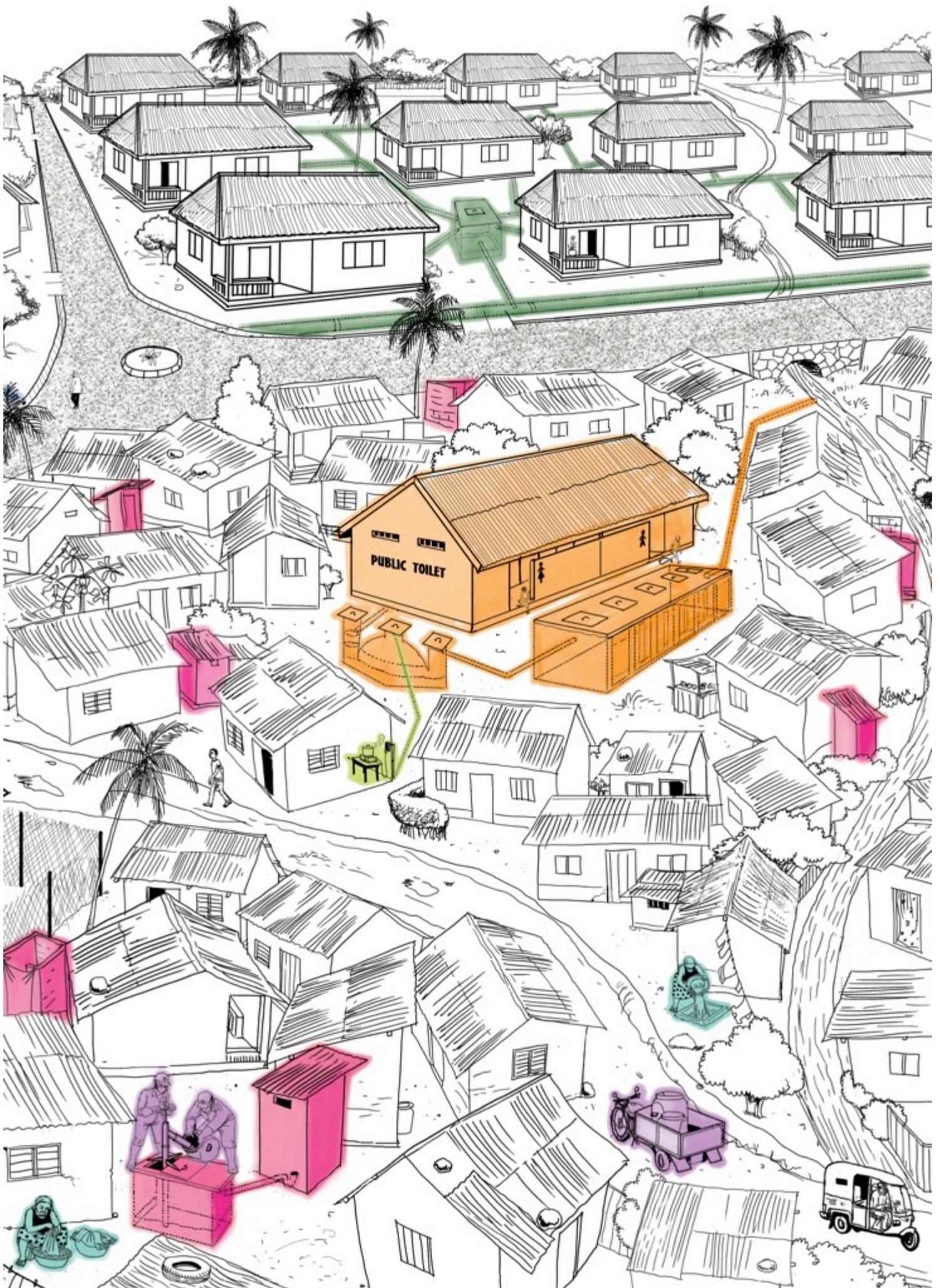
**Households carry waste to:**

- Truck on schedule

**Door-to-door household collection:**

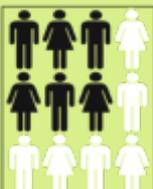
- Truck





## Overlaying the three parameters

The following pages show a comprehensive list of possible environmental sanitation interventions, for each specific settlement category:

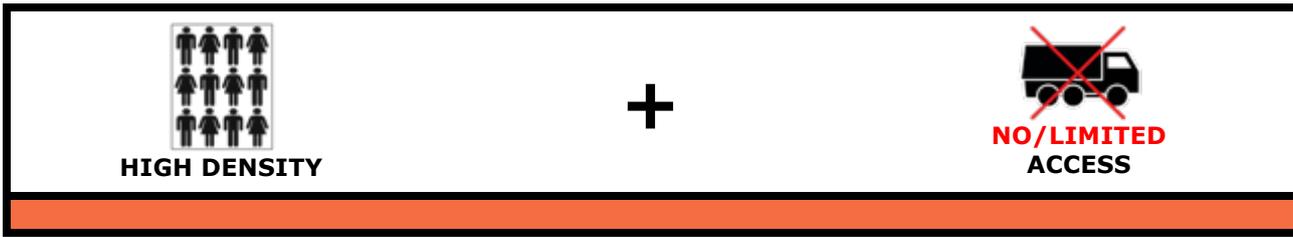
STEP 3.1 POPULATION DENSITY	+ STEP 3.2 ACCESSIBILITY	+ STEP 3.3 INCOME			= List of possible solutions
 HIGH DENSITY	 <b>NO/LIMITED ACCESS</b>	\$	\$\$	\$\$\$	Pages 28-29
	 ACCESSIBLE	\$	\$\$	\$\$\$	Pages 30-31
 MEDIUM DENSITY	 <b>NO/LIMITED ACCESS</b>	\$	\$\$	\$\$\$	Pages 32-33
	 ACCESSIBLE	\$	\$\$	\$\$\$	Pages 34-35
 LOW DENSITY	 <b>NO/LIMITED ACCESS</b>	\$	\$\$	\$\$\$	Pages 36-37
	 ACCESSIBLE	\$	\$\$	\$\$\$	Pages 38-39

**Table 1: This table shows the process of overlaying specific parameters, to arrive at a set of customised solutions listed on the following pages.**

### Certain conditions may apply to some of the interventions (See page 39 for more details on city-specific conditions and by-laws):

- If subsidised by government, or as part of a housing scheme
- If managed by service provider
- Recommended to build under roads to save space
- Demolition of infrastructure / compensations required
- Due to economy of scale, solid-waste collection via **truck** is not viable unless linked with neighbouring areas
- This intervention is only possible if sufficient land is available, or the service connects with other neighbouring areas
- When expanding the water-supply network, wastewater infrastructure must also be extended along with adequate wastewater treatment.
- Truck services only possible at night, to avoid traffic congestion

# Matrix of possible sanitation solutions



**LOW INCOME**  
\*



eg. Tandale



**MIDDLE INCOME**



eg. Ubungo



**HIGH INCOME**

\* There is no example in Dar es Salaam to fit the category **HIGH INCOME + NO/LIMITED ACCESS**. In many cities, this category is unlikely to exist, as high-income areas tend to be sufficiently accessible.

However, even with sufficient road access, traffic congestion in areas that are **HIGH DENSITY** means that truck-access is often severely limited.

For this reason, we still offer solutions for this category on the following page.



**HIGH DENSITY**



**NO/LIMITED  
ACCESS**

\*

 <b>Sanitation, excreta &amp; wastewater management (including greywater and faecal sludge)</b>	<b>Low income \$</b>	<b>Mid income \$\$</b>	<b>High income \$\$\$</b>
<b>Toilet type (source of wastewater generation):</b>			
Build communal sanitation facilities	✓		
Build or improve existing latrines (e.g. VIPs)	✓	✓	
<b>On-site storage/treatment:</b>			
Lined-pit	✓	✓	
Double leach-pit		✓	
On-site septic solution or DEWATS with French drain / soak away		✓	
<b>FSM:</b>			
Manual emptying ("gulper" or shovel) with pushcart or 3-wheel transporter	✓	✓	
Vacuum truck			(h)
<b>Conveyance to off-site treatment:</b>			
Small sewer network extended to public sewer network	(a) (c) (d)	(a) (c) (d)	(c)
<b>Greywater re-use/disposal:</b>			
Connect to individual disposal facility (e.g. Vertical garden / agriculture)	✓	✓	
Connect to communal disposal facility (e.g. Soak pit)	✓		
Connect to existing wastewater system	✓	✓	✓
 <b>Solid Waste Management</b>	<b>\$</b>	<b>\$\$</b>	<b>\$\$\$</b>
<b>Households carry waste to:</b>			
Transfer point/station	✓	✓	
Truck on schedule	✓	✓	
<b>Door-to-door household collection:</b>			
Manual pushcart or 3-wheel transporter	✓	✓	
Truck			(h)
<b>Waste recovery options (DESWAM):</b>			
Material recovery facility (MRF), recycling depot or material separation facility (MSF)	MSF	MSF	
Transfer point (e.g. container)	✓	✓	
Transfer station	(f)	(f)	
 <b>Water supply</b>	<b>\$</b>	<b>\$\$</b>	<b>\$\$\$</b>
<b>Borehole (*must not be located within 50m radius of unlined-pit latrines):</b>			
Individual connection	✓	✓	
Communal water stands/kiosks	✓	✓	
<b>Water-supply delivery:</b>			
Manual pushcart, 3-wheel transporter	✓	✓	✓
Truck			(h)
<b>Extend to water-supply network:</b>			
Individual connection	(a) (c) (d)	(a) (c) (d)	✓
Communal water stands/kiosks			
 <b>Cross-cutting measures</b>	<b>\$</b>	<b>\$\$</b>	<b>\$\$\$</b>
Law enforcement / environmental policies			✓
Awareness creation	✓		
On-site sanitation marketing	✓	✓	

**\*NOTE: Please see page 43 for more information on the importance of emergency intervention in these areas**



**HIGH DENSITY**



**ACCESSIBLE**



**LOW INCOME**



eg. Manzese



**MIDDLE INCOME**



eg. Magomeni



**HIGH INCOME**



eg. Kisutu



**HIGH DENSITY**



**ACCESSIBLE**



**Sanitation, excreta & wastewater management  
(including greywater and faecal sludge)**

	Low income \$	Mid income \$\$	High income \$\$\$
<b>Toilet type (source of wastewater generation):</b>			
Build communal sanitation facilities	✓		
Build or improve existing latrines (e.g. VIPs)	✓	✓	
<b>On-site storage/treatment:</b>			
Lined-pit	✓	✓	
Double leach-pit	✓		
<b>FSM:</b>			
Manual emptying ("gulper" or shovel) with pushcart or 3-wheel transporter	✓		
Vacuum truck	✓	✓	✓
<b>Conveyance to off-site treatment:</b>			
Small sewer network with off-site septic solution	(d)	✓	✓
Small sewer network extended to public sewer network	(a)	✓	✓
<b>Greywater re-use/disposal:</b>			
Connect to individual disposal facility (e.g. Vertical garden / agriculture)	✓		
Connect to communal disposal facility (e.g. Soak pit)	✓		
Connect to existing wastewater system		✓	✓
<b>Solid Waste Management</b>			
	\$	\$\$	\$\$\$
<b>Households carry waste to:</b>			
Transfer point/station	✓		
Truck on schedule	✓		
<b>Door-to-door household collection:</b>			
Manual pushcart or 3-wheel transporter	✓		
Truck	✓	✓	✓
<b>Waste recovery options (DESWAM):</b>			
Material recovery facility (MRF), recycling depot or material separation facility (MSF)	(f)		
Transfer point (e.g. container)	✓		
Transfer station	(f)		
<b>Water supply</b>			
	\$	\$\$	\$\$\$
<b>Borehole (*must not be located within 50m radius of unlined-pit latrines):</b>			
Individual connection	✓	✓	✓
Communal water stands/kiosks	✓		
<b>Water-supply delivery:</b>			
Manual pushcart, 3-wheel transporter	✓		
Truck		✓	✓
<b>Extend to water-supply network:</b>			
Individual connection	✓	✓	✓
Communal water stands/kiosks	✓		
<b>Cross-cutting measures</b>			
	\$	\$\$	\$\$\$
Law enforcement / environmental policies			✓
Awareness creation	✓		
On-site sanitation marketing	✓	✓	



MEDIUM DENSITY

+



**NO/LIMITED  
ACCESS**



**LOW  
INCOME**

\*



eg. Kipawa



**MIDDLE  
INCOME**



eg. Makongo



**HIGH  
INCOME**

\* This category (**NO/LIMITED ACCESS + HIGH INCOME**) is unlikely to exist, as high-income areas tend to be sufficiently accessible.



**MEDIUM DENSITY**



**NO/LIMITED  
ACCESS**

\*

 <b>Sanitation, excreta &amp; wastewater management (including greywater and faecal sludge)</b>	<b>Low income \$</b>	<b>Mid income \$\$</b>	<b>High income \$\$\$</b>
<b>Toilet type (source of wastewater generation):</b>			
Build communal sanitation facilities	✓		
Build or improve existing latrines (e.g. VIPs)	✓	✓	
<b>On-site storage/treatment:</b>			
Lined-pit	✓	✓	
Double leach-pit	✓	✓	
On-site septic solution or DEWATS with French drain / soak away		✓	
<b>FSM:</b>			
Manual emptying ("gulper" or shovel) with pushcart or 3-wheel transporter	✓	✓	
Sludge treatment plant	✓	✓	
<b>Conveyance to off-site treatment:</b>			
Small sewer network with off-site septic solution	(a)	✓	
Small sewer network extended to public sewer network	(a)	✓	
<b>Greywater re-use/disposal:</b>			
Connect to individual disposal facility (e.g. Vertical garden / agriculture)	✓	✓	
Connect to communal disposal facility (e.g. Soak pit)	✓	✓	
Connect to existing wastewater system	(a)	✓	
<b>Solid Waste Management</b>			
	<b>\$</b>	<b>\$\$</b>	<b>\$\$\$</b>
<b>Households carry waste to:</b>			
Transfer point/station	✓	✓	
Truck on schedule	✓	✓	
<b>Door-to-door household collection:</b>			
Manual pushcart or 3-wheel transporter	✓	✓	
<b>Waste recovery options (DESWAM):</b>			
Material recovery facility (MRF), recycling depot or material separation facility (MSF)	✓	✓	
Transfer point (e.g. container)	✓	✓	
Transfer station	✓	✓	
<b>Water supply</b>			
	<b>\$</b>	<b>\$\$</b>	<b>\$\$\$</b>
<b>Borehole (*must not be located within 50m radius of unlined-pit latrines):</b>			
Individual connection		✓	
Communal water stands/kiosks	✓		
<b>Water-supply delivery:</b>			
Manual pushcart, 3-wheel transporter	✓	✓	
<b>Extend to water-supply network:</b>			
Individual connection	(a)	✓	
Communal water stands/kiosks	✓		
<b>Cross-cutting measures</b>			
	<b>\$</b>	<b>\$\$</b>	<b>\$\$\$</b>
Law enforcement / environmental policies			✓
Awareness creation	✓		
On-site sanitation marketing	✓	✓	

**NOTE: Please see page 43 for more information on the importance of urgent planning in these areas**



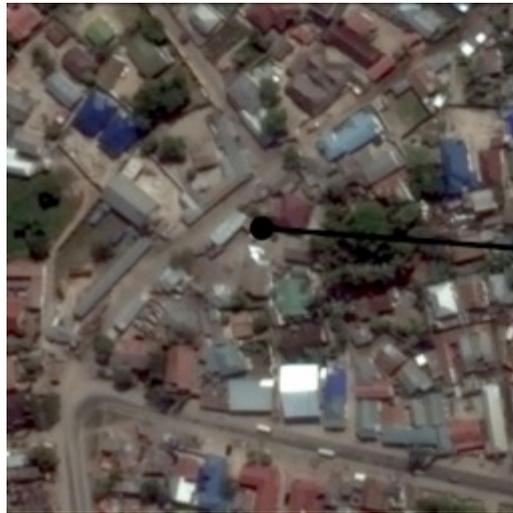
**MEDIUM DENSITY**



**ACCESSIBLE**



**LOW INCOME**



eg. Kipawa

**\*This category might also exist in the form of planned, low-income settlements (e.g. Subsidised housing schemes)**



**MIDDLE INCOME**



eg. Kijitonyama



**HIGH INCOME**



eg. Upanga



MEDIUM DENSITY



ACCESSIBLE



**Sanitation, excreta & wastewater management (including greywater and faecal sludge)**

Low income \$	Mid income \$\$	High income \$\$\$
------------------	--------------------	-----------------------

<b>Toilet type (source of wastewater generation):</b>			
Build communal sanitation facilities	✓		
Build or improve existing latrines (e.g. VIPs)	✓	✓	
<b>On-site storage/treatment:</b>			
Lined-pit	✓	✓	
Double leach-pit	✓	✓	
On-site septic solution or DEWATS with French drain / soak away		✓	✓
<b>FSM:</b>			
Manual emptying ("gulper" or shovel) with pushcart or 3-wheel transporter	✓		
Vacuum truck		✓	✓
<b>Conveyance to off-site treatment:</b>			
Small sewer network with off-site septic solution	✓	(b)	(b)
Small sewer network extended to public sewer network	✓	✓	✓
<b>Greywater re-use/disposal:</b>			
Connect to individual disposal facility (e.g. Vertical garden / agriculture)	✓	✓	
Connect to existing wastewater system	✓	✓	✓



**Solid Waste Management**

\$	\$\$	\$\$\$
----	------	--------

<b>Households carry waste to:</b>			
Transfer point/station	✓		
Truck on schedule	✓	✓	
<b>Door-to-door household collection:</b>			
Manual pushcart or 3-wheel transporter	✓		
Truck	(a)	✓	✓
<b>Waste recovery options (DESWAM):</b>			
Material recovery facility (MRF), recycling depot or material separation facility (MSF)	MSF		
Transfer point (e.g. container)	✓		
Transfer station	✓		



**Water supply**

\$	\$\$	\$\$\$
----	------	--------

<b>Borehole (*must not be located within 50m radius of unlined-pit latrines):</b>			
Individual connection	✓	✓	✓
Communal water stands/kiosks	✓		
<b>Water-supply delivery:</b>			
Manual pushcart, 3-wheel transporter	✓	✓	
Truck		✓	✓
<b>Extend to water-supply network:</b>			
Individual connection		✓	✓
Communal water stands/kiosks	✓		



**Cross-cutting measures**

\$	\$\$	\$\$\$
----	------	--------

Law enforcement / environmental policies			✓
Awareness creation	✓		
On-site sanitation marketing	✓	✓	



LOW DENSITY

+



**NO/LIMITED  
ACCESS**



LOW  
INCOME



eg. Kinyerezi



MIDDLE  
INCOME



eg. Mabwepande



HIGH  
INCOME

\* This category (**NO/LIMITED ACCESS + HIGH INCOME**) is unlikely to exist, as high-income areas tend to be sufficiently accessible.



LOW DENSITY



NO/LIMITED ACCESS

 Sanitation, excreta & wastewater management (including greywater and faecal sludge)	Low income \$	Mid income \$\$	High income \$\$\$
<b>Toilet type (source of wastewater generation):</b>			
Build or improve existing latrines (e.g. VIPs)	✓	✓	
<b>On-site storage/treatment:</b>			
Lined-pit	✓	✓	
Double leach-pit	✓	✓	
On-site septic solution or DEWATS with French drain / soak away		✓	
<b>FSM:</b>			
Manual emptying ("gulper" or shovel) with pushcart or 3-wheel transporter	✓	✓	
Sludge treatment plant	✓	✓	
<b>Conveyance to off-site treatment:</b>			
Small sewer network with off-site septic solution	✓	✓	
<b>Greywater re-use/disposal:</b>			
Connect to individual disposal facility (e.g. Vertical garden / agriculture)	✓	✓	
Connect to existing wastewater system	✓	✓	
 <b>Solid Waste Management</b>	\$	\$\$	\$\$\$
<b>Households carry waste to:</b>			
Transfer point/station	✓		
Truck on schedule	(e)	(e)	
<b>Door-to-door household collection:</b>			
Manual pushcart or 3-wheel transporter	✓	✓	
<b>Waste recovery options (DESWAM):</b>			
Material recovery facility (MRF), recycling depot or material separation facility (MSF)	✓	(f)	
Transfer point (e.g. container)	✓	✓	
Transfer station	✓	✓	
 <b>Water supply</b>	\$	\$\$	\$\$\$
<b>Borehole (*must not be located within 50m radius of unlined-pit latrines):</b>			
Individual connection		✓	
Communal water stands/kiosks	✓		
<b>Water-supply delivery:</b>			
Manual pushcart, 3-wheel transporter	✓	✓	
<b>Extend to water-supply network:</b>			
Individual connection	✓	✓	
Communal water stands/kiosks	✓		
 <b>Cross-cutting measures</b>	\$	\$\$	\$\$\$
Law enforcement / environmental policies			✓
Awareness creation	✓		
On-site sanitation marketing	✓	✓	



**LOW DENSITY**



**ACCESSIBLE**



**LOW INCOME**

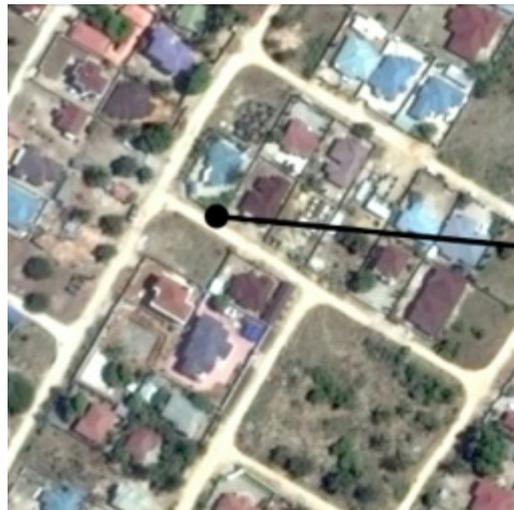


eg. Bunju A

**\*This category might also exist in the form of planned settlements (e.g. WAT Housing Scheme)**



**MIDDLE INCOME**



eg. Bunju A



**HIGH INCOME**



eg. Mikocheni B



LOW DENSITY



ACCESSIBLE

	Low income \$	Mid income \$\$	High income \$\$\$
<b>Sanitation, excreta &amp; wastewater management (including greywater and faecal sludge)</b>			
<b>Toilet type (source of wastewater generation):</b>			
Build or improve existing latrines (e.g. VIPs)	✓	✓	
<b>On-site storage/treatment:</b>			
Lined-pit		✓	
Double leach-pit	✓	✓	
On-site septic solution or DEWATS with French drain / soak away		✓	✓
<b>FSM:</b>			
Manual emptying ("gulper" or shovel) with pushcart or 3-wheel transporter	✓		
Vacuum truck		✓	✓
Sludge treatment plant	✓	✓	✓
<b>Conveyance to off-site treatment:</b>			
Small sewer network with off-site septic solution	✓	(b)	✓
Small sewer network extended to public sewer network			
<b>Greywater re-use/disposal:</b>			
Connect to individual disposal facility (e.g. Vertical garden / agriculture)	✓	✓	
Connect to existing wastewater system	✓	✓	✓
<b>Solid Waste Management</b>			
<b>Households carry waste to:</b>			
Transfer point/station	✓		
Truck on schedule			
<b>Door-to-door household collection:</b>			
Manual pushcart or 3-wheel transporter	✓		
Truck	(a)	✓	✓
<b>Waste recovery options (DESWAM):</b>			
Material recovery facility (MRF), recycling depot or material separation facility (MSF)	MSF	(f)	(f)
Transfer point (e.g. container)	✓		
Transfer station	✓		
<b>Water supply</b>			
<b>Borehole (*must not be located within 50m radius of unlined-pit latrines):</b>			
Individual connection		✓	✓
Communal water stands/kiosks	✓		
<b>Water-supply delivery:</b>			
Truck		✓	✓
<b>Extend to water-supply network:</b>			
Individual connection	✓	✓	✓
Communal water stands/kiosks	✓		
<b>Cross-cutting measures</b>			
Law enforcement / environmental policies			✓
Awareness creation	✓		
On-site sanitation marketing	✓	✓	

## STEP 4: Define other city-specific conditions and by-laws

The outcome of STEPS 1-3 is to arrive at a **full list** of possible environmental sanitation solutions, for each of the various settlement categories throughout the city. In STEP 4, the objective is to assess and **shortlist the most suitable interventions**. At this stage it is crucial to consider additional context-specific factors, which impact the planning and selection of suitable sanitation systems and technologies.

These conditions will differ from one city to another, and decisions for particular areas will be mainly guided by the following factors:

This step will result in a **shortlist of most suitable solutions** for each area

### **Existing coverage (See Figure 10) and proximity to:**

- **Water-supply network**
- **Sewerage network**
- **Storm-water network**
- **Existing wastewater treatment facilities**

### **Physical and public health conditions (See Figure 11):**

- **Ground water:**
  - In areas with high water (anything shallower than 2 meters) or prone to flooding:
    - Unlined pits should **NOT** be constructed, due to the risk of groundwater contamination, as 'soak-aways' and septic tanks are usually 2-4meters deep
    - Solutions need to be designed and constructed to be watertight, or elevated, to avoid stormwater intrusion, overflow or flooding
- **Spatial limitations:**
  - In high density areas with limited available space:
    - DEWATS or simplified sewers can be built under roads or car parks
    - Truck services are only possible at night, to avoid traffic congestion
    - Can services connect to other neighbouring areas?
    - Will existing infrastructure need to be demolished, in order to improve conditions? If yes, how will compensations be arranged?
- **Topographical limitations:**
  - Some areas which appear to be "accessible" according to the road network overlaid in STEP 3.2 might be "inaccessible" in reality due to poor road quality, sharp corners, steep gradients or no-through-roads without turning area.
    - In these areas, service provision via truck will not be possible, and therefore on-site solutions are recommended.

### **By-laws:**

- **Ownership and responsibility:**
  - Who owns the sanitation intervention?
  - Who is paying for the sanitation intervention?
    - Will there be government subsidies for low-income areas, or will it be financed through part of a housing scheme?
  - Who is responsible for operation and maintenance (O&M)?
    - Are there existing service providers in these areas? If not, does economy of scale (E.g. high-density areas) suggest a viable business model? Or can services to this area be connected to other neighbouring areas?
- **City regulations:**
  - Where can solid waste be disposed?
  - Where can pit-latrines or boreholes be constructed? (E.g. in Dar es Salaam, boreholes **CANNOT** be constructed within 50 metres of an unlined-pit latrine)

### **Additional objectives:**

- In areas identified for future expansions of the public water-supply network:
  - Infrastructure for wastewater conveyance or treatment **MUST** also be extended

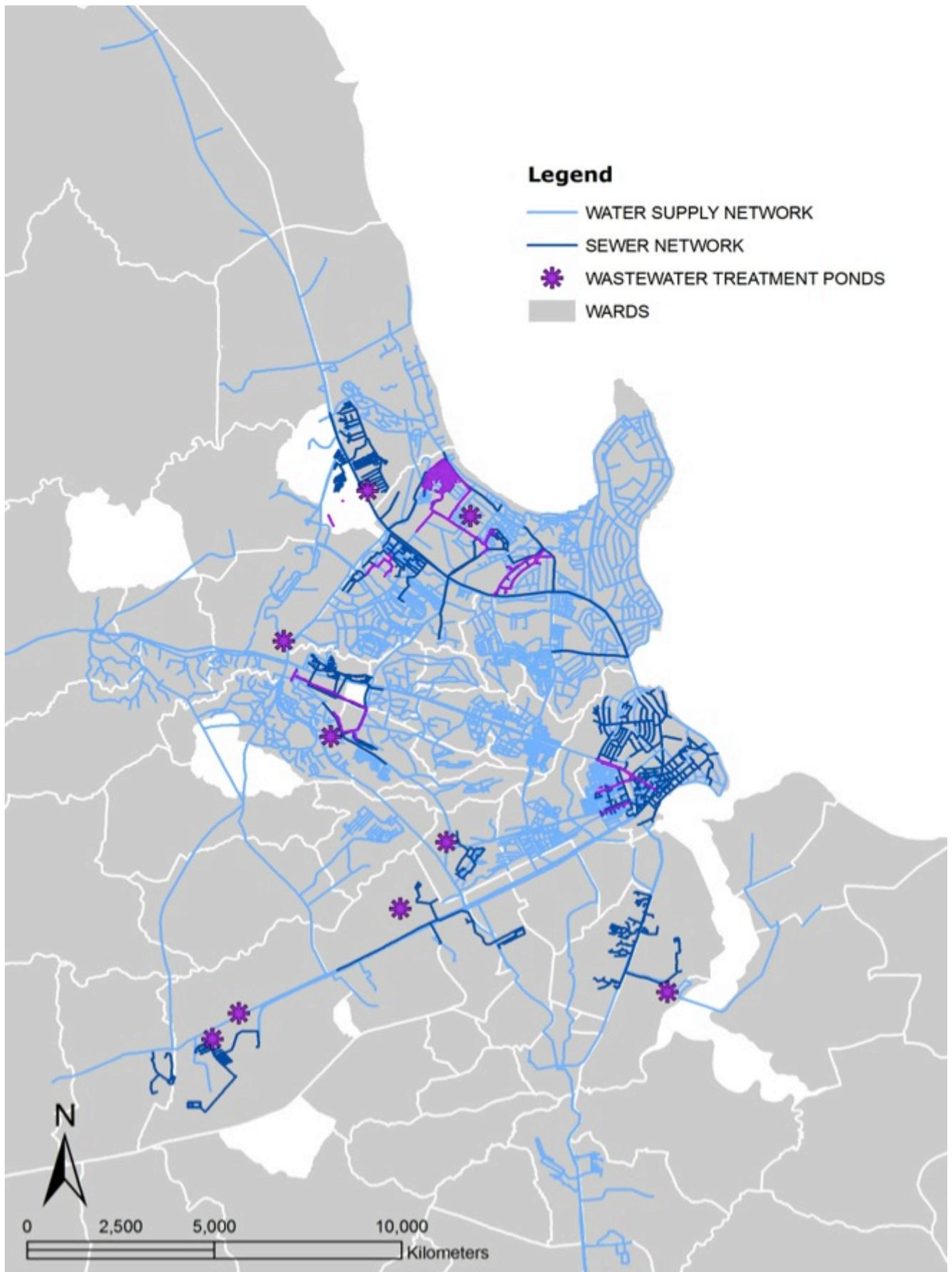
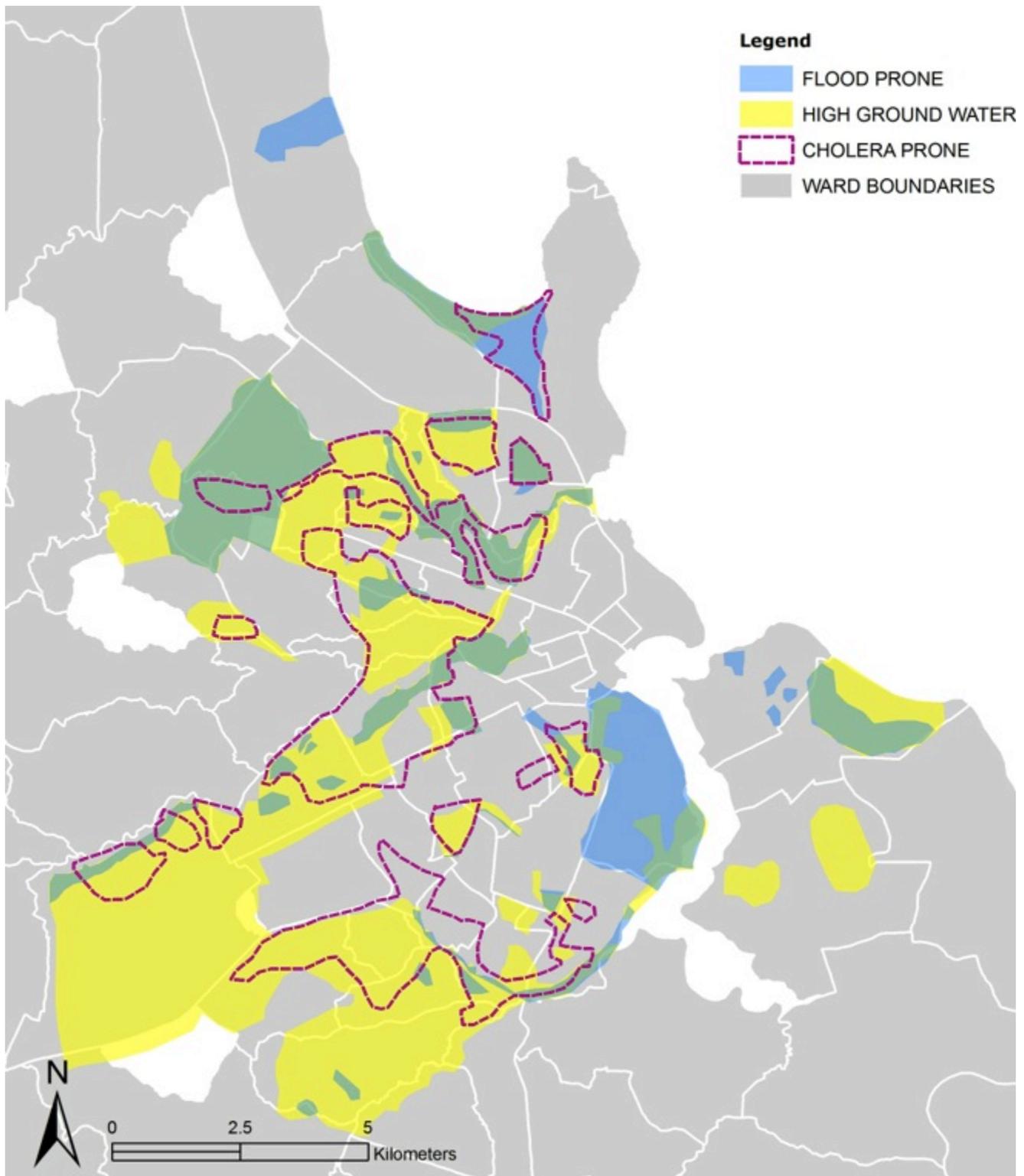


Figure 10: This map shows the existing water-supply and sewerage network in Dar es Salaam (DAWASA 2015)



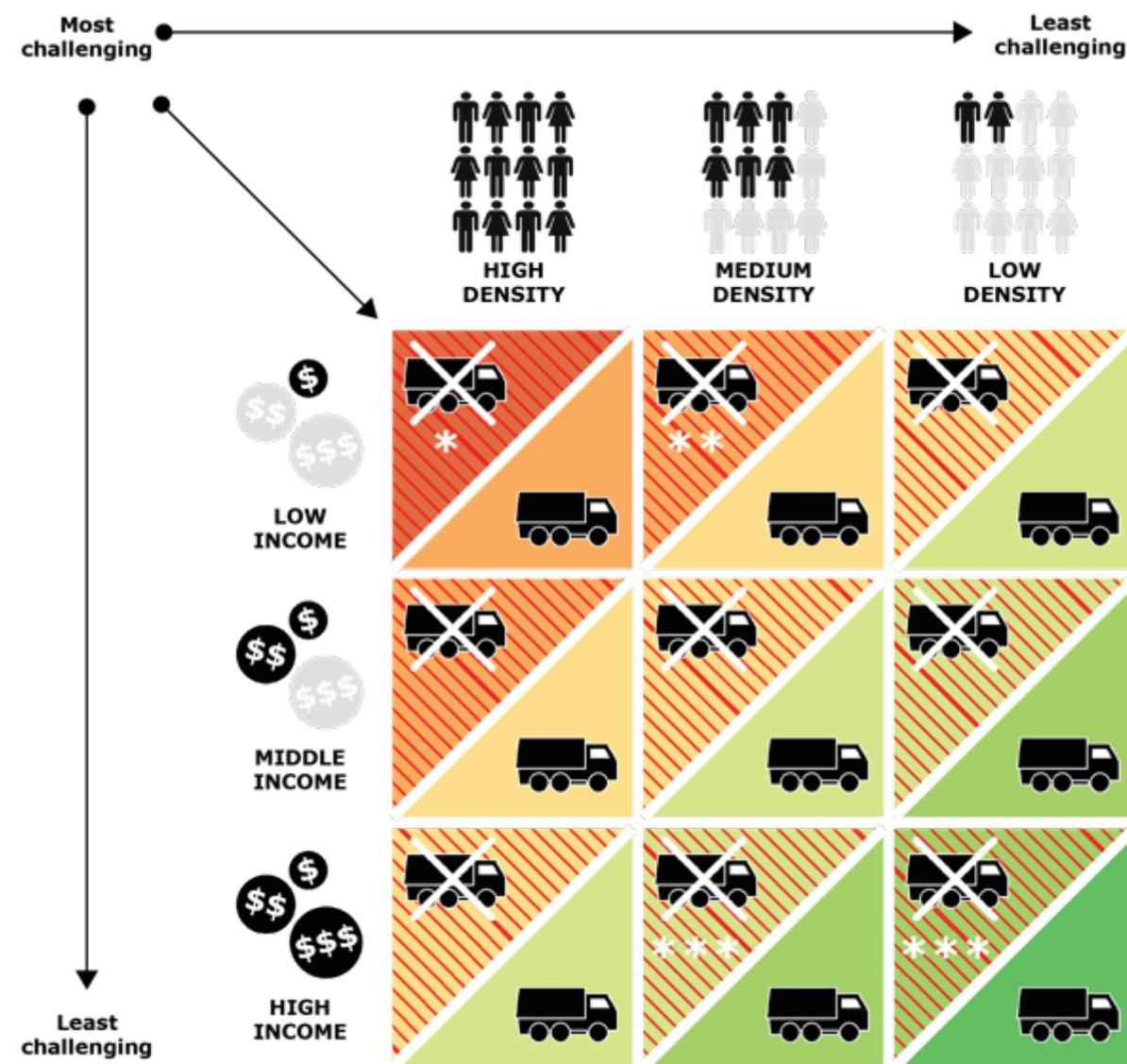
**Figure 11: This map shows “stress areas” in Dar es Salaam, with high groundwater, high risk of flood and/or outbreaks of waterborne disease (Water for People 2015)**

## Prioritising “where to start”

### STEP 5: Identify where the demand/priority is highest

While the previous steps 1-4 intend to guide the selection of the most suitable solutions according to settlement characteristics and city-specific factors, STEP 5 will explain how to identify priority and “stress areas” for intervention.

The parameters incorporated into the abovementioned methodology can also be useful for ranking the most challenging areas, in terms of current environmental sanitation conditions, as well as the ability to implement improved services. Ranking these characteristics as shown in the following table can help to prioritise the intervention of solutions in each of the settlement categories.



**LEGEND**



*	"Stress areas" requiring <b>emergency intervention</b>
**	Areas requiring <b>urgent city sanitation planning</b>
***	This category is unlikely to exist, as high-income areas tend to be sufficiently accessible
	Areas with <b>NO/LIMITED</b> access

**Table 2: Table ranking the various settlement categories, in order to prioritise “where to start”**

As a result of ranking the various settlement categories, it becomes apparent that interventions in these areas needs to occur in parallel:

**\* "Stress areas" requiring emergency intervention [NOW]**

**\*\* Areas requiring urgent CSP [TRANSITION]**

Settlement categories with the following physical and socio-economic characteristics:

 **HIGH DENSITY**

+

 **NO/LIMITED ACCESS**

+

 **LOW INCOME**

E.g. Dar es Salaam: Tandale and Manzese  
(See )

**These high-density areas usually receive no public or conventional services, and present high public health risks and water source contamination.**

Settlement categories with the following physical and socio-economic characteristics:

 **MEDIUM DENSITY**

+

 **NO/LIMITED ACCESS**

+

 **LOW INCOME**

E.g. Dar es Salaam: Kipawa and Gongolamboto

**These areas require urgent planning and strategic intervention, before rapid and unplanned growth results in a densely populated urban slum such as Tandale or Kigogo.**

**AND**

**Areas with high public health risks (e.g. high water table and flood prone) or regular outbreaks of waterborne diseases, such as Cholera.**

(See )

**Delayed investment will only result in future improvements being more costly and difficult to implement, as problems related to rapid urban growth will only increase.**

**Both of these areas are considered critical in terms of existing environmental sanitation conditions, and require immediate, emergency interventions.**

"Stress areas" requiring **emergency intervention**  
[NOW]

Areas: HIGH DENSITY + NO/LIMITED ACCESS + LOW INCOME

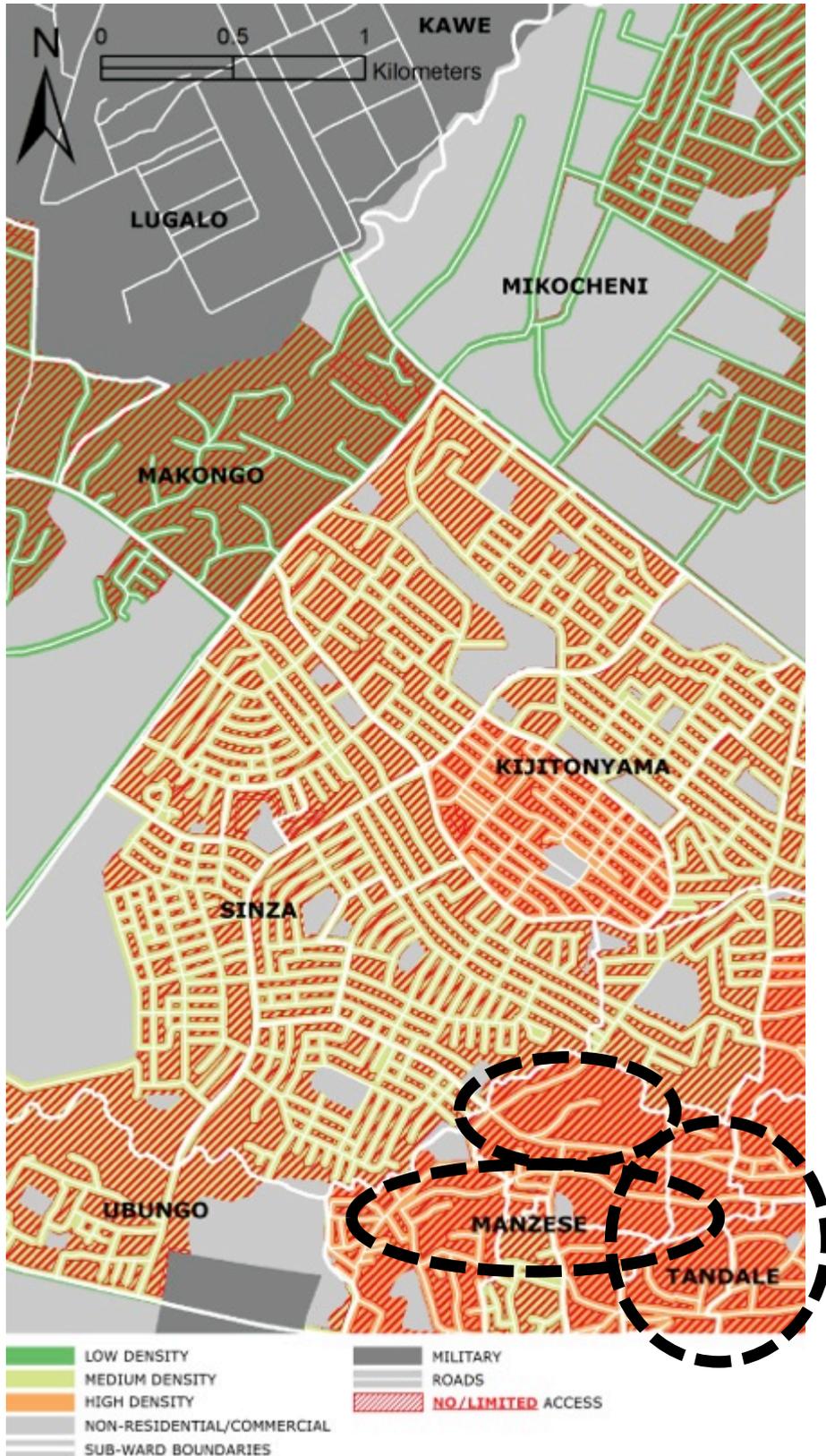


Figure 12: The demarcation on this map shows an example of some "stress" settlement categories in Dar es Salaam

## Next steps: prior to implementation

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The steps described within this document are provided as guidelines for the preparation of city sanitation planning.

These steps shall assist decision makers to identify feasible environmental sanitation service options for various areas of the city, as well as highlighting areas requiring urgent attention.

However, it is important to note that the recommendations within the guide have been determined using data averages and estimations across a large area (macro-level) – therefore, these recommendations are not detailed prescriptions for immediate, micro-level intervention on the ground.

**Prior to implementation, it is therefore essential to consult with environmental sanitation experts and key stakeholders, in order to identify the true landscape and needs of the beneficiaries. This shall be conducted in the form of a feasibility study or field surveys in selected areas.**

**Selection of the most suitable sanitation solutions also needs to include a thorough economic analysis.**

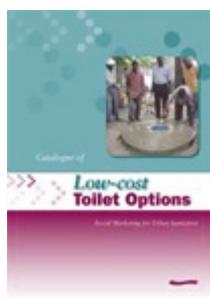
**Only then can the most feasible environmental sanitation interventions for specific areas be implemented.**

## Additional resources

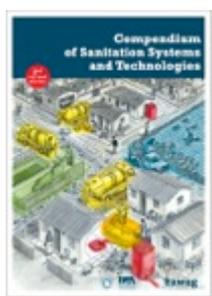
For additional information on any of the environmental sanitation options mentioned within this planning guide, along with other city sanitation planning approaches, please refer to the following resources:



**BORDA, 2009**  
*"Decentralised Wastewater Treatment Systems (DEWATS) and Sanitation in Developing Countries: A Practical Guide"*



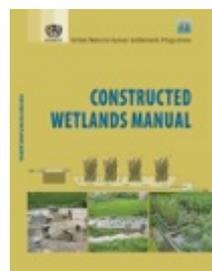
**WEDC, 2004**  
*"Catalogue of Low-cost Toilet Options: for Dar es Salaam"*



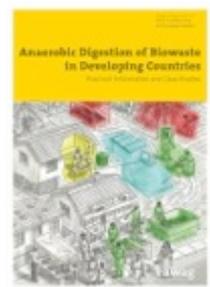
**Eawag / Sandec, 2014**  
*"Compendium of Sanitation Systems and Technologies" 2<sup>nd</sup> Edition*



**Eawag / Sandec, 2014**  
*"Faecal Sludge Management book"*



**UN-HABITAT, 2008**  
*"Constructed Wetlands Manual"*



**Eawag / Sandec, 2014**  
*"Anaerobic Digestion of Biowaste in Developing Countries: Practical Information and Case Studies"*



**People's Development Forum (PDF) & Polytechnic University of Madrid, 2013**  
*"Bidhaa za usafi wa mazingira kwa bei nafuu: CHOO BORA na MAZINGIRA SAFI. Wlaya ya Chamwino"*

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- National Bureau of Statistics (NBS) (2014) *Census Results 2012 - Statistics for Development*. Dar es Salaam, Tanzania: Tanzania National Bureau of Statistics.
- Water for People (2015) *Sanitation Mapping Data: Dar es Salaam, Tanzania*. Available at: sanmap.org.
- WSSCC (2000) *Bellagio Statement: Clean, Healthy and Productive Living: A New Approach to Environmental Sanitation* [online], WSSCC Working Group Environmental Sanitation, Swiss Federal Institute of Aquatic Science and Technology (Eawag): Dübendorf, Switzerland.

