

## Lesson Plan 29: Sizing Holding Tanks



50 minutes total

### Lesson Description



This is an optional lesson. In this lesson participants discuss what goes into a holding tank. They learn about the factors that contribute to sizing a holding tank and the key information that is needed. An example is worked through as a large group and practice questions may be done individually.

### Learning Outcomes



At the end of this session participants will be able to:

1. Discuss the importance of sizing a holding tank.
2. Determine the size of a holding tank.

### Materials

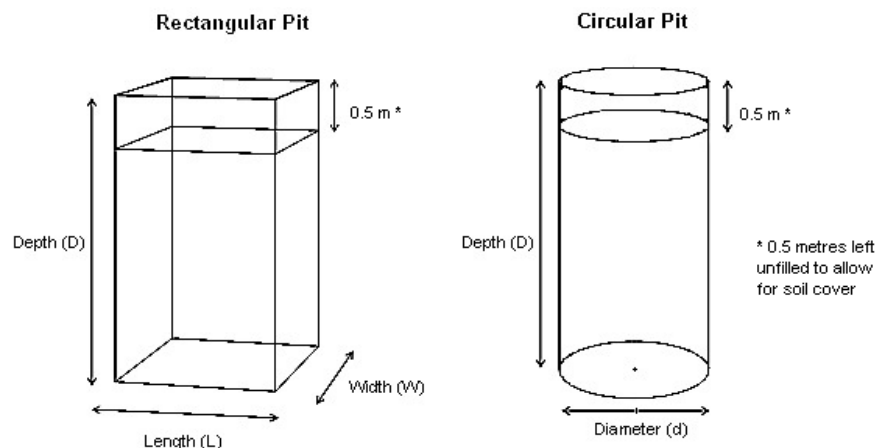


- Flipchart paper
- Tape
- Markers
- Pencils
- Erasers
- Calculators (optional, participants can also use their mobile phones)

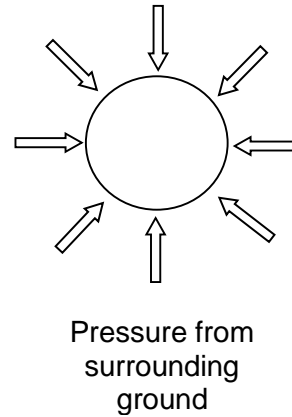
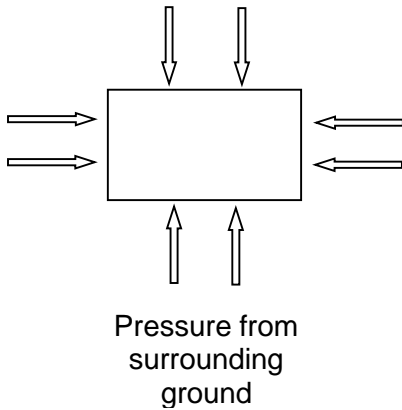
### Preparation



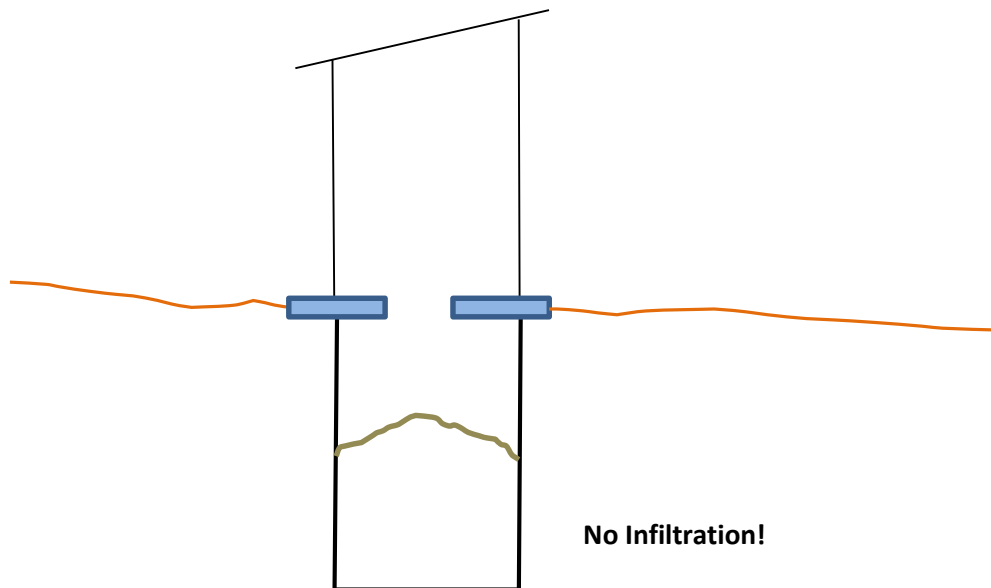
- Review topic in the Technical Brief: Sizing Holding Tanks
- Review and practice calculating holding tank sizes by using formulas
- Write the heading “*Key Information*” on flipchart paper
- Optional: Write the learning outcomes on flipchart paper
- Optional: Draw the following pit diagrams on flipchart papers:



- Optional: Draw the following diagram on flipchart paper:



- Draw a latrine diagram on flipchart paper:



**Introduction**

**5 minutes**



- In pairs, ask the participants to discuss "Why is it important to figure out the size of a holding tank?" Share some responses as a large group.
  - So that you know how big to make the tank
  - So that you know how often it will need to be emptied
  - So that you know how big to make your slab
  - So that you know how much space you will need
- Present the lesson description or the learning outcomes.

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**Factors Affecting Holding Tank Size**
**20 minutes**

1. Explain to participants that this lesson is for sizing latrine holding tanks, which are fully lined impermeable pits or tanks with no outlet and no infiltration. These calculations do not apply to sizing latrine pits with permeable linings or no linings, latrine chambers, septic tanks or any other type of latrine.



2. Tell the participants that there are five key pieces of information needed to calculate holding tank sizes. Ask the participants “What information do you need to calculate how big your holding tank should be?” Record the following list on the “Key Information” flipchart.

- *Number of Users (N)*
- *Expected Lifetime (Y) (or how often it will be emptied)*
- *Holding Tank Dimensions – Length (L), Width (W), Diameter (d)*
- *Holding Tank Depth (D)*
- *Sludge Accumulation Rate (R)*

3. Explain the Number of Users (N).

- *The number of people using the latrine on a regular basis will affect how quickly the holding tank fills up. Usually the number of people in the household.*

4. Explain the Expected Lifetime (Y).

- *How long you want the holding tank to last. Holding tanks usually fill up very quickly, and need to be emptied frequently.*

5. Explain the Tank Dimensions using the rectangular and circular tank diagrams.

- *Tanks are usually made square, rectangular or round.*



6. Ask the participants “Which shape of tank is stronger and why?” Use the diagrams on flipchart to help explain.

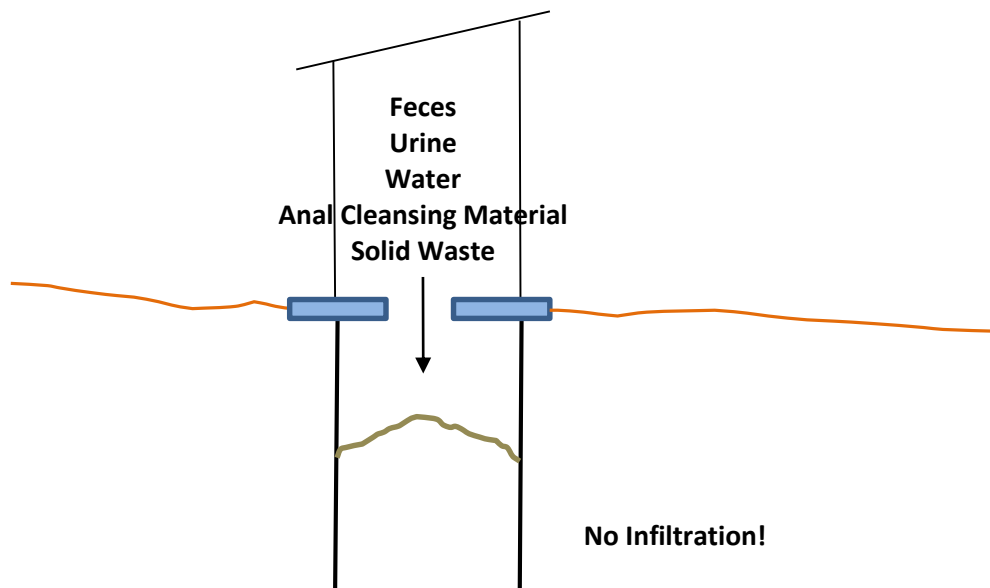
- *Circular tanks are less likely to collapse at greater depths (more than 1.5 metres) because the pressure from the surrounding soil is evenly spread.*
- *Square or rectangular tanks tend to collapse more often at greater depths because pressure is placed on the four walls. This leaves the corners to absorb the stress. But a rectangular tank is easier to dig.*



7. Explain the Tank Depth (D) using the rectangular and circular tank diagrams on flipchart.

- *The depth of the tank will depend on soil conditions, cost of lining, and emptying method. The groundwater level will not affect the depth of holding tanks as they are completely sealed.*
- *The tank depth includes an extra 0.5 metres which is left unfilled at the top. This is to ensure there is a “buffer” space, to prevent the excreta from getting too close to the users (so users can’t see it, aren’t afraid they might come into contact with it, and to stop users from getting splashed).*

8. Show participants the latrine diagram on the flipchart. Ask the participants what goes into the holding tank, and write each material on the flipchart.



9. Explain the Sludge Accumulation Rate (R), or fill rate, using the latrine diagram on flipchart.
- *Sludge accumulation rate is how quickly sludge builds up in the holding tank over time. The units are usually litres/person/year. Because holding tanks fill up quickly, you should use litres/person/day, which calculates the life of the tank in days.*
  - *Because there is no infiltration, and not usually enough time for much biological degradation, sludge accumulates at the rate material is added to the latrine (Volume In = Volume Out). To figure out the sludge accumulation rate in this case, you just add up everything that goes into the holding tank.*
10. Using the latrine diagram, ask the participants to guess how much they think goes into the tank every day, per person. Once people have guessed, write the numbers below on the flipchart next to the appropriate word.

Materials	Range (Per Person Per Day)	Average (Per Person Per Day)
Feces	0.12 – 0.40 L	0.26 L
Urine	0.6 – 1.5 L	1.05 L
Flush water	2–3 L per flush for a pour flush toilet 4–25 L per flush for a cistern flush toilet 2–3 flushes per day = 4–9 L for pour flush toilet = 8–75 L for cistern flush toilet	6.25 L for pour flush toilet 41.5 L for cistern flush toilet
Anal cleansing water	1–2 L per use 2–3 uses per day = 2–6 L	4 L
Toilet paper	24 g (0.024 L)	24 g (0.024 L)
Solid waste	If added to holding tank, add an extra 5-10% of volume	If added to holding tank, add an extra 5-10% of volume



11. Explain that sizing latrine pits, tanks and chambers is an uncertain science. There are many factors that affect the rate at which sludge builds up in the latrine, and it cannot always be estimated ahead of time with accuracy. Ask the participants “Why may holding tanks need to be emptied either more or less frequently than calculated?”

- *The number of individuals using a pit may fluctuate throughout the week and over the years.*
- *The volume each person contributes to the pit will be affected by age, diet, whether she or he is away from the home during the day, and a variety of other factors*
- *Flushing practices may vary – some people may use more or less water, some people may flush only after defecation or after either defecation and/or urination.*
- *It is difficult to predict how much anal cleansing material people will use and the effect it will have on the sludge volume.*
- *It is difficult to predict how much solid waste people will put in the latrine. However, user education and a solid waste collection program can reduce the amount of solid waste put into the latrine.*
- *Biological activity has a large effect on reducing the volume of sludge in a pit over time. These processes are not well understood or quantified.*
- *If holding tanks are not built properly, they may*
  - *Leak (infiltrate) liquid into the surrounding soil, which may cause the holding tank to fill up less quickly*
  - *Leak rainwater, surface water or groundwater into the holding tank, causing it to fill up more quickly.*



12. Explain that using local experience is a good way to estimate the lifetime or fill rate for latrines. Ask the participants “When it would *not* be appropriate to compare latrine lifetimes or fill rates?”

- *The proposed latrine is a different type (e.g., a holding tank cannot be compared to an unlined pit)*
- *The user situation is very different (e.g., 15 users instead of 4, or users are displaced people during an emergency rather than settled villagers)*
- *The environmental conditions are very different (e.g., soil is clay instead of sand)*

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### Sizing Holding Tanks Using Formulas

**20 minutes**

Ensure that you fully understand the formulas and how they work together before teaching this lesson. Sizing latrine holding tanks by formulas requires extensive understanding of mathematics.



1. Explain that to size a holding tank, you either calculate the size of the tank (if you know how often it will be emptied), or you calculate how long it will take to fill up (if you know the size).



2. Explain to participants that they will now size a holding tank. Tell participants that you will all do one problem together as a large group. Refer participants to the Technical Brief: Sizing Holding Tanks.
3. Tell the participants to look at Practice Question 1. Explain they are building a holding tank for 6 users. The holding tank is a plastic tank with a volume of 2 m<sup>3</sup> (or 2,000 L). The dimensions of the tank are 1 m wide, 1 m long and 2 m deep. The pour flush toilet uses 2.5 litres per flush. People use water for anal cleansing. There is a good solid waste collection program, so no solid waste is put into the holding tank. How often must the tank be emptied by vacuum truck?
4. Ask the participants to look at the diagram on the flipchart and tell you how much of each material is going into the tank per person every day. Use average values. Write the values on a flipchart.
  - *Feces: The average of 0.12–0.40 is 0.26 litres of feces per person per day.*
  - *Urine: The average of 0.6–1.5 is 1.05 litres of urine per person per day.*
  - *Flushing water: Explain that the pour flush toilet uses 2.5 L of water per flush. Each user flushes 2–3 times per day, averaging 6.25 L per person per day.*
  - *Anal cleansing material: People use a minimum of 4 L per person per day.*
  - *Solid waste: There is a very good solid waste collection program, so no solid waste is thrown into the latrine.*
5. Add up all of the fill rates (L/day) of materials to find out how much goes into the tank every day per person.
  - *0.26 L/person/day [Feces] + 1.05 L/person/day [Urine] + 6.25 L/person/day [Flushing] + 4 L/person/day [Anal cleansing] = 11.56 L per person day*
6. Tell the participants to look at the Summary of Formulas section of the Technical Brief. Ask the participants “Which formula should be used to find out how often the tank must be emptied?”
7. Write the lifetime formula on a flipchart.
 
$$Y = \frac{(V - 0.5 \times A) \times 1000}{N \times R}$$
8. Explain to the participants that they just calculated the sludge accumulation rate that is represented by the symbol R. Ask the participants “What values do we have and which values are we missing?”
  - *We have the sludge accumulation value R: 11.56 L/person/day*
  - *We have the number of users N: 6 users.*
  - *We have the volume V: 2 m<sup>3</sup>, which is the same as 2,000 L.*
  - *We do not have the area A.*
9. Ask the participants “How can you calculate the area of the tank?”
10. Write the area formula for a rectangle on a flipchart.

$$A = L \times W$$

11. Ask the participants “What is the length and width of the tank?”

- *The length of the tank is 1 m long.*
- *The width of the tank is 1 m long.*

12. Calculate the area by multiplying 1 by 1. The area is 1 m<sup>2</sup>.

$$A = L \times W = 1 \times 1 = 1 \text{ m}^2$$

13. Calculate the lifetime of the tank by filling in the lifetime formula. Write out the different calculation steps on a flipchart. Remind participants that it is important to use the correct units for each value.

$$Y = \frac{(2 - 0.5 \times 1) \times 1000}{6 \times 11.56} = \frac{1.5 \times 1000}{69} = 21.7$$

14. Ask participants “How long it will take the tank to fill up?”

- *22 days*

15. Ask the participants what it may mean for the household to have to have the tank emptied that frequently.

- *Must organize an emptying service to come empty the latrine each time*
- *Must pay for the emptying – gets expensive!*
- *Must frequently deal with the hassle, smell, and potential health & safety issues of having their latrine emptied*

16. Ask participants “What are the benefits of having a holding tank? Is it worth it?”

- *No groundwater contamination*

17. Let participants discuss if preventing groundwater contamination is worth the expense and hassle of having the tank emptied frequently.

18. Optional: Participants can work on the remaining practice problems individually or in groups of 2 or 3 people. You may want to mix groups so that people most comfortable with math are with people who are less comfortable. You may choose one of the following example questions, or use them all.



19. Remind participants that the calculations are only rough estimates and the holding tank may actually fill up at a slightly different rate. More accurate local figures rates should be obtained if possible.



20. Optional: Do one or two Practice Questions again with the whole group, but change one variable to see how much difference it makes to the answer. For example:

- Do Practice Question 1 again with a different feces rate. Instead of using the average value of 0.26 L per person per day, use 0.4 L. Then do the calculation again with a different flushing water volume. Instead of using (2.5 L x 2.5 times per day), use (3 L x 5 times per day). This illustrates that compared to the flush water volume, the feces volume has little impact on how often the tank must be emptied.
- Do Practice Question 2 again with a different feces rate (use 0.4 L instead of the average value 0.26 L). This illustrates that for a dry latrine, the feces volume can have a noticeable impact on how often the latrine must be emptied.

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**Review****5 minutes**

1. In pairs, ask participants to discuss whether they think using holding tanks is a good idea. Why or why not? Tell participants they will have 3 minutes to discuss.
2. As a large group, ask the participants to raise their hands if they think holding tanks are a good idea. Then ask those participants who do not think holding tanks are a good idea to raise their hands. Ask the participants “Is there is anyone who did not raise their hand yet? Why not?”
  - *It may depend on the context, for example: whether groundwater must be protected, if there are any other appropriate latrine options, the size and life of the holding tank required, whether there is an emptying service available.*

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**Reflections on Lesson**