How to Build a Self-Watering Wicking Bed

A **wicking bed** is a self-watering raised garden bed, and even though the design is a relatively new innovation that is catching the attention of many produce gardeners worldwide, it is essentially nothing more than a large scale version of a self-watering pot. Self-watering pots have been around for decades, and are based o the principle of **sub-irrigation**, where the water supply sits below the pot that is wicked upward into the soil in the container above.

This article provides detailed step-by-step instructions on how to build a wicking bed, but before we start building anything it is important to understand how wicking beds work, so we know exactly what we're building and how to modify the design to our needs if we need to.

Also, when considering wicking beds, it is really important to determine whether this system of gardening is suitable for our needs as gardeners. By understanding the pros and cons of wicking bed gardening, we can make the right choice and get the best results gardening with this wicking beds.

The Advantages and Disadvantages of Growing in Wicking Beds

Wicking beds are great for situations where watering is infrequent, such as community gardens and school gardens where nobody is present over holiday periods to water the garden beds. The water reservoir in a wicking bed can carry enough water to keep the plants alive for up to several weeks depending on climate, season and location. They're also useful for gardening under and around trees with invasive roots that extract every last bit of moisture from the soil, such as Australian eucalyptus trees.

Growing plants in wicking bed systems is a useful technique that increases the range of possibilities of what you can grow where, and wicking beds have their place and purpose in a gardeners repertoire, but they also have their limitations just like any artificial gardening system. What are these limitations you may be asking?

Most plants require a wet-dry cycle to grow, but wicking beds create an environment with constantly moist soil which is unsuitable for many plants. Since water is retained in a wicking bed, this leads to a build-up of fertiliser and the evaporation of water from the soil combined with the upward wicking creates a situation where the concentration of salts can build up to dangerous levels in the soil that can burn the roots of the plants. Also, the upward moving water carries the excess salts upwards, so the salts accumulate at the upper soil levels where shallow rooted seedlings are planted.

Another issue is that the lowest soil levels in wicking beds are always wet, while the upper levels can be fairly dry, because the soil can only wick moisture up so high through the forces of capillary action, adhesion and cohesion against the forces of gravity. As a consequence, the moisture available to plants depends on the height of the garden bed and the depth of the plant roots. Deep rooted plants which dislike 'wet feet' (constantly waterlogged soil) will be very unhappy in a wicking bed and will usually fail due to root rot. It is also important to consider that a wicking bed in in fact a container garden, and all containers of soil or potting mix/medium have what is termed a 'perched water table', a layer of water-saturated soil at the bottom of the container that never drains away. If this layer is constantly wicking up more water, it can never dry due to evaporation or uptake by plant roots, and becomes a soggy, anaerobic (without air/oxygen) sludge that may promote root diseases.

The main drawback for most people is cost. Large properly built wicking beds are expensive to build. In my mind gardening should be simple, cheap and sustainable. My basic rule of gardening construction is as follows. Only use a raised garden bed when growing in the ground is not possible. If using a raised bed is not possible, ***only then use a wicking bed***. The cost and construction effort involved going from gardening in the ground to raised beds to wicking beds jumps astronomically with each step.
Wicking beds are not a universal gardening solution, and if we keep this in mind and use them where they perform best, we can best make use of the benefits while avoiding the disadvantages.
Wicking beds in my opinion, much like hydroponic systems, are best suited to growing annual vegetables, which are so short lived they don't live long enough to develop long term problems due to the soil conditions, and require large amounts of nutrients in a short period. Since wicking beds retain fertiliser all too readily, less fertiliser can be used for annual vegie growing. As such, wicking beds make great intensive vegie beds and kitchen garden beds.

Now that we understand the benefits and limitations of a wicking bed system, let's have a look at how they work.

Wicking Bed Design Theory

A wicking bed is quite a simple design as shown in the diagram below

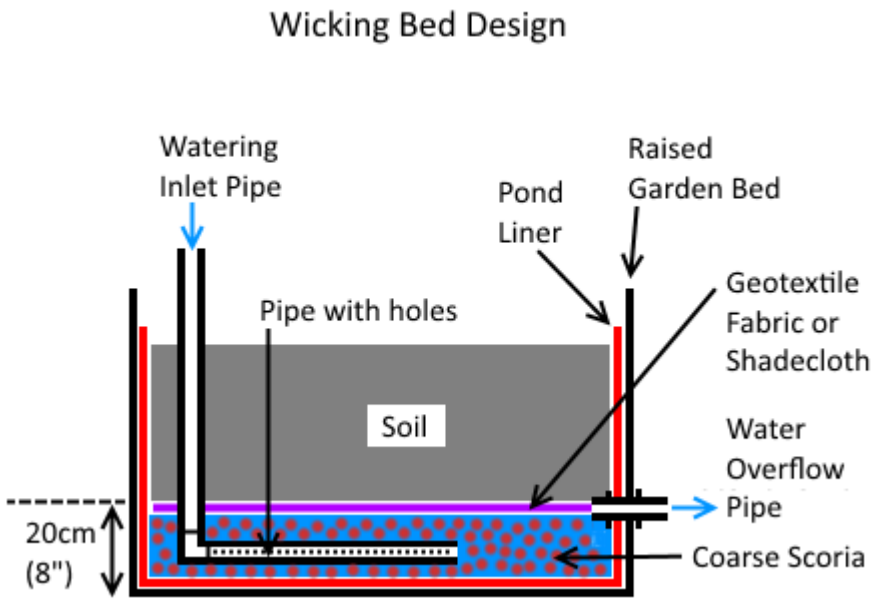
The size of the wicking bed is essentially personal preference, it can be varied from a small tub which sits on a table or stand, all the way through to a full garden bed sized wicking bed system.

Common wicking bed sizes are determined by the dimensions of commercially available raised beds or construction materials.

- For very large wicking beds, railway sleepers are often used, and the dimensions and efficient use of materials dictate the size. A railway sleeper is 2.4m (8') long so a popular size is 2.4m (8') x 1.2m (4') as this uses three sleepers to construct a single level. A typical height when using such materials is 60cm (2') high, as each sleeper is 20cm (5") high, and if they are stacked three high, the total height is 3 x 20cm = 60cm (3 x 8" = 24" = 2'). Such a design uses 9 full-length railway sleepers. Another design option to save 1/3 of the materials is to dig a trench in the ground for the water reservoir level so the pond liner sits

below the ground 20cm (8”) with the outlet at the same level as the ground, this way you can use only so the two levels of sleepers instead. By comparison, such a design uses only 6 full-length railway sleepers.

- Galvanised or coated steel raised garden beds of various dimensions are also commonly used as long as they are of adequate depth. Typically, something around 70cm (28”) high works well as this allows for a good depth of soil, and enough of a lip above the soil level to hold mulch in place.
- If using a small container which isn’t that deep you won’t be needing a 20cm (8”) deep water reservoir, you can scale it down to suit the dimensions of the container.



Wicking beds design showing the components of the system

If we look at the wicking bed design shown in the diagram, we can see it is constructed of several layers or levels. The best way to explain how the wicking bed system work is layer by layer, in the same way that it is constructed.

1. The ‘shell’ of a wicking bed is a pre-constructed or prefabricated raised bed, it can be made of steel, wood, whatever is strong enough to hold the required amount of soil.
2. The raised bed ‘shell’ is lined with pond liner so that it can hold a large volume of water. It turns the raised bed into a very large watertight container.
3. A hole is drilled through the raised bed and pond liner to fit the overflow pipe (threaded tank inlet or bulkhead fitting), at a height of 20cm (8”), which allows the water to flow out when the water level gets too high.
4. The pond liner water reservoir is filled with coarse scoria (a porous red volcanic rock) to the height of the overflow pipe. This layer will hold the water. the water sits in the spaces between the scoria, and wick it upwards. The scoria layer also serves as a structural support to hold up the soil above it away from the water below.
5. The L=shaped inlet pipe is put into place before the scoria is laid down, it serves as a water inlet to fill the water reservoir with water. The vertical pipe is joined to the horizontal pipe with a 90-degree elbow join. The lower horizontal pipe has holes drilled right along its length, so water drains out more easily.
6. The scoria layer is covered with geotextile fabric or shade cloth to keep the soil layer above it from falling into the scoria layer water reservoir – essentially it is a barrier that separates the water below from the soil above.
7. The soil then fills the bed to a level just below the edge of the pond liner, so the pond liber sits slightly higher than the soil level.

The wicking bed is filled with water from the inlet pipe to fill the water reservoir, when it is full, some water will flow out of the overflow outlet. The water will then wick upwards as high as it can to keep the soil damp.

By understanding how a wicking bed works, we can get a better idea about how we want to design one and determine the quantities of materials required tor construction.

Wicking Bed Materials

Wicking beds require a lot of materials to construct, and as a result, they are not cheap.

To construct a wicking bed, you will need the following materials:

- **Raised garden bed** – prefabricated steel raised garden bed or DIY timber raised garden bed
- **Pond liner** – either PVC or the more expensive butyl rubber (*these have very long warranties on then and are designed not to leak. While some people use black builders' plastic, it is not as durable as pond liner and not recommended*). You will need enough pond liner to line the sides and bottom of the raised bed. So, your width of materials will need to be **(width of bed + 2x the height)**, and the length of pond liner will need to be **(length of bed + 2x the height)**.
- **Scoria (Coarse Grade)** – this is a porous volcanic rock that fills the water reservoir, the water occupies the scoria layer and wicks upwards. You will need enough to fill the raised garden bed to a height of 20cm (8"). To work out the volume in litres, use the following formula: **(length of garden bed (cm) x width of garden bed (cm) x 20cm)/1000**, so for example a 2mx1m garden bed will take (200*100*20)/1000 = 400L of scoria. or 0.4 cubic metres.
- **Geotextile fabric** – separates the soil from the scoria-filled water reservoir. Geotextile fabric is synthetic and does not break down, which is important. Geotextile fabric is sold as fine grade weed mat which looks like see-through cloth (it does NOT look like plastic) and can come in a few colours, often grey-black or white. As it is quite thin it is a good idea to use a double layer of geotextile fabric. If geotextile fabric is unavailable, you can use shade cloth with a high shading factor as possible such as 90% shading shade cloth, as the holes are smaller. Whichever material you use, you will need enough to cover the bottom of the raised bed and extend a little up around the sides by at least 15cm (6").
- **Soil Mix** – use a high-grade soil with a good level of organic matter in it. Ideally, a mix of 50% premium soil, 25% organic compost and 25% organic cow manure will give your vegies a good start.
- **Water Overflow Outlet Fitting** – use a 20mm Threaded Tank Inlet (Bulkhead fitting) and get a drill with the appropriate drill bit or hole cutter to drill a hole to fit the fitting into the side of the raised bed.

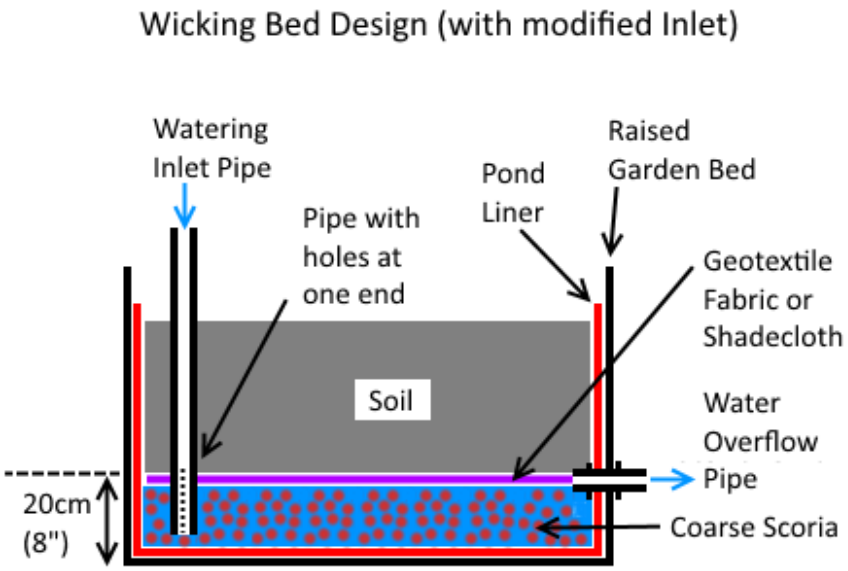
- **Water Inlet Pipes** – use two pieces 50mm (2”) PVC pipe, joined by a 90-degree elbow joint. The vertical segment of pipe should extend above the soil line at a height that allows the gardener to comfortably pour water into it (not too high), but not so low that it is lost amongst the vegetation. The horizontal section should be approximately half to three quarters the length of the bed and should be drilled all around and over its length with holes approximately 10mm-12mm (3/8”-1/2”).
- **Tools required** – spirit level for levelling the garden bed and scoria laver, a drill and appropriate drill bits and hole cutters as discussed above, a set of small spring or screw clamps for holding the pond liner in place while filling, and scissors to cut pond liner.

After we have gathered the required materials, we can then begin construction. Allow a few hours for construction if you have never built a wicking bed before as you’ll be learning as you go. Once you are familiar with the process and have developed and refined a system that works for you, you’ll be able to build them rather quickly. The ***two*** wicking beds in the following instructions were built at a kindergarten with a colleague (and a lot of little children with tiny plastic spades and buckets) in a little over an hour!

Wicking Bed Construction – Step by Step

In this instructional article we’ll be using a galvanised steel raised bed as the base for our wicking bed.

Also, for ease of construction, we’ll use a slightly simpler design where the water inlet tube is just a straight pipe with no bend in it, as shown in the diagram below:



1. Place or construct the raised bed in the desired location, once it is filled with soil it will be immovable!
2. Ensure that it is level by using a spirit level – place the spirit level crossways and lengthways and at various angles to determine if it is level. The wicking bed needs to be level because it will hold water at a specific height, if it is angled it will drain out one side and be too dry on the higher side or not drain properly and be wetter on the lower side. If a side of the bed is low and needs raising, lift the bed slightly and pack more soil underneath to elevate it, if it is high, dig some soil out.
3.

If you're wondering about the four white tubes inside the top edge of the raised bed, they are part of it, it's purchased that way. The vertical tubes are used for attaching flexible pipe from one side of the bed to the other to make a half-circle tunnel -shaped frame to support a covering material such as bird or insect netting. shade-cloth or plastic.

4. Drill hole in the side of the raised bed, 20cm (8") above the ground.

5. Lay down the pond liner inside the raised garden bed and check that it fits properly.

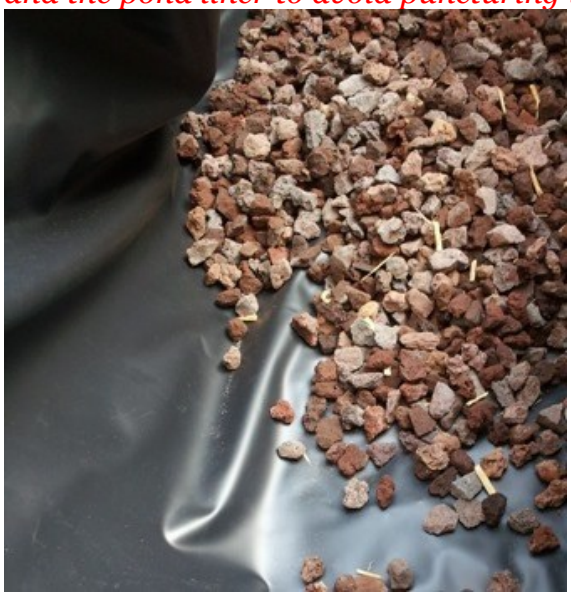
6. Install the 20mm threaded pipe outlet (bulkhead connector). Cut a hole in the pond liner just big enough to fit it through the hole, no larger, and ensure that the rubber washer of the fitting is against the pond liner to ensure a watertight seal.

7. Prepare the water inlet pipes – if using the vertical modified design, drill 10mm (3/8”) holes all around the last 30cm (12”) of the 50mm (2”) wide PVC pipe, length should extend high enough above raised bed to allow efficient watering without reaching too high or pushing plants out of the way to find the watering inlet.

If using the more common design of an “L” shaped water inlet, use two lengths of pipe and an elbow join. The horizontal section should be approximately half to three quarters the length of the bed and should be drilled all around and over its length with holes approximately 10mm-12mm (3/8”-1/2”). Join the two pipes with the elbow join, just push-fit the pieces together, a friction-fit is sufficient.

8. Lay down a thin layer of coarse scoria over the pond liner. This will bed it down and put a protective layer of scoria over the pond liner so that it can’t be damaged by the PVC inlet pipe.

Important – This modified design used only one shorter piece of inlet pipe and no elbow joint for the pipe, it is ‘I” shaped and not “L” shaped as in the previous design, so the cut end of the pipe is pointing straight down onto the pond liner, make sure there is an adequate layer (5cm or 2”) of gently packed-down scoria between the end of the pipe and the pond liner to avoid puncturing it if the pipe is pushed down!



9. Clamp the pond liner to the top edges of the garden bed right around using small spring or screw clamps to keep the pond liner in place while the bed is filled with materials.

10. Fill the garden bed with coarse scoria to the height that is level with the overflow outlet. Make sure that the scoria layer is fairly level and even.

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11. Lay down geotextile fabric (or shade cloth) over the scoria layer.

12. Wrap well around inlet pipe, allow the fabric to come up around the pipe to prevent any soil entering the scoria layer.

13. Cover the scoria layer with two layers of geotextile fabric (or a single layer of dense shade cloth) and extend it up around the sides of the pond liner by at least 15cm (6”).
The geotextile fabric can be tucked in all around where it makes a corner with the sides to secure it in place, just push the bottom part or the vertically extending sections between the pond liner and scoria. This is to make sure that no soil can get into the scoria layer.

14. Check that the scoria layer is level. If there are any high spots, pat them down. Low spots can be raised by pressing around the sides of the low area to push scoria into the area to fill it.

If the scoria is far too uneven, lift a section of the geotextile fabric, level the scoria layer, and then put the geotextile fabric back in place.

15. Check once more that the scoria layer is level under the geotextile fabric.

16. Begin filling the raised bed with the soil (*50% soil, 25% compost, 25% cow manure mix or your own blend*), ensuring that the pond liner is kept against the walls of the raised bed as you fill with soil.

The blue plastic pot at the top of the water inlet is there as a cap to prevent dirt and other objects entering the water reservoir.

17. Trim off excess pond liner with scissors leaving about 3cm (1-1/4”) of pond liner the soil line.

18. Wicking bed completed and ready to plant and water! To get the system to wick properly, you need to evenly wet all the soil first by gently watering the soil from above repeatedly until water starts running into the scoria layer.

    Once the soil is evenly wet, fill the water reservoir through the inlet pipe until water begins to flow out of the overflow pipe. Plants up the wicking bed and mulch your plants to conserve moisture, then sit back and relax!

Getting More Out of Your Wicking Bed

Mulch – The reason why there is a considerable lip or edge above the soil level, around 10cm (4”), is to allow the bed to hold a nice thick layer of mulch above the soil. Mulch keeps the moisture in the soil, prevents evaporation, and conserves water, and the purpose of building a wicking bed in the first place was to reduce watering. If you’re building your wicking bed in the warm seasons, always mulch!
Mulch with a layer of mulch around 5-7cm (2”-3”) so the water lasts longer, and your plants roots stay cool. The mulch will also break down slowly and add nutrients to the soil. For mulch material in a vegetable garden bed, you can use pea straw, lucerne, hay or sugar cane mulch.

In-soil worm farms – you can also construct worm farms directly in the wicking bed using worm tunnels (see article Build a Worm Tunnel Vermicomposting System) so that the whole wicking bed becomes a wicking worm farm, that way the earthworms generate worm castings, one of the best known fertilizers, within the garden bed itself!

Water recycling – the water that flows out of the water overflow outlet will be loaded with fertiliser so you can run that water into a bog garden, reed bed system or a garden bed in the ground for moisture loving plants (if you get enough water overflowing!)

Extra growing space – wicking beds, like other raised beds, can support frames or trellises to grow climbing plants on such as beans, peas, cucumbers, watermelon and any other edible annual climber you fancy. Keep in mind that you can’t hammer stakes or poles into the wicking bed itself, that will punctuate the pond liner and destroy the watering system. The frame, trellis or support has to either be anchored into the ground or attached to a wall behind the wicking bed.

Protective covers – as with other raised beds, you can make a frame to support bird netting or insect exclusion netting to protect the plants in your wicking bed from pests. Another possibility is to use clear greenhouse plastic to make a cloche tunnel for extended season growing.

Wicking Bed Maintenance

To maintain a wicking bed, flush out the whole system at least once a year. If the wicking bed is undercover and not exposed to rain, which helps flush it out naturally, consider carrying out the task perhaps twice a year.

To clear away high levels of salts that are building up at the top layers of the soil, water from above to wash them out into the water reservoir and out of the outlet pipe.

Also, remember to go easy on the fertiliser when feeding the garden bed in spring and autumn, as fertiliser levels can accumulate in wicking beds because every bit of fertiliser that you put in stay in the system unless it is washed out.

Other than that, maintain a wicking bed just like any other raised bed.

Now that you know whether you really do need a wicking bed, how it works, and how to build one, the rest is up to you! Happy growing!