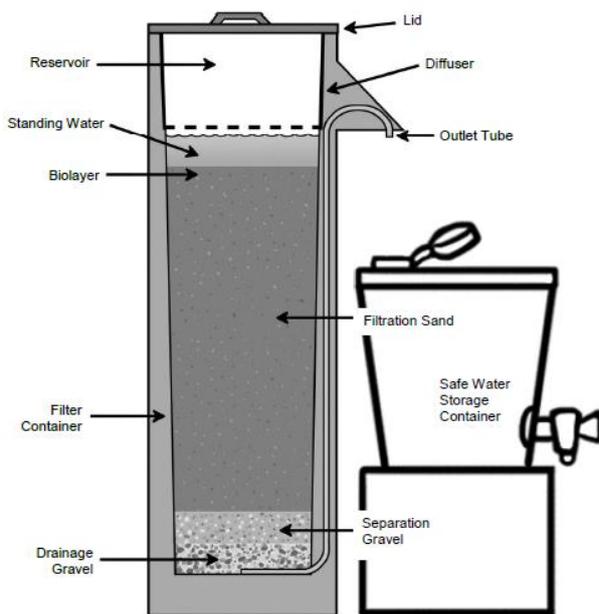


WHAT IS A BIO-SAND FILTER?



The bio-sand filter (BSF) is a water filter that makes dirty water safe to drink. It is typically used in both houses and schools. Made of concrete or plastic, the BSF is filled with layers of sand and gravel that are carefully prepared to go inside the filter. The BSF is an essential step in the multi-barrier approach to safe water.¹

The BSF is an adaptation of the traditional slow sand filter, which has been used for community water treatment for almost 200 hundred years. It is smaller and adapted for intermittent use, making it suitable for households.

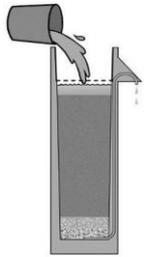
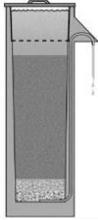
Parts of the bio-sand filter

- The **lid** keeps insects out and stops other things from falling into the BSF. It must always be kept tight.
- The **reservoir** is the top of the filter where water is poured in. The reservoir can hold about 12 litres, or one bucket of water.
- The **diffuser** catches the water poured into the BSF. It has little holes in it, so the water slowly drips through to the sand. It can take the form of a box or plate. The diffuser also protects the top of the sand when water is poured in, by preventing the water from making holes in the sand and hurting the biolayer.
- When water stops flowing, there should be 5 cm of water on top of the sand. This is the **standing layer** – it prevents the biolayer from drying out by allowing air through it.
- The **filter container** holds the sand, gravel and water. It can be made of concrete or plastic and take either a square or round shape.
- The sand inside the filter, ie. the **filtration sand** is the most important part of the BSF. It removes almost all pathogens and dirt from the water. For the filter to work, the sand must be prepared correctly.

¹ The Multi-Barrier Approach to safe drinking water consists of five steps to getting safe drinking water. Each step stops dirt and pathogens from getting into the water we drink, which can make us sick. All five steps are followed in modern water treatment plants and can be replicated on a household or village level. They include 1) protecting the source water; 2) sedimenting the water; 3) filtering the water; 4) disinfecting the water and 5) storing the water safely.

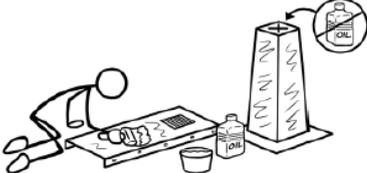
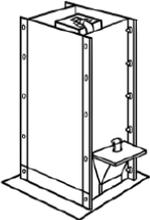
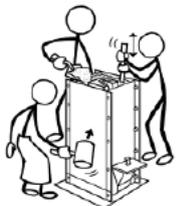
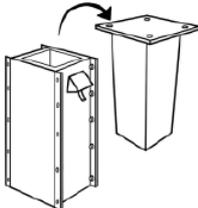
- The **biolayer** is the top layer of sand (1-2 cm or 0.8" deep), where very small microbes live. They are responsible for the pathogens in the water that make us sick. The sand removes almost all the pathogens and dirt from the water. For the filter to work, the sand must be prepared correctly.
- The **separation gravel** (small gravel) stops the sand from moving down and blocking the outlet tube.
- The **drainage gravel** (large gravel) stops the small gravel from moving and blocking the outlet tube.
- The **outlet tube** is the channel from which clean water flows out. The tube can be made of soft plastic or copper.
- The **safe storage container** collects water as it flows out of the outlet tube and needs to be kept clean.

HOW TO BUILD A BIO-SAND FILTER

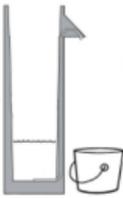
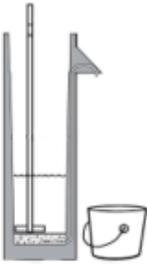
<p>1</p>		<p>Pour a bucket of water in the top of the filter. Water will start to flow out of the tube. Put the lid back on the filter. The filter should be filled between 1 and 4 times every day.</p> <p>You can use any kind of water in the BSF: water <u>from the river</u>, <u>from a pond</u>, <u>from a well</u>, or <u>rainwater</u>.</p> <ul style="list-style-type: none"> ▪ Use the best quality water you can in the filter. The water should be the cleanest available since the filter is not able to remove 100% of the pathogens and turbidity (dirtiness or cloudiness). ▪ Use clear water. Higher turbidity levels (above 50 NTU) will plug the filtration sand layer more quickly. In this case, the user will need to do maintenance (a process called Swirl and Dump) more often to maintain a convenient flow rate. A simple test to measure the turbidity is to use a 2 litre clear, plastic bottle filled with the source water. Place this on top of a paper with large letters on it, such as the logo on this manual. If you can see the letters looking down through the top of the bottle, the water probably has a turbidity of less than 50 NTU. ▪ Do not pour water that has been chlorinated into the filter. The chlorine will kill the biolayer. ▪ If the water is very dirty, settle the dirt out by letting it sit in the bucket for a few hours before pouring it into the BSF. ▪ Use the same source water all the time to get the cleanest, safest water.
<p>2</p>		<p>The top of the filter is called the reservoir. It can hold 12 litres of water - about 1 bucket. Water coming out will flow fastest when the reservoir is full.</p>
<p>3</p>		<p>It usually takes at least 1 hour for the water to stop flowing.</p>

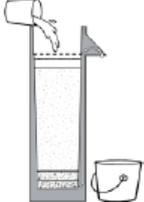
4		<p>After the water stops flowing, the filter must rest. The filter must rest for at least 1 hour before pouring more water in. This is called the Pause Period.</p>
---	---	--

Build water filter

1		<p>Grease the mould so the finished product can be easily removed.</p>
2		<p>Assemble the mould.</p>
3		<p>Make the cement.</p> <ul style="list-style-type: none"> ▪ Measure the cement, sand and gravel into a pile using a bucket, where 1 part is 12L 1 part cement : 1 part 6-12 mm gravel : 1 part 1-6 mm gravel : 2 parts sand ▪ Mix the dry materials well ▪ Add 7-10 L of water slowly while mixing
4		<p>Fill the mould with cement.</p> <p>Use a long, thin piece of wood/metal rebar to push the concrete down.</p>
5		<p>Wait for the cement to dry, for up to 24 hours.</p>
6		<p>Remove the filter from the mould.</p>

Install water filter

1		<p>Wash and rinse the gravel and sand (6 times).</p> <p>Pour away the scum and dirty water.</p>
2		<p>Put a stick into the filter and touch the bottom of the filter.</p> <p>Draw a line on the stick even with the top of the filter.</p> <p>Put a bucket under the filter outlet to catch any water that flows out during the installation.</p>
3		<p>Draw another line on the stick 5 cm (2") down from the first line.</p> <p>Draw a third line 5 cm (2") down from the second line.</p>
4		<p>Draw a line on the inside of the filter, about 24 to 26 cm down from the top. This is about where the sand should come to.</p> <p>Put about 10 litres of water in the filter (about mid-level).</p>
5		<p>Put drainage gravel (coarse granite stones) into the filter until it is 5 cm (2") deep. This should be about 3 litres of gravel.</p> <p>Make the top of the gravel flat and level using the stick.</p> <p>Put the stick on-top of the gravel. If the second line on the stick is level with the top of the filter, you have added enough gravel (5 cm).</p>
6		<p>Put separation gravel (mid-size stones) into the filter until it is 5 cm (2") deep. This should be about 3¼ litres of gravel.</p> <p>Make the top of the gravel flat and level using the stick.</p> <p>Put the stick on-top of the gravel. If the third (bottom) line on the stick is level with the top of the filter, you have added enough gravel (5 cm).</p>

7		<p>Add about 30 L of filtration sand, until the sand comes up to the line you drew on the inside of the filter.</p> <p>As you add the sand, the water level in the filter should always be higher than the sand.</p> <p>It is okay you have a little dry sand at the very top.</p>
8		<p>Put in the diffuser plate and add chlorine. Pour a bucket of water into the top of the filter.</p> <ul style="list-style-type: none"> ▪ Run a backflow test – to prevent any contamination of water in case a backflow occurs. ▪ Run a flow rate test. Rate of flow should be 400mL/min.

8 Key Filter Performance Points

1	<p>The filter was installed more than 30 days ago. It takes 30 days for the biolayer to grow and be working well.</p>
2	<p>The filter is used at least once every day, with water from the same source every time. Don't forget the Pause Period: after the water stops running, you must wait at least 1 hour before filling it again.</p>
3	<p>The water poured into the BSF is clear. The source water should be less than 50 NTU. If you only have dirty or cloudy water, leave it in a bucket until the sediment has settled to the bottom. Then pour the clear water in the bucket into the BSF. Do not pour the sediment in.</p>
4	<p>The filter container does not have cracks and is not leaking. Users may not use filters that don't look nice or that make a mess. Also, a leak may cause the standing water level to be too shallow, and the biolayer may be damaged.</p>
5	<p>There is a diffuser. It should be in good condition, so the biolayer is protected when you pour the water in. There should be no cracks or large holes in the diffuser.</p>
6	<p>When the water stops running, the water surface is 5cm (2") above the top of the sand. If you don't have a ruler with you, 5 cm is about the length of your middle finger from the tip to the second knuckle. It is ok if the water depth is between 4 - 6 cm (1.5 - 2.5").</p>
7	<p>The top of the sand is flat and level. If there are dents, holes or "valleys" in the sand, the biolayer may be damaged.</p>
8	<p>When the filter is full, the flow rate is 400 mL or less per minute. If you get more than 400mL/min, the filter may not be operating at its highest possible treatment efficiency.</p> <p>If the flow rate is less than 400mL/min, the filter will still work. However, users may not like a slow flow rate. The flow rate will get even slower as they use the filter because the top of the sand clogs with dirt. If the flow rate gets too slow, they may stop using the filter.</p> <p>If the flow rate is more than 400mL/min, the filter might not work as well. It might not remove as many pathogens from the water.</p> <p>If the flow rate is higher than 450mL/min, you should replace the sand. Take all the sand out of the filter. Start with new sand and wash it less.</p>

IMPORTANT: Once the filter is filled with sand and gravel, it cannot be moved!

If the user wants the filter moved, all the sand and gravel must be taken out and reinstalled as if it was a new filter. If the filter is moved without first taking out the sand and gravel, it may not work as well after it is moved, as sand or gravel may block the outlet tube.