

## Step 6

# Design operations

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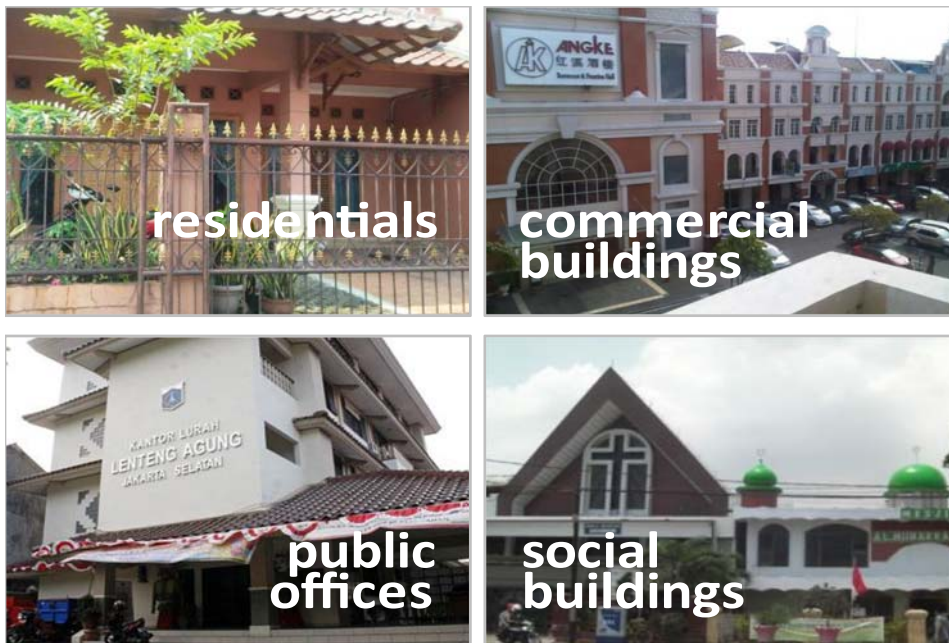
*By now, the team has actual information about the number of septic tanks in the city and the buildings that use them. The team also knows the capacity of the existing septage treatment plant which often becomes the limiting factor of a scheduled desludging operation. With all the information available, the team can develop the design of scheduled desludging operation in the city. Not only for the initial stage of operation, but also for the later stages. A combination of various modes of desludging and septage transportation can be considered in the design for service efficiency.*

### 6.1 CLASSIFY TARGETS

Scheduled desludging targets are classified according to the type of buildings that use the septic tanks, for example residential households, government or public offices, commercial buildings and social buildings (see [Figure 6.1](#)). Classification of scheduled desludging targets can also follow the classification of customers that already applies to other services. If the scheduled desludging is managed by the same institution that manages water supply, the classification of the scheduled desludging targets can follow the existing water supply customer classification.

Some cities have communal wastewater services that use shared septic tanks or other types of anaerobic treatment units that also require a regular septage desludging (see [Figure 6.2](#)). A separate customer categorization is often needed for group of buildings with such communal service. The registered target might be the community group that manage the service.

Classification of the targets is necessary to differentiate the services provided to each group and the service charge. For example, differentiation of desludging periods, maximum desludging volumes and customer rates. If there will be no distinction, no target classification is needed.



**Figure 6.1** The targets of scheduled desludging can be classified according to the use and function of the buildings. The classification can further be specified according to the size of the building and the location of the building. It can also be specified according to the condition of the area where the building is located, for example the width of the road and the status of the area.

## 6.2 DIVIDE SERVICE ZONES

The division of service zones will make it easier for the service provider to manage their targets and to reduce the movement of their desludging fleet. Service zones can be divided as follows:

- Administrative area: where the boundaries of a service zone follow the boundaries of one subdistrict or several adjacent villages.
- Existing service zones: for example, following water supply service zones in cities that will appoint the water supply service provider as scheduled desludging service provider.
- Distance radius to septage treatment plant: where a service zone is formed from areas within a 5 km radius of the septage treatment plant.

It is important to remember that service zoning is only needed if scheduled desludging scheme has either a very large area, a large number of customers or more than one septage treatment plant.

## 6.3 CONFIRM DESLUDGING PERIOD

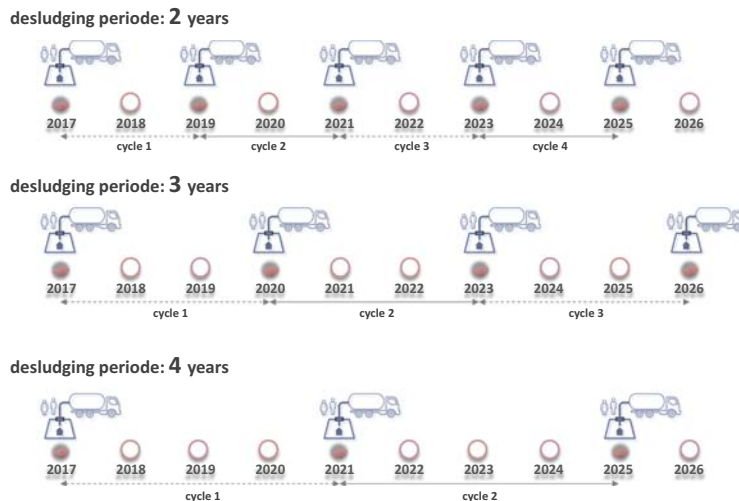
Theoretically, the scheduled desludging period can be determined if we know (a) the average volume of septic tanks in the city, (b) the annual amount of sludge generation per person, and (c) the average number of residents of a building. In practice, it is impossible to get a correct number of desludging period due to the high variations of septic tank volume and number of residents. A desludging period of 2–5 years is common practice in cities throughout the world. Indonesian septic tank standard requires the



**Figure 6.2** Community-based wastewater system uses a treatment unit that also require periodic sludge removal services. If agreed, they can also be the target of the scheduled desludging service.

sludge compartment of a septic tank to be designed for a 3-year holding capacity (see [Figure 6.3](#)). Accordingly, many Indonesian cities plan to use the mandatory desludging period of 3 years.

The desludging period affects the volume of septage to be treated. The longer the desludging period, the less the daily amount of septage to be treated. The same effect also for the number of the desludging trucks required. The longer the desludging period, the less the number of desludging units needed. It is also possible that each building classification will have a different desludging period. For example, 3 years for households, 2 years for public offices and 1 year for commercial buildings.



**Figure 6.3** Illustration of scheduled desludging period of 2, 3, and 4 years. The shorter the desludging period, the higher the desludging frequency is carried out and the more desludging units are needed.

## 6.4 SPECIFY LEVEL OF SERVICE

It is difficult to ensure periodic desludging services will be available for all buildings in the city since the initial cycle. The 100% level of service may only be achieved in the third or fourth cycle along with the readiness of the infrastructure and the service provider. Service level of scheduled desludging must be determined realistically with thorough considerations on:

- **Regulation:** If there is no mandatory requirement for periodical desludging, it is difficult for a city to set high service level.
- **Septic tank condition:** The fewer the number of viable septic tanks, it is difficult for a city to set high service level.
- **Septage treatment:** The capacity of septage treatment plant might be the determining factor of the city in setting the level of service, especially in the initial cycle.
- **Wastewater development policy:** If available, we need to refer to the existing and future coverage of sewerage system in the city before we can set the service level of scheduled desludging.
- **Capacity of service provider:** The higher the service level, the higher the demand for the service provider capacity. Not only concerning the staffing but also the availability of management system and facilities.
- **Financial goals:** Scheduled desludging can be planned for cost recovery but also can be planned for being subsidized. Level of service must provide revenues and expenses that are consistent with the financial plan.

The planned level of service determines the scale of scheduled desludging operation. The higher the service level plans, the higher the frequency of the desludging and transportation operation. The financial aspects of scheduled desludging follow the same pattern; the higher the level of service will be, the greater the financial transaction within the scheduled desludging scheme. In short, there are technical and financial implications to be considered when determining the level of service of the future scheduled desludging operation. Determination of service levels often requires iteration to ensure a service level target does not exceed septage treatment capacity or other constraints.

The team can plan the level of service for each building classification. Distinguishing the service level might be necessary, especially at the beginning of scheduled desludging implementation. When households are not considered ready, it is better for a municipality to prioritize scheduled desludging for public offices or other buildings (see the following table). Thus, the level of service for public buildings will be higher than for other building classification. In the next cycles, service level for households and commercial buildings will be increased.

Service targets for each customer classification

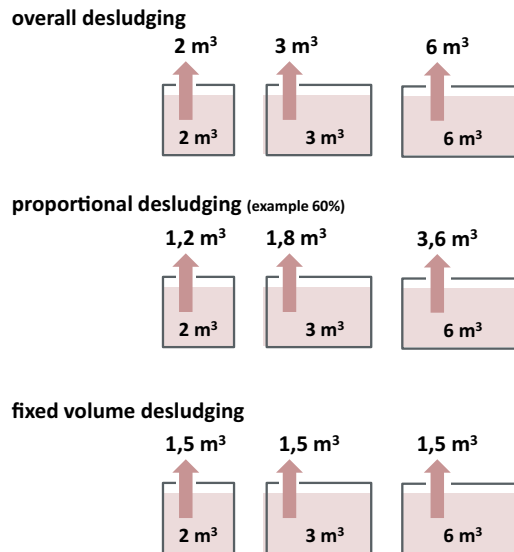
Classification of Buildings	Targeted Level of Service (% buildings)		
	Cycle 1	Cycle 2	Cycle 3
Households	10	60	90
Public buildings	80	85	90
Commercial buildings	10	80	90
Social buildings	0	60	90

## 6.5 DETERMINE MODES OF OPERATION

### 6.5.1 Three desludging modes

There are three modes of desludging that can be applied in a scheduled desludging scheme (see Figure 6.4): (a) overall desludging, (b) proportional desludging and (c) fixed volume desludging. The selection of a desludging mode will affect the number of trucks needed and the number of transportation trips to the septage treatment plant.

- In an **overall desludging mode**, the service provider will remove all septage from the septic tank. This desludging mode will allow the septic tank to regain its maximum storage volume until the next desludging event. Given the high variation of septic tank volume, it is difficult for the service provider to make the trucks work efficiently.
- In a **proportional desludging mode**, the service provider will remove septage with a fixed volumetric proportion of the septic tank. For example, with a 60% proportional desludging, the desludging truck will extract  $1.2 \text{ m}^3$  of septage from the  $2 \text{ m}^3$  septic tank or remove  $1.8 \text{ m}^3$  of septage from a  $3 \text{ m}^3$  septic tank. Technically, the proportional desludging mode has the best basis for consideration. However, the application of this mode will face the same inefficiencies as the overall desludging mode. In addition, it is difficult for desludging worker to ensure that the septage has been removed in proportion to the volume of the septic tank.
- In a **fixed volume mode**, the service provider will remove septage with a constant volume from the entire septic tank. For example, with a fixed desludging of  $1.5 \text{ m}^3$ , the desludging truck will remove the same volume of  $1.5 \text{ m}^3$  of septage from the  $2 \text{ m}^3$  septic tank or from the  $3 \text{ m}^3$  septic tank. The operations of the desludging fleet can be more efficient with this fixed desludging mode. The disadvantage is this mode does not return the volume of the septic tank to its maximum holding capacity.



**Figure 6.4** There are at least three desludging modes that can be selected for scheduled desludging scheme. Each has its own advantages and disadvantages. In the initial stages, it helps to use the simplest mode, that is, the fixed volume mode.

Use information of the average septic tank volume obtained from the survey, before selecting the proportional volume mode or the fixed volume mode. The technical and financial risks of each selection can be minimized by choosing the proper tank dimension of the desludging truck. Please be aware that the households need to be informed of the reason a particular desludging mode is selected.

### 6.5.2 Two transportation modes

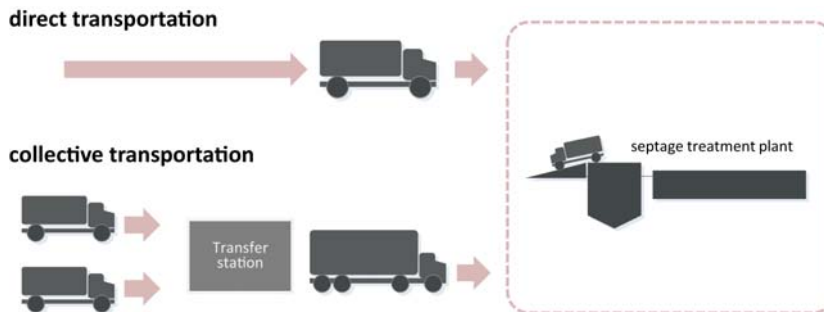
There are two transportation modes that a city can apply to bring the septage to the specified treatment facility (see Figure 6.5): (a) direct transportation and (b) collective transportation. The selection of transportation mode will affect the number of desludging trucks needed and the number of trips required to transport the septage to treatment facility.

**The direct transportation mode** is applied if we want to transport the septage by the desludging unit that just previously carried out a septic tank desludging operation. This transportation mode is suitable for service zones that are close to the septage treatment facility. For service areas that are far from the treatment facility, for example those over 20 kilometers away, the application of **the collective transportation mode** is worth considering. Desludging units will collect septage in a transfer station, or temporary sludge storage (TSS), before a large sludge truck brings the septage to the treatment facility. A mobile transfer station has the advantage that it can be used in several locations while a fixed mobile transfer station ensures better reliability. The application of the collective transportation mode will reduce the number of fleets moving towards the septage treatment facility. Traffic density at STP is automatically reduced.

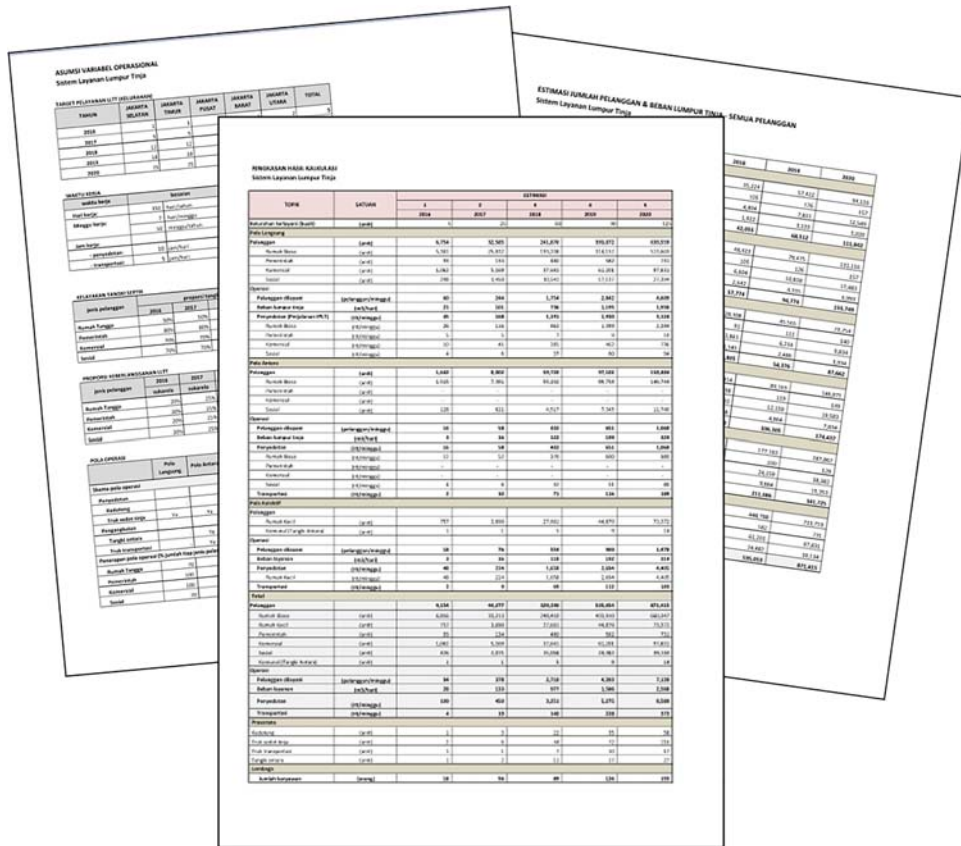
Septage can also be transported to septage treatment facility through the available sewer pipelines. However, this practice is allowed only if there is a special solid–liquid separation unit in the septage receiving point. The unit will reduce significantly the solid content in the septage before it enters the piping system. This mode is certainly only applicable in cities with sewerage systems that still have idle capacity.

### 6.5.3 Three scheduling algorithms

Scheduled desludging requires algorithms to determine the order in which septic tank desludging is carried out over a specified time span. This algorithm will later help the service provider to determine which buildings the desludging will be conducted at on an operation day. Some scheduling algorithms are:



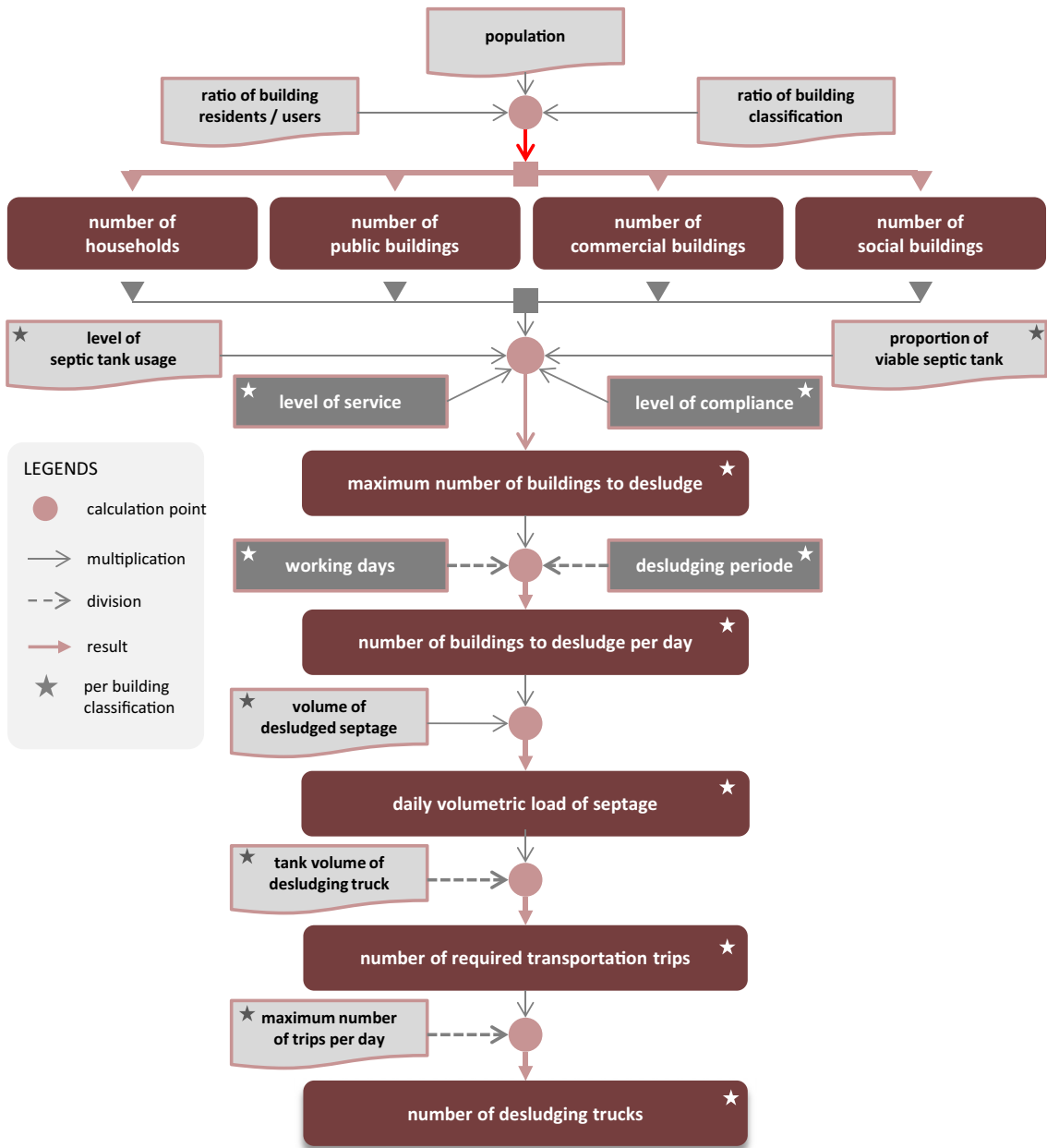
**Figure 6.5** Scheduled desludging scheme can apply direct and/or collective transportation modes. The selection of the mode is influenced by the distance to septage treatment plant, number of trucks available and the road accessibility.



**Figure 6.6** Scheduled desludging simulation needs to use the help of spreadsheet software such as Microsoft Excel since the calculations performed can be very large and complex.

- **By area:** Desludging is carried out for all septic tanks in one area before moving to another area. The determination of the work area should follow the division of territory in a city as well as take into account the division of service zone.
- **By building classification:** Desludging is carried out for all septic tanks in buildings belonging to a particular classification before continuing to another classification. For example, septic tank desludging is scheduled for public buildings in semester 1, commercial buildings in semester 2, households in semesters 3 and 4.
- **By distance:** Desludging is carried out for all septic tanks located within a certain distance (radius) from the septage treatment plant before moving to the next radius. For example, septic tank desludging is scheduled for buildings within the radius of 0–3 km in semester 1, radius of 3–4 km in semester 2, then radius 4–5 km in semester 3.

The service provider can combine these two or three modes to create more efficient scheduling operation that are within their capabilities. For example, combining area-based scheduling mode with building classification scheduling mode.



**Figure 6.7** Simulation flow diagram for scheduled desludging operation. Calculations are made for each building classification that might have its own targeted service level. The calculations in the simulation actually are similar to simple calculations in the making of the initial scheduled desludging concept. The difference is that operating simulations use more diverse operating modes and more actual technical parameter values.



## 6.6 SIMULATE OPERATION

The scheduled desludging operation should be simulated to estimate the desludging and transportation workload in accordance with the targeted level of service for an operating cycle. The simulation will also determine the requirements of desludging units (trucks or pick-up) and septage treatment facilities. There are several operating parameters with known values before we can simulate the operation, namely (a) the ratio of building residents, (b) proportion of building types, (c) proportion of septic tank usage, and (d) average volume of septic tanks. We can use the number of buildings to serve from the results of the survey or census. As for the next cycles, the number of buildings to serve must factor in the population growth and the change of service levels.

After determining the simulation time span, for example 2020–2030 or cycles 1–4, project the number of buildings for each operation cycle. Next, just follow these steps (see [Figures 7.6](#) and [7.7](#)):

- Calculate the maximum number of buildings to desludge (those using viable septic tank) for each classification with this general formula:

$$\begin{aligned} \text{Maximum number of buildings to desludge} &= (\text{number of buildings}) \\ &\quad \times (\text{proportion of septic tank usage}) \\ &\quad \times (\text{proportion of viable septic tank}) \end{aligned}$$

- Calculate the number of buildings to desludge. Use the targeted level of service with assumed compliance level with this general formula:

$$\begin{aligned} \text{Number of buildings to desludge} &= (\text{maximum number of buildings to serve}) \\ &\quad \times (\text{level of service}) \times (\text{assumed compliance level}) \end{aligned}$$

- Calculate the number of buildings to desludge in one day. Use the number of working days per year and the confirmed desludging period in this general formula:

$$\begin{aligned} \text{Number of buildings to desludge per day} &= (\text{number of buildings to desludge}) / \\ &\quad [(\text{desludging period}) \times (\text{working days in a year})] \end{aligned}$$

- Calculate the volume of septage (which later required treatment). Use the number of buildings to desludge per day and the average volume of desludged septage in this formula:

$$\begin{aligned} \text{Daily septage load} &= (\text{number of buildings to desludge per day}) \\ &\quad \times (\text{desludging volume}) \end{aligned}$$

- Calculate the number of transportation trips to the septage treatment plant. Use the daily septage load and the volume of desludging truck tank in this formula:

$$\text{Number of required transportation trips} = (\text{daily septage load}) / (\text{tank volume of desludging truck})$$

- Calculate the number of desludging trucks required. Use the number of septage transportation trips and the maximum number of trips per day in this formula:

$$\begin{aligned} \text{Number of desludging trucks} &= (\text{Number of required transportation trips}) / \\ &\quad (\text{Maximum number of trips per day}) \end{aligned}$$

**Annex H** contains an example of a series of spreadsheets made to plan the operation.