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1	IBC Tank		9	Polystyrene Sheet	
2	200 Litter Blue Barrels		10	Plumbers Tape (Teflon)	
3	Fish Tank Shading		11	Cable Ties	
4	Plastic Net		12	Waterproof Eclectic Box	
5	Concrete Blocks		13	110 mm Wide Pipe	
6	Wood Lengths of 8x1cm in size		14	50 mm Pipe	
7	Submersible Electric Water Pump min 2000 lph		15	75 mm Pipe with Bell End (27cm Long) + 75 stopper (Pipe End) + 75 mm Rubber Washer	
8	Eco- Soap Or Lubricant		16	Pvc 25 mm Pipe	

17	25/20 mm Polyethylene Pipe		25	25mm X 1" Female Adaptor	
18	50/110 mm Uni-seal		26	20 mm Push On Tap	
19	50/110 mm Sealing Rubber Washer		27	3/4" Male X 3/4" Female Plastic or Metal Tap	
20	Pvc 40-25mm Eenlarger		28	20 Litter Bucket	
21	Pvc 25mm X 1" Female		29	Air Pump 2 Exits	
22	20mm X 3/4" Male Adaptor		30	Air Pipe	
23	25mm X 1" Female Elbow		31	Plastic Bottle	
24	25mm X 3/4" Male Elbow		32	Air Stone	

33	Fish Net		41	110mm Elbow	
34	Bio Balls or Bottle Caps		42	110mm T Connector	
35	Volcanic Gravel 4-20mm		43	110mm Straight Adaptor Coupling	
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37	50mm Elbow		45	1" Barrel Connector B Type	
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39	50mm T Connector		47	1" Male X 1" Female Plastic or Metal Tap	
40	50mm Stopper (Pipe End)		48	20 mm Push On Elbow Connector	

49	25mm X 3/4" Female Elbow	
50	20 mm Push On T Connector	
51	110mm Stopper (Pipe End)	
52	25mm X 3/4" Female Adaptor	
53	25mm X 1" Female x 25mm T Connector	
54	25mm X 25mm Elbow	
55	25mm T Connector	
56	25mm X 1" Male Elbow	

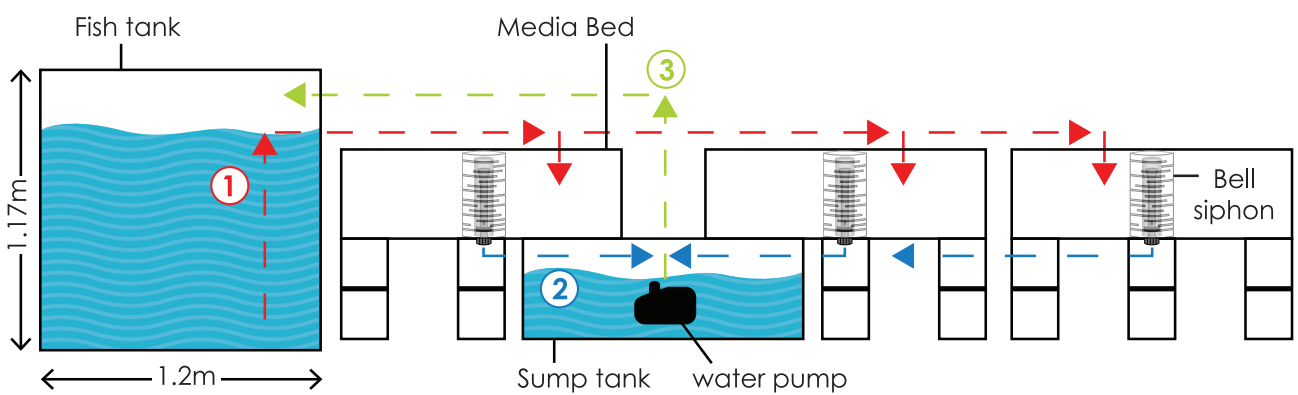
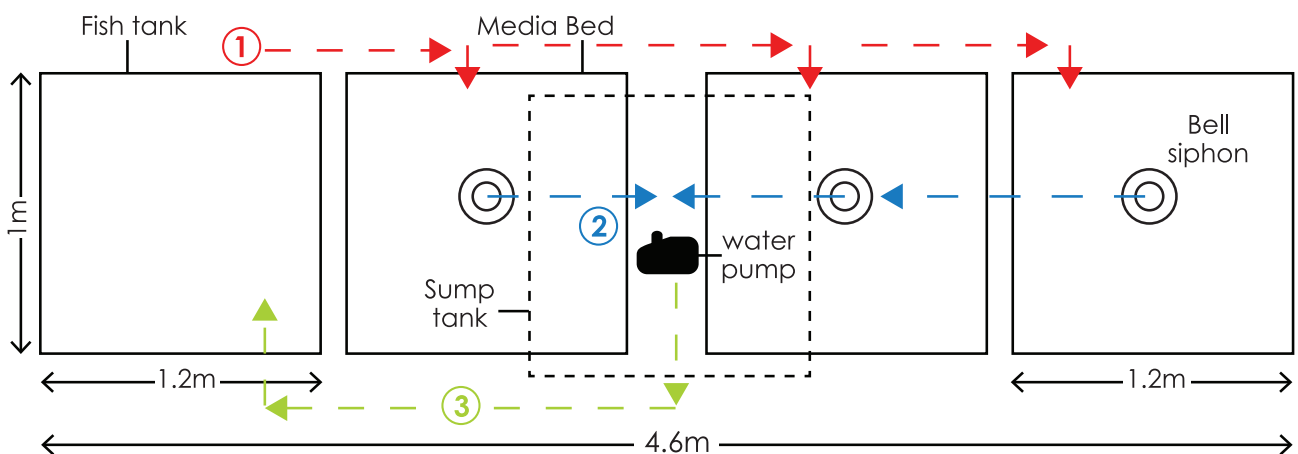
57	25mm X 3/4" Female X 25mm T Connector	
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## Index of Tools

1	Ear Protectors		9	Pliers	
2	Working Gloves		10	Screw Driver	
3	Safety Goggles		11	Electric Drill Machine	
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8	Hammer		16	Circular Drill Bit	

17	Angle Grinder	
18	Star-Headed Key	
19	Stop watch	<p data-bbox="560 779 679 808">Stop watch</p> <p data-bbox="671 837 759 866">00:06.72</p> <p data-bbox="488 869 759 936">00:06.72</p>

## Section 1) The Media Bed Unit



### Water flow diagram

1. Water flows by gravitation from the fish tank to the media beds
2. Water flows from the media bed into the sump tank
3. Water flows back to the fish tank from the sump by using the water pump

#	List of Items For the Media Bed Unit	Quantity	Number in The List of Items
1	IBC Tanks	3	1
2	Submersible Electric Water Pump min 2000 lph	1	7
3	Air Pump 2 Exits	1	29
4	Air Pump Pipe	3 m	30
5	Air Stone	2	32
6	Concrete Blocks	48	5
7	Wood Lengths of 8x1cm	21 m	6
8	Volcanic Gravel 4-20 mm	750 l	35
9	Fish Tank Shading	2 m	3
10	Plumbers Tape (Teflon)	1	10
11	Cable Ties	15	11
12	Waterproof Eclectic Box	1	12
13	Pipe Lubricant	1	8
14	Plastic Bottle	1	21
	<b>Piping&amp;Fitting</b>		
15	50 mm Pipe	7.5 m	14
16	50 mm Rubber Washer	1	18
17	50 mm Elbow	5	37
18	50 mm – 50 mm Straight Adaptor Coupling	6	38
19	50 mm T Connector	2	39
20	50 mm Stopper (Pipe End)	4	40
21	1" Barrel Connector B Type	3	45
22	1" Male – in 1" Female Plastic or Metal Tap	3	47
23	57 mm uni-seal	1	18
	<b>Bell siphon</b>		
24	110 mm pipe White Pipe	0.9 m	13
25	75 mm Pipe with Bell End (27cm Long) + 75 stopper (Pipe End) + 75 mm Rubber Washer	3	15
26	Pvc 25 mm Pipe	0.8 m	16
27	1" Barrel Connector V Type	3	46
28	Pvc 40-25mm Eenlarger	3	20
29	Pvc 25mm X 1" Female	3	21
30	25mm X 1" Female Elbow	3	23
31	Polyethylene 25 mm pipe	9	17



## A) Media Bed unit

### 1. Preparing the fish tank

1.1 Remove the two horizontal steel lengths attached to top surface of the IBC tank holding the inner plastic container in place. The steel lengths are fixed with 4 star headed screws\*. Remove these four screws (image 1) using a star headed screwdriver (image 2) or star headed allen key (image 3). Once the steel lengths are removed pull out the inner plastic tank

\* If there is no star key, cut the screws with an angle grinder.



1.2 After pulling out the tank, draw a rough square shape on the top surface of the tank 5 cm from the 4 sides of the tank (image 4). Then using angle grinder (image 5) cut along the square shape and remove the cut piece from the top (image 6). Once removed, wash the inside of the container thoroughly with soap and warm water and leave to dry for 24 hours (image 7).

\*It's possible to keep the cut piece and use it as the fish tank cover later.



### 2. Installing the fish tank exit pipe:

2.1 On one side of the IBC tank, mark a point 12 cms from the top and 12 cm from the side of the tank (image 9) and drill a hole at the point using the 57mm circular drill bit (image 8). Insert a 50 mm uni-seal (image 10) inside this hole.

\*Attention drill size should be 57 mm and not 50 mm (image 8)



2.2 The fish tank exit pipe is made of 2 x 50mm lengths of PVC 50mm pipe attached using a 50mm elbow and 50mm straight connector (Image 11). The 50mm length along the bottom surface of the tank is cut using the angle grinder with horizontal slits 2-3mm thick (Image 12). to allow solid waste to enter the pipe but prevent fish from doing so. The open end of the PVC length along the bottom surface is (Image 13). Slot in a 50mm elbow into the 50mm uni-seal (image 11) and attach the other (vertical) pipe length to the elbow that is now inside the 50mm uni-seal. Finally, drill a 2-3cm diameter hole into the 50mm elbow slotted into the 50mm (see image 13). This small hole prevents any air seal forming inside the pipe which would drain all the water out of the fish tank if the pump cut out.

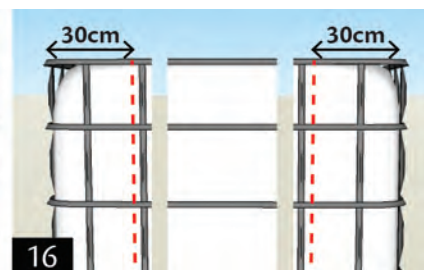
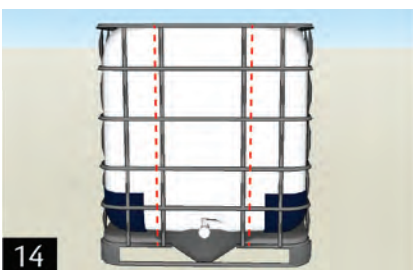


### 3. Preparing the grow beds and sump tank-

To make the 3 grow beds and sump tank you'll need the two other IBC tanks; the first to cut out the sump tank and 1 grow bed and the second to make the two remaining grow beds. Take the two IBC tanks and remove the four steel profiles and pull out the plastic containers as shown in pictures (1-3)

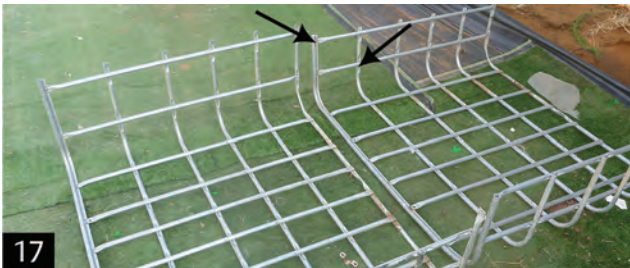
### 4. Fabricating 2 grow beds from 1 IBC

First, stand the plastic inner container (image 14) upright and mark, using an meter stick and pencil, two bisecting lines 30cms from both sides of the tank (as seen in image15) Make sure to mark the exact lines (shown in the image 15). Take the angle grinder and carefully cut along both bisecting lines made out to create two uniform containers with a depth of 30 cms. (image 16). Then, take both containers and wash them thoroughly using natural soap and warm water and leave them out to dry in the sun for 24 hours.

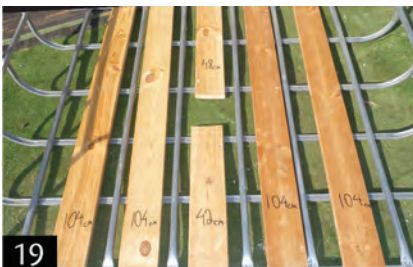


### 5. Metal Supports for both grow beds

5.1 Take the IBC metal support frame and cut out two support frames by following the same bisecting lines shown in (image 14) using the angle grinder (image 17). When cutting the two 30cm sides of the support frame, make sure to keep two horizontal steel profiles intact as they will provide excellent support to the sides of the beds once they're full with water and media frame (see image18).

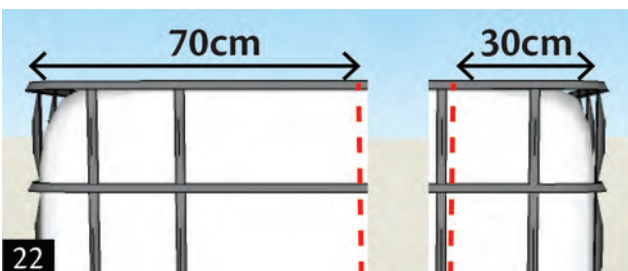


5.2 Then, take both support frames and lay them out on the floor. Take the wood lengths (4 x 104 cm lengths, 1 x 42 cm length and 1 x 48 cm length) and place them on top of the support frame as shown in image 19. These wood lengths keep the plastic grow bed horizontal which is vital for the functioning of the bell siphons. Next, take the washed grow beds and place them on top of the support frame and wood lengths (image 20). Finally slot in the remaining wood lengths in-between the plastic grow bed and support frame on both sides of each bed to provide further support (see image 21).

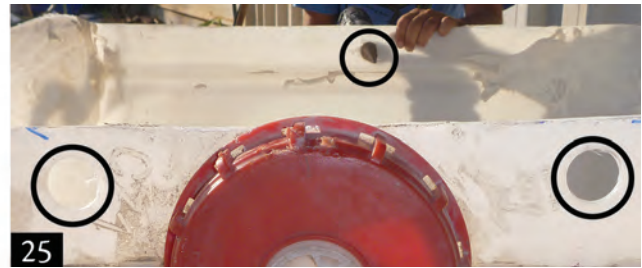


## 6. Fabricating a sump tank & 1 grow bed from an IBC

6.1 Take the remaining IBC, place it upright and mark out, using a meter stick and pencil, only one 30cm bisecting line as seen in image 23. Then, take the angle grinder and cut the inner plastic container and metal support frame at once by following the bisecting line (see image 22). Remove the 30cm container (3rd grow bed) from the remaining 70cm container (sump tank) (image 23). Wash out both containers thoroughly with natural soap and warm water and leave in the sun for 24 hours.



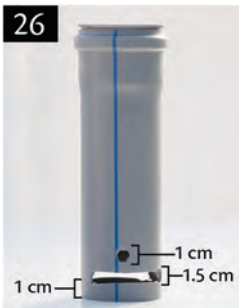
6.2 For the 3rd grow bed, follow the same steps with the wood lengths as detailed above for the first two. Finally, take the sump tank container and drill two holes (25mm diameter) using the conical drill bit as shown in (image 25) (25mm pipe will be inserted into both of these holes later that will drain water from each grow bed).



## 7. Preparing 3 bell siphons



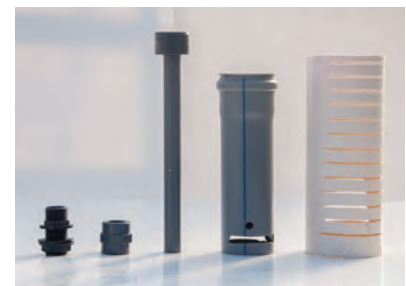
As explained in chapter 4, bell siphons are simple mechanisms used to automatically flood and drain each grow bed. The following materials are needed to make 3 siphons: 3 x 30cm Media guards(110 mm pipe), 75 mm Pipe with Bell End (27cm Long) + 75 stopper (Pipe End) + 75 mm Rubber Washer; 3 x 16 cm standpipe (25mm pipe); 3 x 25mm Barrel connectors; 3 x Pvc 40-25mm Eenlarger; 3 x Pvc 25mm X 1" Female; 3x 25mm X 1" Female Elbow



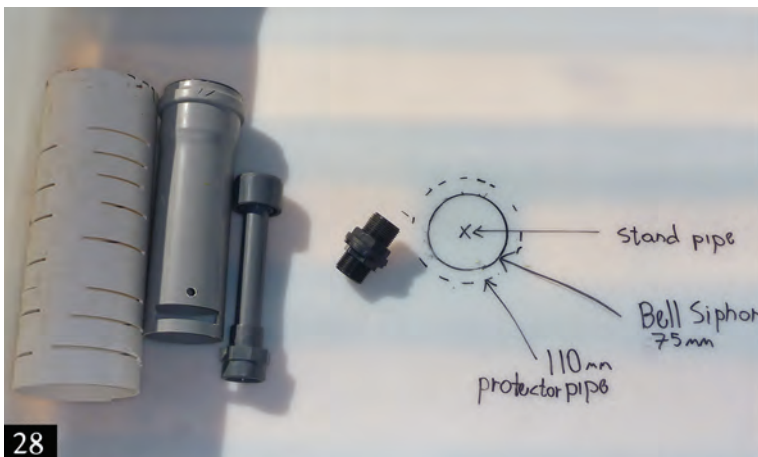
a) First, take 75mm Bells and cut out 2 pieces as shown in image26 using the angle grinder. Then, drill a hole (10 mm diameter) using a 10mm drill bit roughly 1.5cms from the 2 cut pieces as shown in image 26. Finally, seal one end of bell using the pipe end and rubber washer.



b) Next, take the media guards and cut 5mm slots along its entire length using the angle grinder (see image 27).



c) Now, take each grow bed and mark their center points in-between the two wooden lengths below as shown in (image 28). Drill a 25mm diameter hole at each center point (image 29) and insert the 25mm barrel connector with the rubber washer placed inside the grow bed. Tighten both sides of the connector using a wrench (see image 30).



d) Screw the 1"-25mm adapter onto the 25mm barrel connector inside the grow bed and then slot the standpipe into the 1"-25mm adaptor. After, attach the 25mm-40mm adaptor to the top of the stand pipe (see image 31-33) (The purpose of this adaptor is to allow a larger volume of water to initially flow down the standpipe when the water has reached the top. This helps the siphon mechanism to begin draining the water out into the sump tank)



e) Place the bell siphons and the media guards over the stand pipes (images 34-36).



f) Finally, connect the 1"-25mm elbow to the other end of the barrel connector underneath the grow bed which allows the water to flow out of the grow bed (see image 37-39).

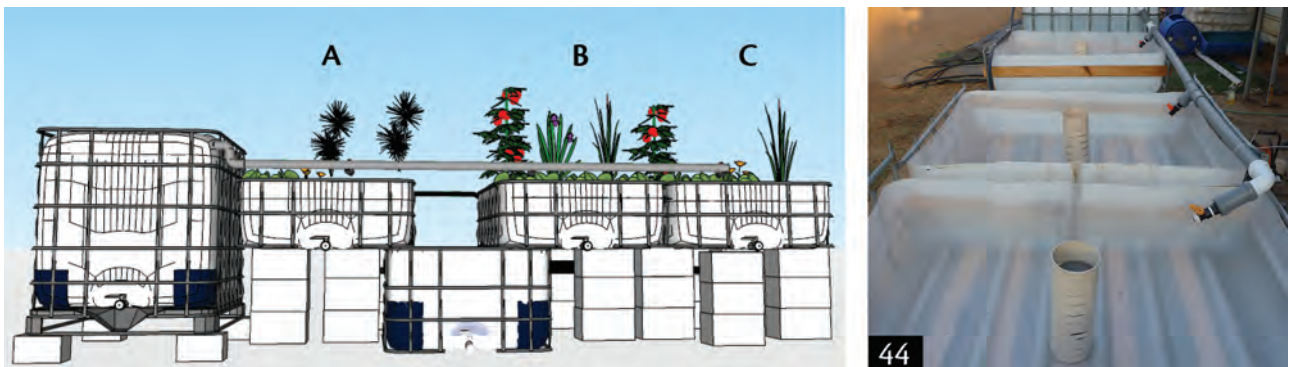


## 8. Assembling the grow beds and sump tank

First place the sump tank and brace it with six blocks from each side (12 total) as shown in images 40 - 41. Make sure the blocks do not cover the hole already drilled into the sump tanks, (see image 42).



Place the remaining blocks and the fish tank according to the distances described in image 43. The fish tank should be raised up approximately 15cm from the ground. You can do this using concrete blocks as shown in image 43. Finally, Place the three grow beds (including the metal support frames and wood lengths) on top of the blocks (as shown in image 44). Make sure the growbeds are secure on top of the blocks. If not, slightly adjust the layout of the blocks underneath.



## 9. Plumbing the unit: Fish tank to the GrowBeds

9.1 The plumbing parts needed for this section are as follows: 3 x 25mm barrel connectors B type; 3 x 1" plastic tap; 3 x 50 mm stopper (end pipe) ; 2 x 50 mm elbow; 2 x 50 mm T connector; 3 x 50 mm straight adapter coupling; 1 x 150cm 50mm pipe; 1 x 85 cm 50mm pipe

9.2 Go back to the 'preparing the fish tank' instructions. The last instruction shows a 50mm elbow slotted into the 57mm uni-seal. Take another 50mm elbow and connect it to the elbow slotted through the uni-seal (see image 45). Then, attach a 50mm straight adaptor to the elbow and fix a length of 50mm pipe to the straight so the end of the pipe meets the grow beds.



9.3 At each grow bed a valve is used to control the water entering the bed. To integrate a valve, first take the 50 mm pipe cap and drill a 25mm diameter hole. Insert a 25mm barrel connector into the hole and tighten both ends using a wrench. Then, rap Teflon tape around the end of the 25mm barrel connector and screw 1" plastic tap valve onto the barrel connector (see images 47-50).



9.4 Next, attach a 50mm elbow to the end of the pipe and then follow the pipe layout shown in image 51 that allows water to flow into each grow bed (materials include: both 50mm pipe lengths, 50mm T and elbow connectors). Next, take the pipe cap fitted with the 20 mm valve and attach it to the 50mm straight adapter as shown in the picture (image 51). Finally, attach the 50mm straight adapters to the T and elbow connections at each grow bed (see image 51).



## 10. Plumbing the unit: Grow beds to the sump tank

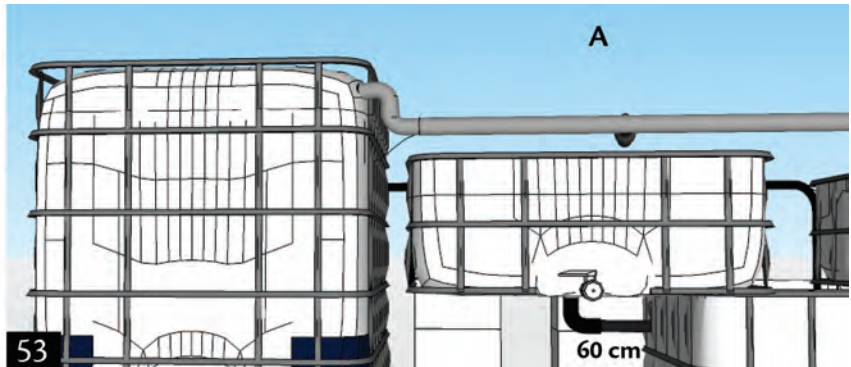
10.1 Image 53 and 54 shows the grow beds marked as A, B and C. For grow bed A, attach a 60cm length of 25mm pipe to the elbow connection underneath the the grow bed. Next, slot the 60cm pipe into the closest drilled whole on the side of the sump tank allowing the water to flow directly into the tank.

10.2 Attaching Grow bed B and C (image 54): Under grow bed B, attach a 25mm to 1" elbow connector to the end of the barrel connector. Then, take a length of 25mm polyethylene pipe (roughly 2 meters) and attach it to the sump tank's drilled holes at the side of the sump tank.

10.3 Do the same with grow bed B but with only 1 meter of 25 mm of polyethylene pipe. Now, the water exiting grow bed B and C will flow through the 25mm pipe into the sump tank.

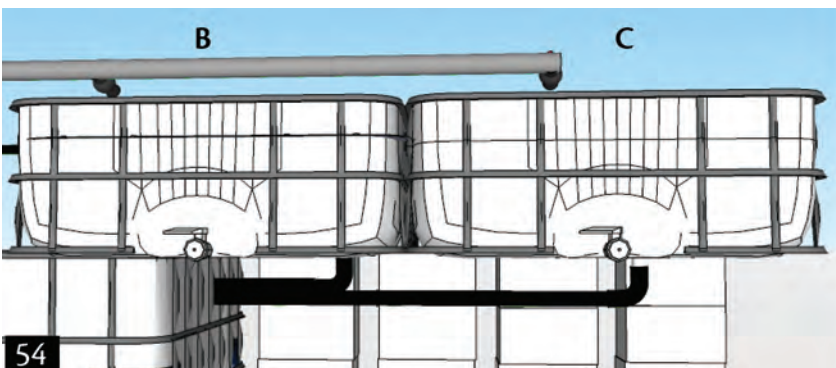


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Finally, it is advisable to fix the pipes underneath the beds to the metal frame using cable ties to relieve any pressure on the pipe fittings.



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### 11. Plumbing the unit: Sump tank to the fish tank.

Take the submersible pump and fix a 1"-25mm straight connection to it which allows 25mm pipe to be connected to it or any other connector that can fit the pump to the 25mm pipe. Take a length of the 25mm pipe (long enough to reach inside the fish tank from the submersible pump) and attach one end to the 1"-25mm connection at the submersible pump and the other into the top of the fish tank (see image 57-60). Attach a 1" tap to the end of the pipe in the fish tank and keep the tap open. (It's possible to use elbows at certain points along the 25mm pipe to the fish tank to maximize space but these connections will lower the pumping capacity of the pump).

Place the electric box in a safe place higher than the water level and shaded from direct sunlight. Make sure it is still water proof after plugging in the water and air pump plugs.



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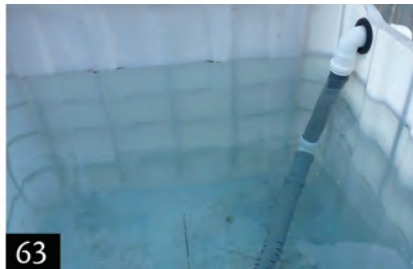
## 12. Add the media and running the unit

12.1 All parts of the system are now in place except for the grow media (volcanic gravel) in the beds. Yet before the media is added, it is recommended to fill the fish tank and sump tank with water and run the pump to check for any leaks in the system (while checking for leaks, remove the standpipe and bell siphon so the water flows straight into the sump tank, see if leaks appear, fix them immediately where they arise by tightening the plumbing connections, re-applying Teflon to treaded connections and making sure all taps are in there ideal position (see images 64-67).

12.2 Once all the leaks are fixed and the water is flowing smoothly through all components of the unit, re-assemble the siphon bell & stand pipes and begin filling the beds with media right up to the 30cm depth (see image 69)



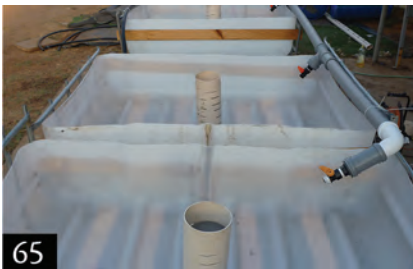
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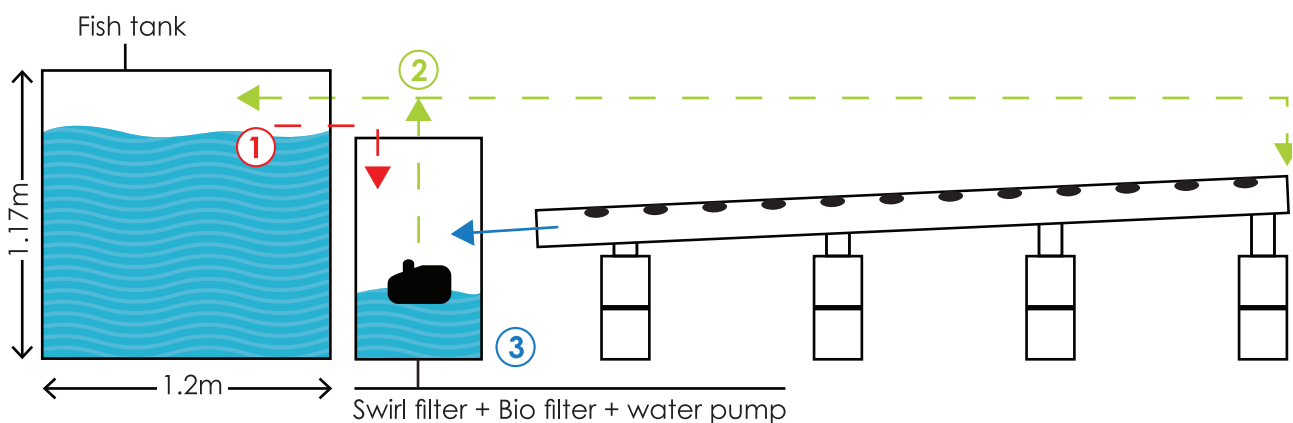
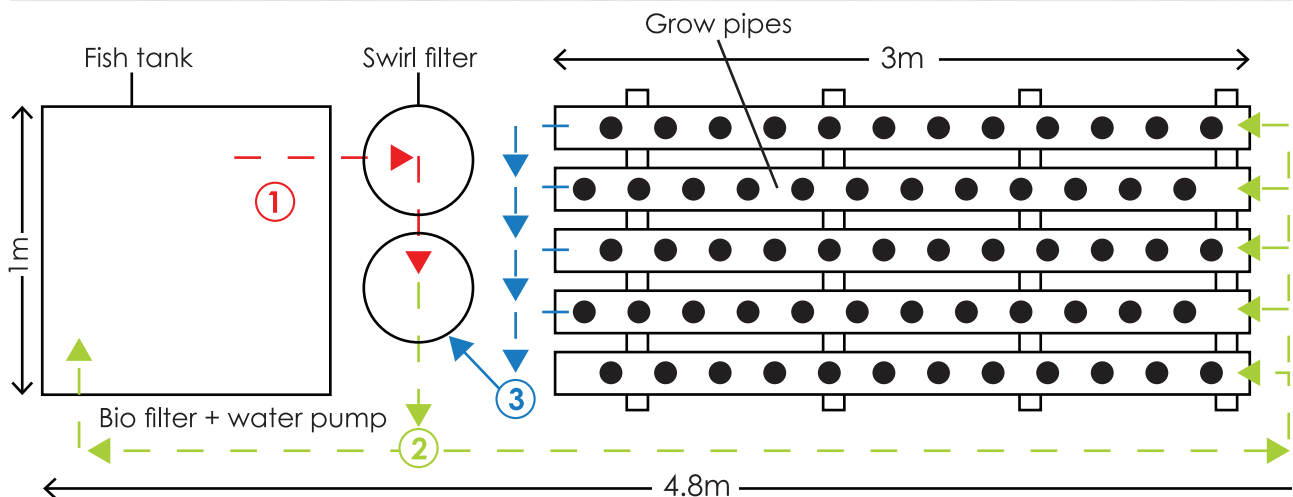
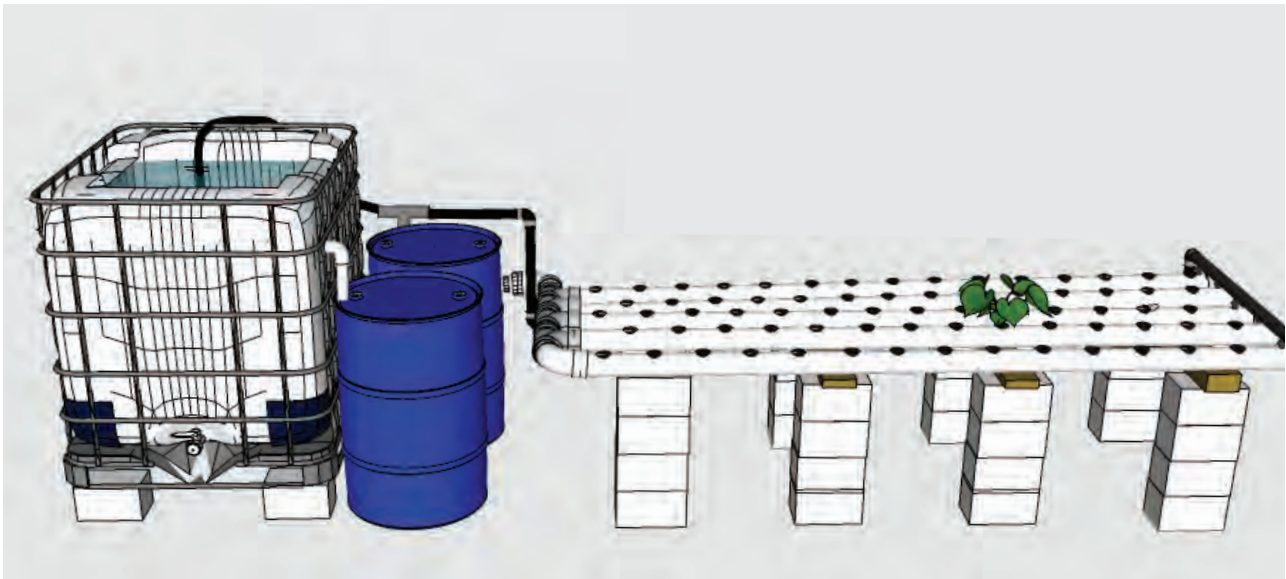


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## Section 2) NFT Unit



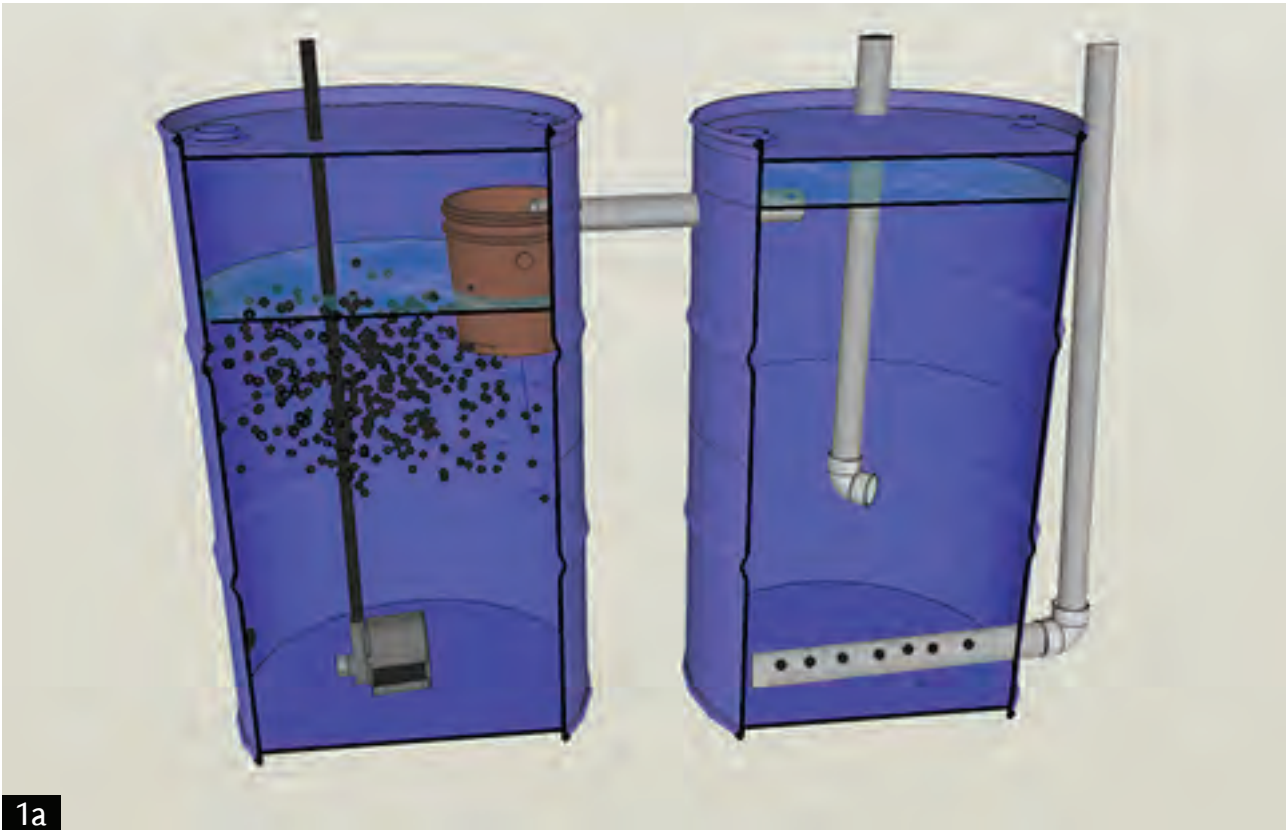
### Water flow diagram

1. Water flows by gravitation from the fish tank to the swirl filter and bio filter.
2. Water is pumped, using the submersible pump, from the bio-filter to the fish tank (80% of the flow) and the grow pipes (20% of the flow).
3. Water flows back from the pipes into bio filter.

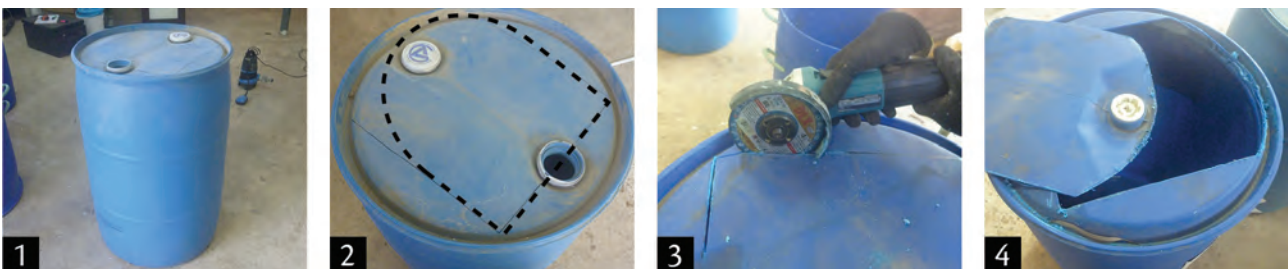
#	List of Items for the NFT unit	Quantity	# number in the list of items table
1	IBC Tanks	1	1
2	20 Litter Bucket	1	28
3	200 Litter Blue Barrels	2	2
4	Bio Balls or Bottle Cups	40 - 80 liters	34
5	Submersible Electric Water Pump 2000 lph	1	7
6	Air Pump	1	29
7	Air Pump Pipe	3 m	30
8	Air Stone	2	31
9	Concrete Blocks	32	5
10	Wood Lengths of 8x1cm	8m	6
11	Fish Tank Shading	2 m	3
12	Fish Net	1	33
13	Plumbers Tape (Teflon)	1	10
14	Cable Ties	25	11
15	Waterproof Electric Box	1	12
16	Plastic Net Planting Cups	80	36
17	Volcanic Gravel 4-20mm	30	35
18	Pipe Lubricant	1	8
	piping&fitting		
19	110mm Pipe	16	13
20	110mm T Connector	4	42
21	110mm elbow	2	41
22	110 - 110mm Straight Adaptor Coupling	1	43
23	110mm stopper (Pipe End)	5	51
24	110mm - 50 Reducer	1	44
25	110mm Rubber Washer	20	19
26	50mm Pipe	5m	15
27	50mm Uni-seal	5	18
28	50mm Elbow	6	37
29	50 - 50mm Straight Adaptor Coupling	4	38
30	50mm Stopper (Pipe End)	1	40
31	50mm Rubber Washer	8	19
32	25mm Polyethylene Pipe	8	17
33	25mm T Connector	2	55
34	25mm - 3/4" Elbow Female	2	49
35	20mm X 3/4" Male Adaptor	1	52
36	20mm Polyethylene Pipe	2	17
37	20mm Push On T Connector	4	27
38	20mm Push On Elbow Connector	1	48
39	20mm Push On Tap	5	26
40	25mm - 1" Female Adaptor		

## B) NFT unit

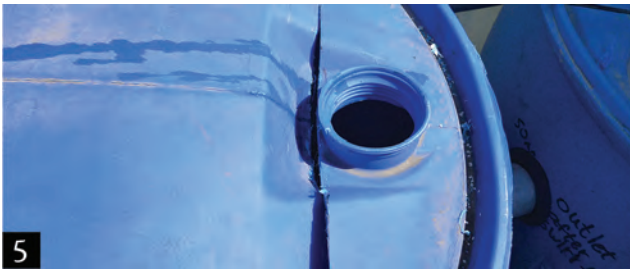
1. Preparing the fish tank (same as in Grow Bed unit, sections 1-2)
2. Preparing the swirl-filter and bio-filter (image 1a)



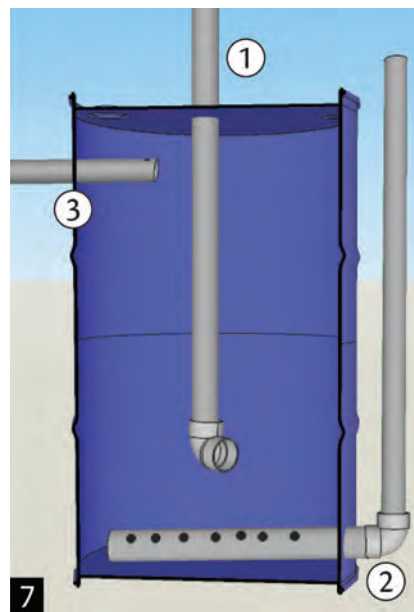
Take the 2 x 200 L blue barrels (image No 1) and cut out the shapes marked in the images underneath (image 2-4) using the angle grinder. Afterwards wash both barrels with soap and warm water thoroughly and leave to dry in the sun for 24 hours.



The cut pieces of both barrels can also be used as barrel covers. They can be fixed to the top of the barrel using cable ties (see image 5-6).



### 3. Barrel #1 – The swirl filter



#### Inlet / outlet pipes in the swirl filter

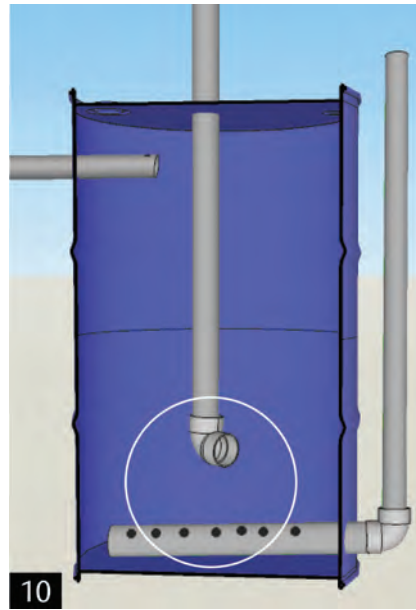
- 1) inlet pipe from the fish tank
- 2) drainage pipe at the bottom of the swirl filter
- 3) outlet pipe into the biofilter

#### Inlet pipe from the fish tank

Drill a 50mm hole using the 50mm circular drill bit at the top surface of the barrel and slide in the fish tank exit pipe (image 8-9).



Make sure that the exit pipe reaches to 30cms above the bottom of the swirl filter container and fix a 50mm elbow at the bottom of the pipe so the water flows tangentially to the container forcing the water to circulate (image 10).



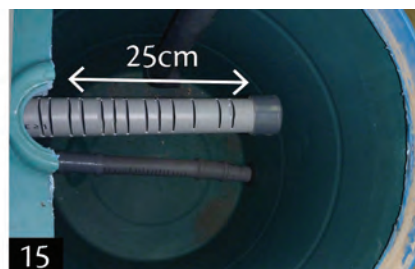
### Drainage pipe at the bottom of the swirl filter

Next, take a 50 mm pipe and cut 2-3mm horizontal slits along the entire length using the angle grinder (image 11). Drill a 57 mm hole on the outside of the barrel 5 cm above the bottom and insert another 50mm uni-seal (Image 12). Slide the 50mm pipe cut with slits into the uni-seal and connect a 50mm elbow to the end of the pipe outside the barrel. Finally, attach another 50mm pipe that is 60-70cms in length, to the elbow making sure the end of the pipe is above the maximum water level of the barrel (image13).(The slits on drainage pipe will allow solid waste to enter it and be flushed out using the other vertical pipe attached outside of the barrel).

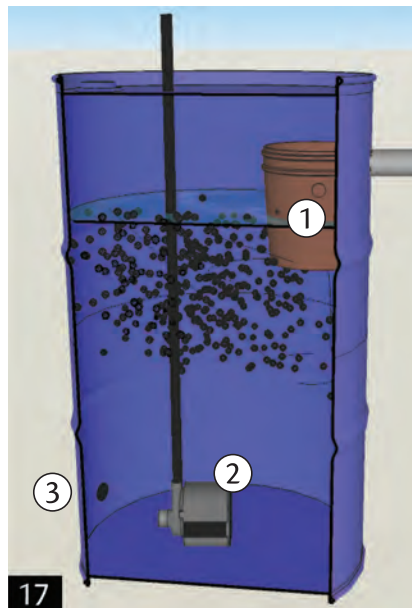


### Transfer pipe connecting the swirl filter to the bio-filter

Take a 50mm pipe 65cms in length and cut the same horizontal slits as above for only the first 25 cm of the pipe using the angle grinder (image 14). Seal the slotted end of the 50 mm pipe using a 50mm pipe cap. Next, Drill a 57 mm hole with the 57mm circular drill bit 70 cms from the bottom barrel and insert a uni-seal inside the hole. Slot the 50mm pipe into the uni-seal making sure the end with 25 cm slits is inside the swirl filter barrel (image 15-16).



#### 4. Barrel #2– the bio filter (image17)



##### Inlet / outlet pipes in the bio filter

- 1) inlet pipe from the swirl filter
- 2) water outlet from the water pump
- 3) Drainage tap

#### 25mm Drain tap:

Drill a 25mm hole at the very bottom of the bio-filter barrel and insert a 25mm V type barrel connector into the hole and fasten it tight. Attach a 25mm tap to the barrel connector on the outside of the barrel making sure the connector is wrapped with Teflon to make a water tight seal (image 18). (This tap is used to flush out any solid waste accumulating at the bottom of the bio-filter container).



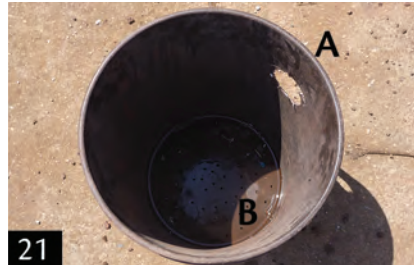
#### Inlet pipe from the swirl filter

Drill a 57 mm hole using the 57mm circular drill bit 70 cm from the bottom of the barrel and insert a uni-seal in the hole (image 19). Place the bio-filter barrel adjacent to the swirl filter barrel. Take the 65cm PVC pipe length already attached to the swirl filter barrel and slot it through the uni-seal in the bio-filter barrel as well. Now, both barrels are joined together using this 65mm pipe length (image 20).



### Preparing the solids capture bucket

- Drill a 50 mm hole in the 20 Liter bucket 5 cm below the top rim of the bucket (image 21A)
- Drill at least 20 holes (8mm diameter) into the bottom of the bucket using an 8mm drill bit (image 33) to allow water to drain into the bio-filter (image 21B).



- Insert and slide the bucket along the 65cm pipe inside the bio-filter (the same 65cm pipe that connects both filter barrels (image 22-23))
- Drill a 20mm hole into the 50mm pipe and insert a small bit of 20mm pipe (6-10cms)(image 23) to prevent the solids capture bucket from sliding off the 50mm pipe



- Place filtration media (perlite, sponge, volcanic gravel etc) inside the bucket (image 24).

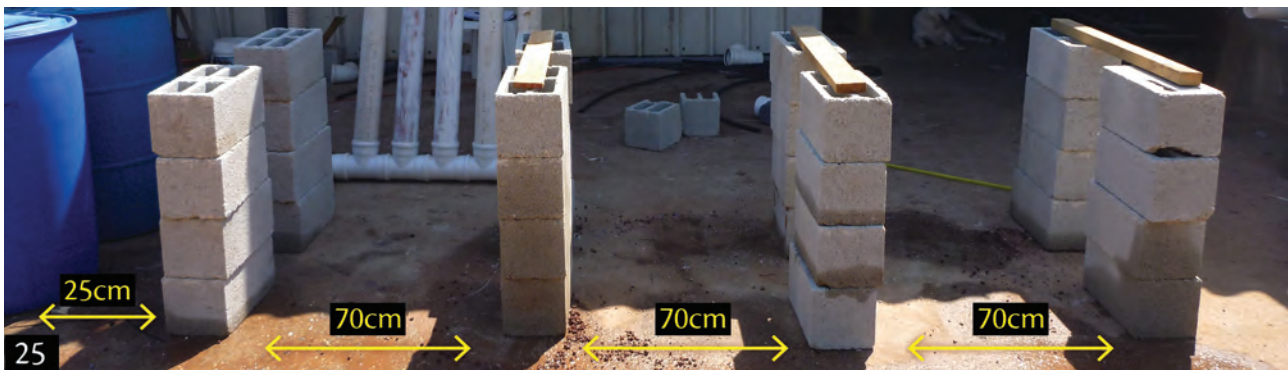


### 5. Positioning the grow pipes:

The materials needed for this section are as follows: 48 blocks; 1 x 1m wood length (30mm thick); 1 x 1m wood length (20mm thick); 1 x 1m wood length (10mm thick)

Place the concrete blocks according to the distances in (image 25) Each stand is made of 8 blocks - 2 columns 4 blocks high. Place the wood lengths on to the blocks: place the 3cm thickness length along the column of blocks furthest away from the tank, the 2cm thickness length on the middle columns and the 1cm thickness length on the closest columns. This arrangement will create a small slope allowing the water to easily flow through the pipes and back into the bio-filter barrel (image 25).





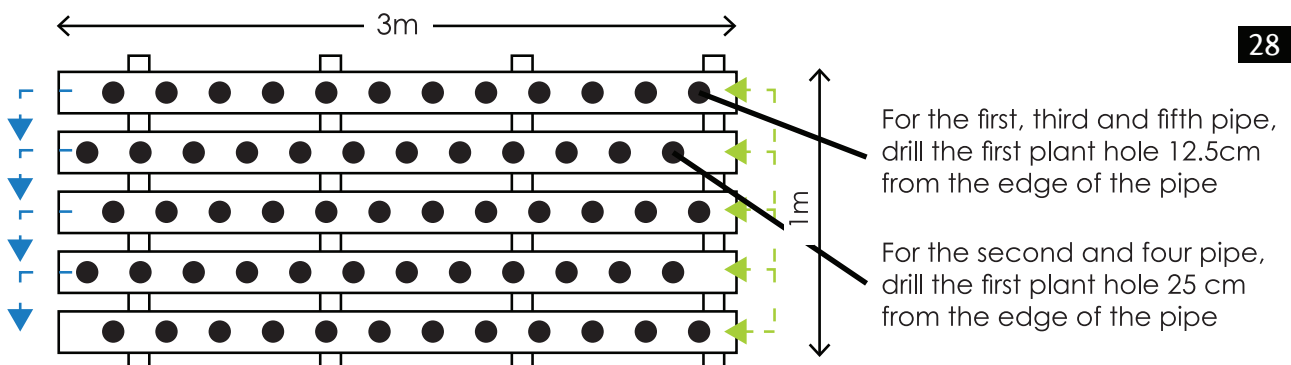
## 6. Connecting the grow pipes

The materials needs for this section are as follows: 5 x 110 mm white pipe (3 meters long), 2 x 110 mm elbows; 4 x 110 mm T connectors; 5 x 110 mm pipe ends; 15 x 110 mm rubber washer; Soap or any other organic lubricant.

Connect the pipe system according to the image (image 27) (make sure that each 110mm pipe or pipe fitting has a lubricated rubber seal fitted inside)

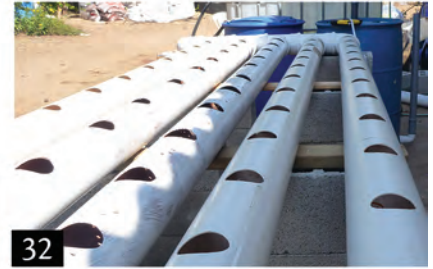
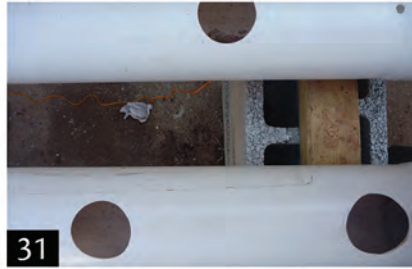
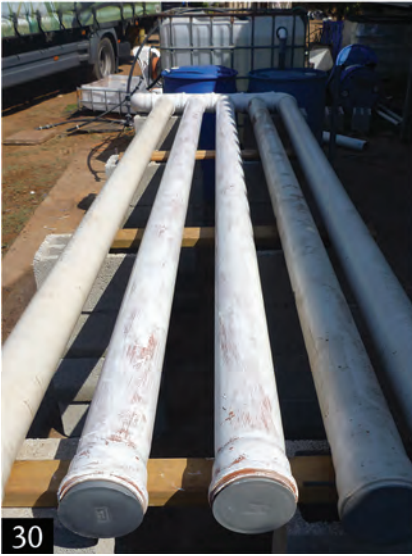
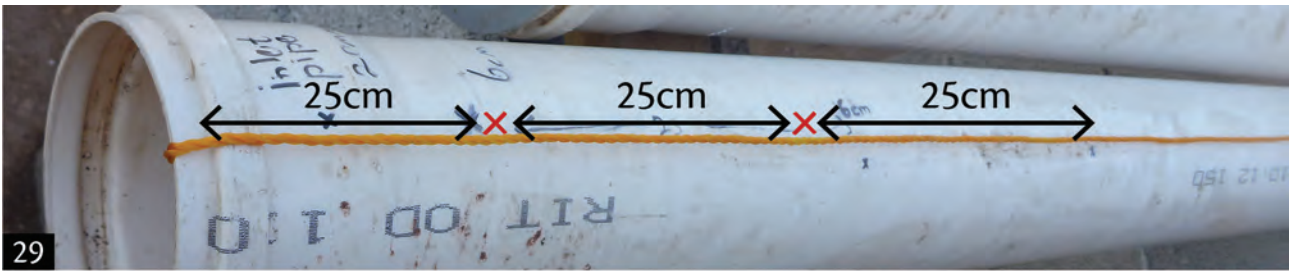


## 7. Marking the plant holes

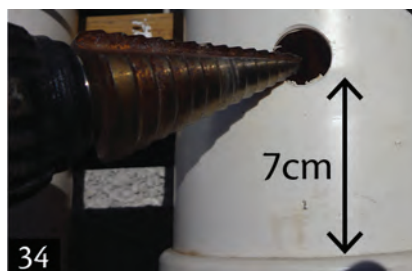


Place the grow pipes on top of the blocks and wood lengths and fit the 5 pipe ends (110mm) to the ends furthest from the fish tank (image 30)

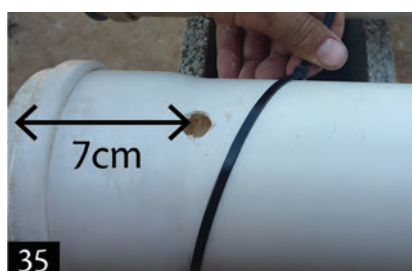
The most effective method for marking the plant holes is to stretch and secure a thin piece of rope along the top of the pipe allowing you to mark uniform hole distances accurately. Having secured the piece of rope, mark hole points 25 cm from each other and drill holes according to the size of the cups that you planning to use in this system (for more information see section 14 on the marks using the circular drill bit). For optimal plant growing space, follow the bee-hive hole spacing pattern adopted for the pipes (seen in images 28 and 31).



Put the 110 mm end caps at the beginning of each pipe (image 30). Finally, drill 20 mm holes 7 cm from the ends of the pipe furthest from the fish tank to allow water to enter the grow pipes (image 34).

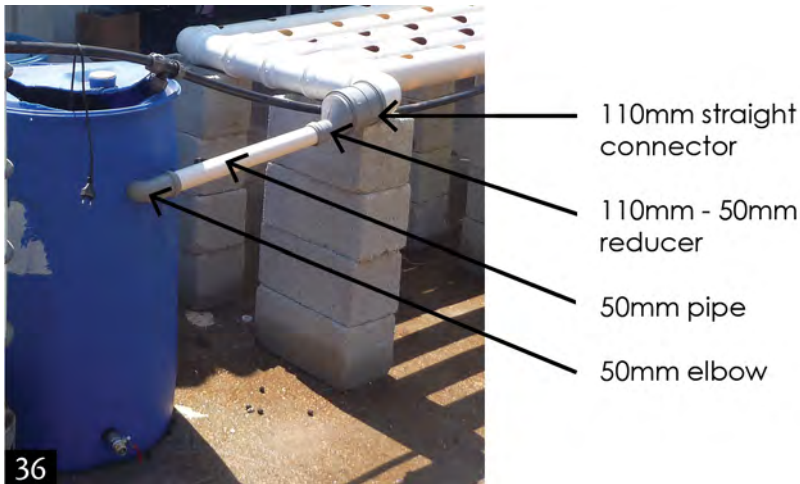


Secure the grow pipes to the wood length using the cable ties plastic stripes (image 35)



## 8. Connecting the end of the grow pipes back to the bio-filter

Take a 110mm straight connector and attach it to the final 110mm elbow in the chain of 110 T connections located at the end of the grow pipes. Then, attach a 110mm – 50 mm reducer to the 110mm straight connector. Next, drill a 50 mm hole on the outside of the bio filter 10 cm lower than the bottom of the grow pipes. Then, Fit a 50 mm elbow into 50mm hole. Finally take some 50 mm PVC pipe and connect the bio-filter elbow with the 110-50mm reducer allowing the water to flow from the grow pipes back into the bio-filter barrel. (Image 36-38).



## 9. Installing the distribution piping for each grow pipe

The materials needed for this section are as follows: 5 x 20 mm push on taps; 4 x 20 mm push on T connectors; 2 x 20 mm push on elbow connectors; 20 mm pipe; 20 mm - 3/4" adapter; 25 mm – 3/4" elbow female connector; plumber tape (Teflon). Connect all of the pipe and fittings according to the images above (image 39 -40).



25 mm – 3/4" elbow female connector

20 mm – 3/4" male adaptor

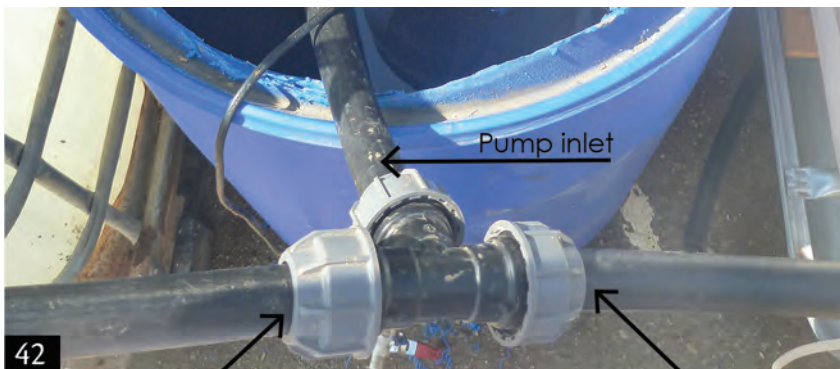
## 10. Adding the submersible pump

For this unit, the submersible pump is placed at the bottom of the bio-filter barrel. (image 41 a + b) Water is pumped from there into 2 locations: the grow pipes and to the fish tank. 80-90% of the water flows to the fish tank while 10-20% flows into the grow pipes. The taps are used to control the water flow at each location.



## 11. Pumping to the fish tank:

Connect the submersible pump to a 25 mm pipe length using a 25mm -1" female adapter (or any connection that fits the pump). The 25 mm pipe should be at least 1 m long. Place a 25mm T connection at the end of the pipe allowing water to flow to the fish tank and the grow pipes.

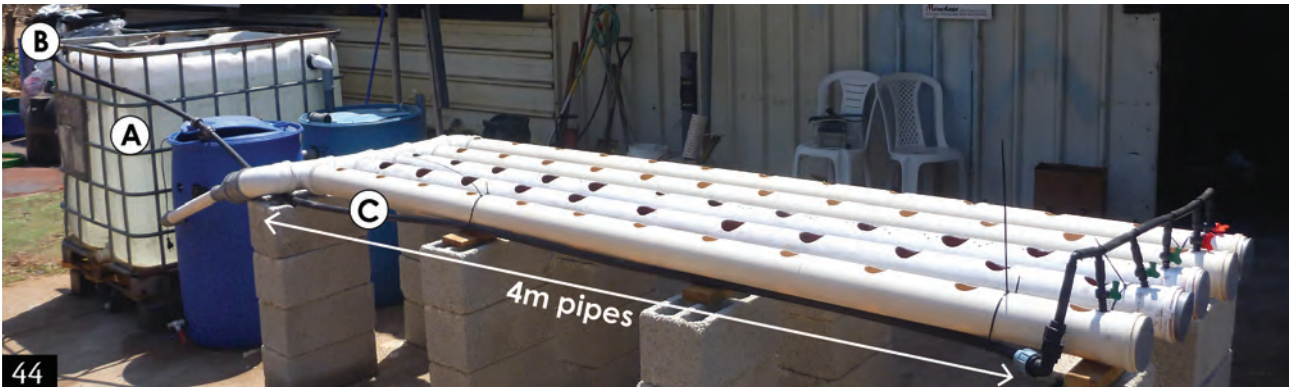


Fish tank outlet

Growing pipe outlet

Attach 25mm pipe to one end of the T connection long enough to reach the fish tank (image 44A) (Use flexible pipe if possible as this removes the need for other 25mm elbow connections which reduces the pumping capacity of the pump). Attach a 25mm tap to the end of the pipe allowing you to control the water flow into the fish tank. (image 44 B)

Next, take approximately 4 meters of 25mm pipe and attach one end to the other side of the 25mm T connection at the bio-filter. Then finally, attach the other end of the pipe to the 25mm elbow at the distribution piping for each grow pipe (image 44).



### 12. Electric box + Air pump (image 45 - 46)

Place the electric box in a safe place higher than the water level and shaded from direct sunlight. Make sure it is still water proof after plugging in the water and air pump plugs, and put the air stones inside the fish tank.



### 13. Final checks

All parts of the system are now in place yet before adding ammonia, fish or plants, it is recommended to fill the fish tank and both filters with water and run the pump to check for any leaks in the system. If leaks appear, fix them immediately where they arise (image 47-49)

fish tank filling with water



Swirl filter drainage check ( image 50 – 52 )



- Filling the bio filter with media, water (image 53 a+b)
- Filling the swirl filter with water (image 54)
- Swirl filter + biofilter (image 55)



- tightening the plumbing connections,
- Checking all uni-seals and taps for both filters
- re-applying Teflon to treaded connections
- making use all valves are in their ideal position



Finally, check the flow rate of the water flowing into each grow pipe is roughly 1-2 liters per minute. You can do this using a simple electric timer & an empty 1 liter plastic bottle (image 56)

Once all the leaks are fixed and the water is flowing smoothly through all components of the unit you can begin cycling the unit using ammonia (see chapter 5 for more details on this process)

#### 14. Planting – making the planting cups (57 – 61)

Do as described in the pictures.

- Make sure the plant cup has enough holes to allow the root system to grow out into the pipe but also to prevent the grow media from falling out.

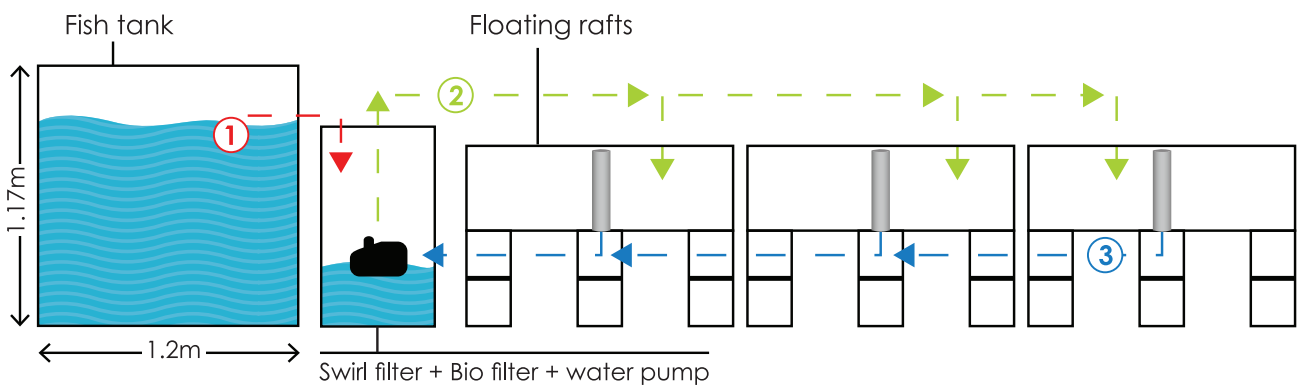
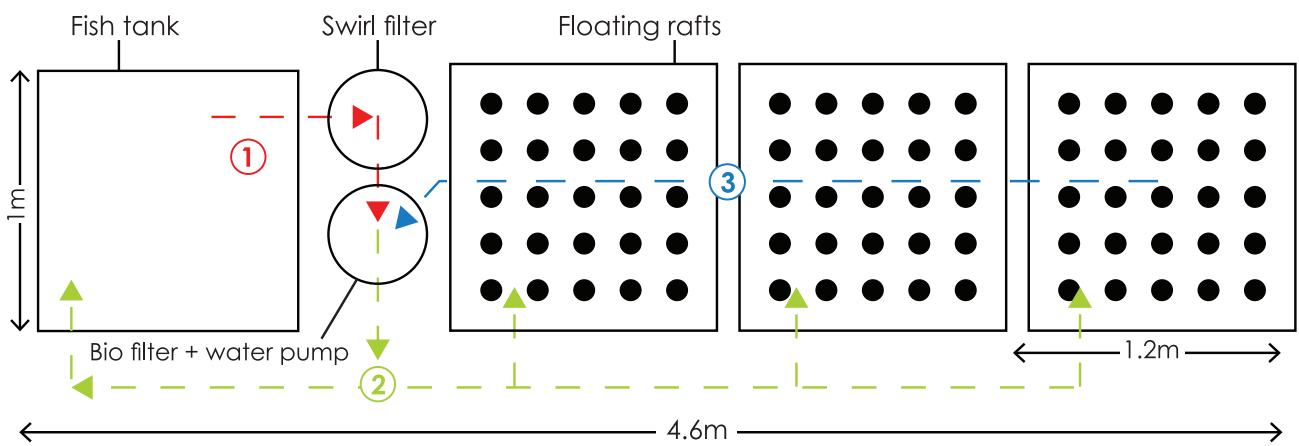
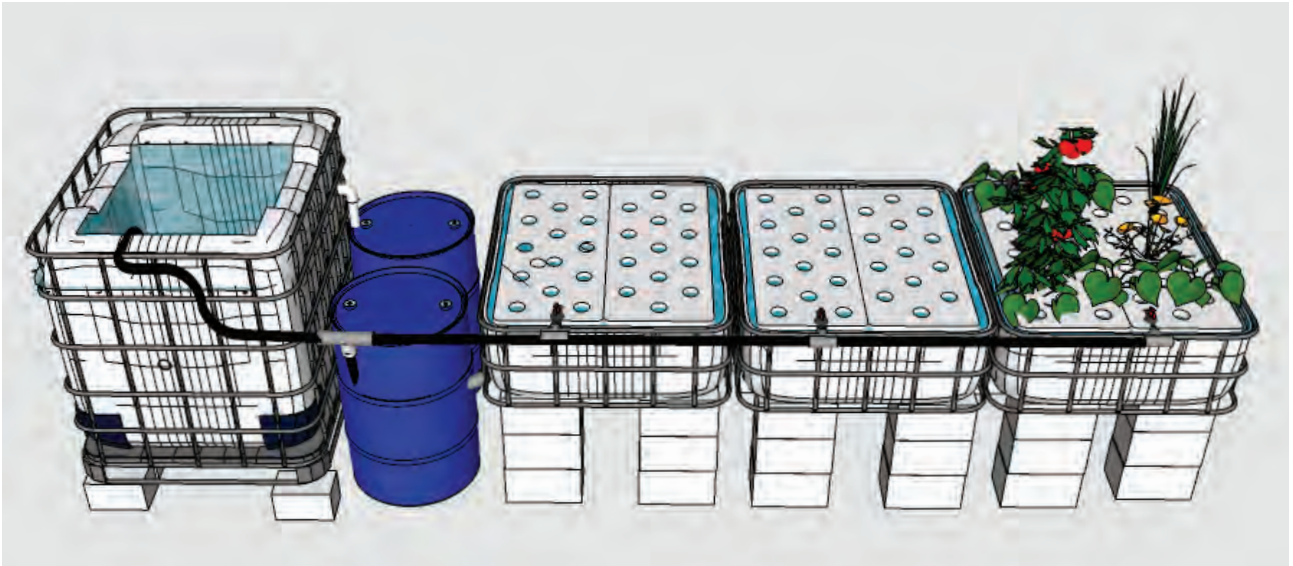
A plant cup made from a net cup and 10cm of 50mm pipe (images 57-59)



A plant cup made from simple plastic/paper cups and a plastic bottle (images 60 & 61)



## Section 3) The DWC Unit



### Water flow diagram

1. Water flows by gravitation from the fish tank to the swirl filter and bio filter.
2. Water is pumped, using the submersible pump, from the bio-filter to the fish tank (80% of the flow) and the DWC canals (20% of the flow).
3. Water flows back from the canals to the bio filter .



#	List of Items Floating Rafts	Quantity	# number in the list of item table
1	IBC tanks	1	1
2	20 Litter Bucket	1	28
3	200 Litter Blue Barrels	2	2
4	Bio Balls or Bottle Cups	40 – 80 liters	34
5	Submersible Electric Water Pump 2000 lph	1	7
6	Air Pump(4 Exits)	1	29
7	Air Pump Pipe	10 m	30
8	Air Stone	4	32
9	Concrete Blocks	40	5
10	Wood Lengths of 8x1cm	8m	6
11	Fish Tank Shading	2 m	3
12	Fish Net	1	33
13	Plumbers Tape (Teplon)	1	10
14	Cable Ties	25	11
15	Waterproof Electric Box	1	12
16	Plastic Net Planting Cups	80	36
17	Volcanic Gravel 4-20mm	30 l	35
18	Polystyrene Sheet	3sqm.	9
19	Pipe Lubricant	1	12
	piping&fitting		
20	3/4" male - 3/4" Female Plastic or Metal Tap	4	27
21	1" male - 1" Female Plastic or Metal Tap	1	47
22	25mm - 3/4" Male Elbow	3	24
23	25mm - 3/4" Female Elbow	1	49
24	25mm - 1" Female - 25mm T Connector	2	53
25	25mm - 3/4" Female - 25mm T Connector	2	57
26	25mm - 1" Female Elbow	2	23
27	25mm - 3/4" Female Elbow	1	49
28	25mm - 3/4" Female Connector	1	52
29	PVC 25mm - 1" Female	3	21
30	1" Barrel Connector V Type	5	46
31	25mm Polyethylene	8	17
32	25mm T Connector	1	59
33	25mm PVC Pipe	0.9m	16
34	50mm Pipe	2	14
35	57mm Uni-seal	5	18
36	50mm Elbow	6	37
37	50mm - 50mm Straight Adaptor Coupling	5	38
38	50mm Stopper (Pipe End)	1	40
39	50mm Rubber Washer	10	19

## C) DWC unit

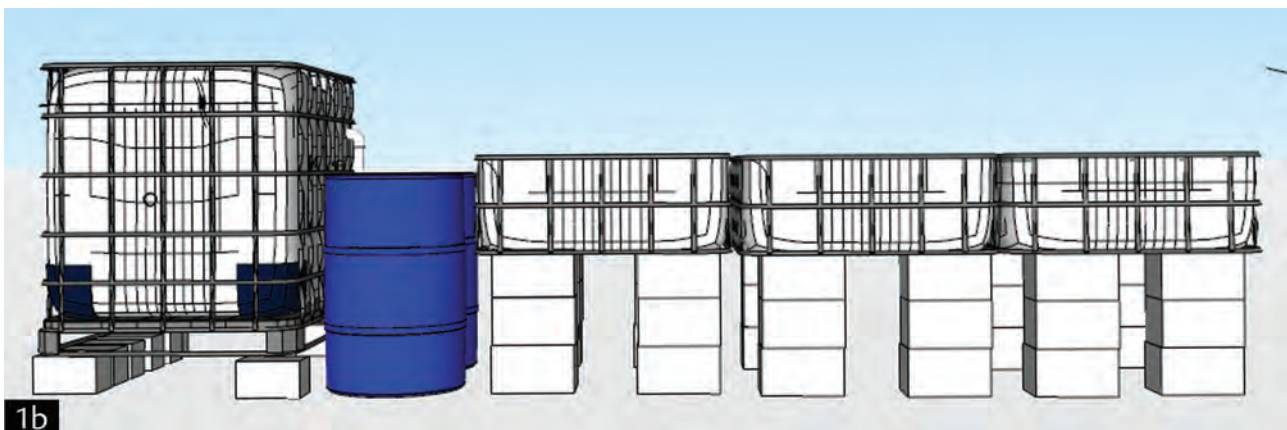
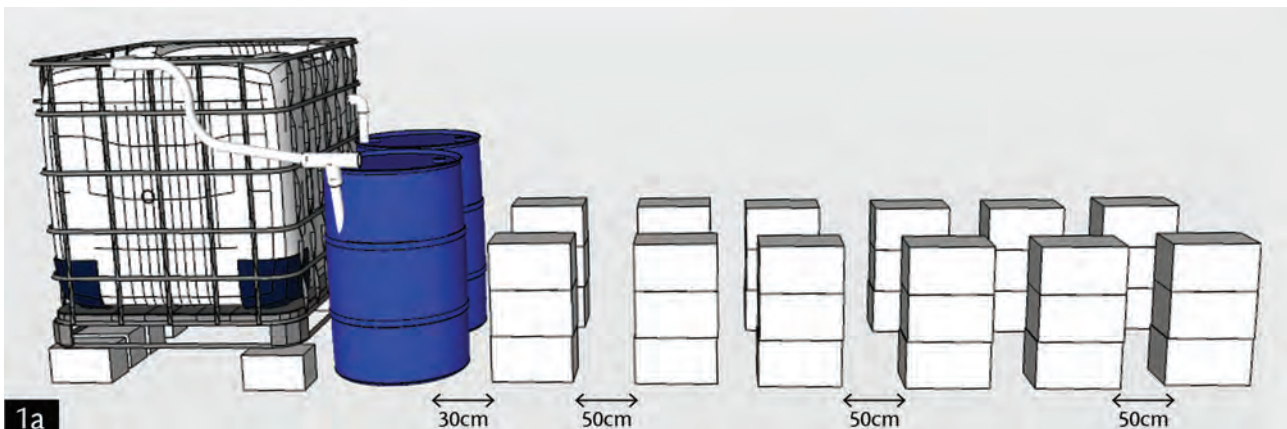
1. Preparing the fish tank (Same as Grow bed section 1 & 2)
2. Preparing the Swirl filter and bio-filter (Same as NFT unit sections, 1-4)
3. Fabricating 3 Canals from 2 IBC tanks.

4.

Having followed the steps for setting up the fish tank, swirl filter, bio-filter and **Fabricating 3 Canals from 2 IBC tanks** in the previous sections, the next step for DWC units is to **Assemble the canals**

### 5. Assembling the canals

Place the concrete blocks according to the distances described in the (image 1A) The fish tank should be raised up approximately 15 cm, do it by using concrete blocks. Then, place the 3 grow beds (including the metal support frames) on top of the blocks as shown in (image B1) (Make sure the growbeds are secure on top of the blocks. If not, slightly adjust the layout of the blocks underneath)



## 6. Preparing the canal drainage pipes into the biofilter

The following materials are needed to make 3 drainage pipe units: 3 x 24cm standpipes (25mm pipe); 3 x 25mm Barrel connectors; 3 x 1" - 25mm adapter; 1" x 1" - 25mm elbows; 2" x 1" - 25 T connectors

a) Take each canal and mark their center points. Drill a 25mm diameter hole at each center point and insert the 25mm barrel connector with the rubber washer placed inside the grow bed. Tighten both sides of the connector using a wrench (see image 2-4)



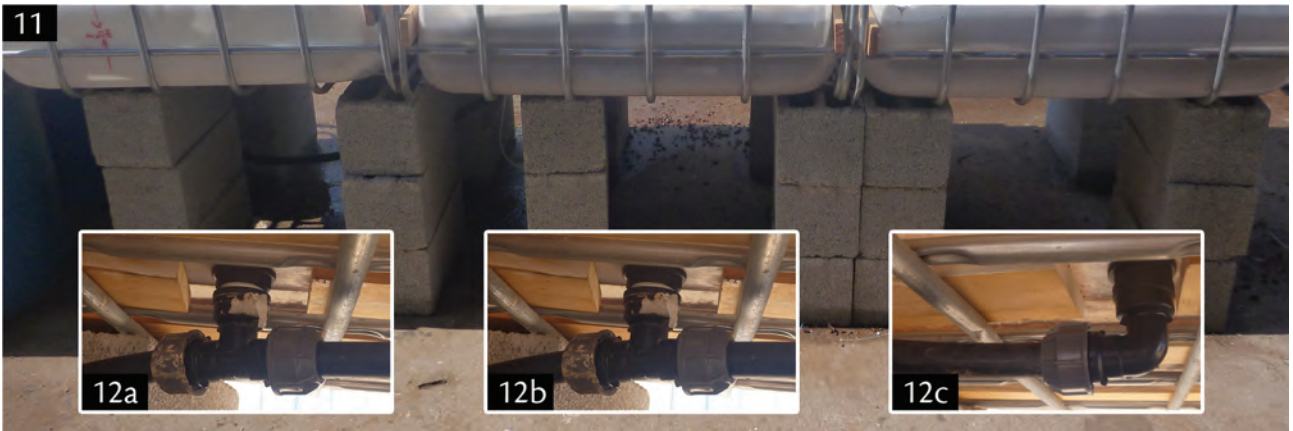
b) Screw the PVC 1" female - 25mm adapter on to the 25mm barrel connector inside the grow beds and then slot the standpipe into the adapter. Make sure to cut five longitudinal slots on the upper end of the stand pipe to prevent the pipe from clogging. (image 5-6)



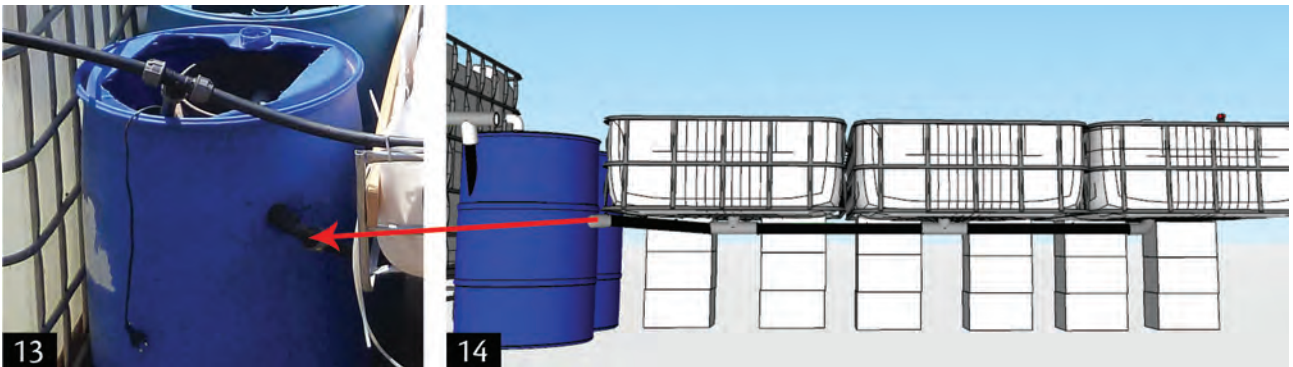
c) Next, connect the 25mm - 1" female elbow to the end of the barrel connector underneath the canal that is furthest from the fish tank. Then fix the remaining 2 x 25mm - 1" female - 25mm T Connector to the barrel connectors underneath the other 2 canals. (see image 7-9). Take 3 pieces of 25mm pipe (roughly 1 meter each) and connect the elbow to the 2 T connectors underneath the canals.



### Connection between A+B+C canals



d) Finally, drill a 25mm hole into the side of the bio-filter barrel using the circular drill bit at least 15cm below the standpipe height in the canals and insert a 1" barrel connector in it, after connect a 25 – 1" elbow to the barrel connector and than Take 1 more piece of 25mm pipe and connect the 25 – 1" elbow (bio filter) to the final T connector underneath the canal number 1 and slot the other into the 25mm hole in the bio-filter (image 13 -14).



### 7. Adding the submersible pump

For this unit, the submersible pump is placed at the bottom of the bio-filter barrel.(image15-16)

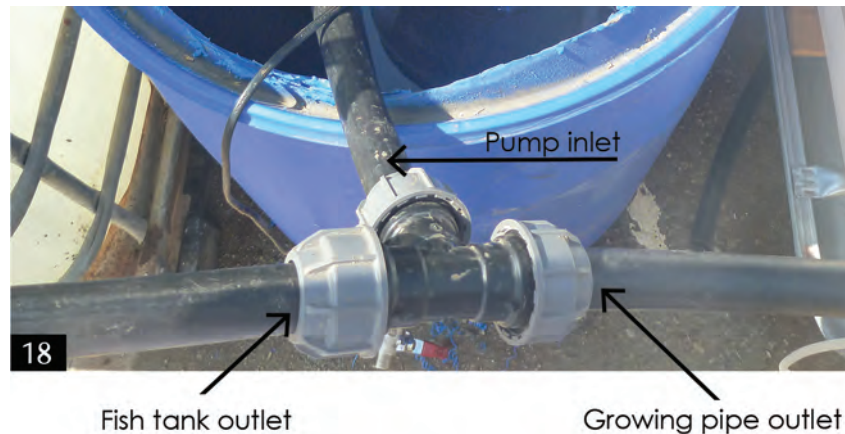


Water is pumped from there into 2 locations: the 3 canals and to the fish tank. 80% of the water flows to the fish tank while 20% flows into the canals. The taps are used to control the water flow at each location (image 17)



## 8. Pumping to the fish tank and canals:

Connect the submersible pump to a 25 mm pipe length using a 1" female - 25mm Adaptor (or any Connection that fits to the pump). The 25 mm pipe should be at least 1 m long. Place a 25mm T connection at the end of the pipe allowing water to flow to the fish tank and the grow pipes. (image 18)



Attach 25mm pipe to one end of the T connection long enough to reach the fish tank (Use flexible pipe if possible as this removes the need for other 25mm elbow connections which reduce the pumping capacity of the pump), (image 19). Attach a 1 X 25mm male elbow 1 X 1" male - 1" female plastic or metal tap to the end of the pipe allowing you to control the water flow into the fish tank.



Next, take approximately 3.5 meters of 25mm polyethylene pipe and attach one end to the other side of the 25mm T connection at the bio-filter. Then, take the 3.5 meter pipe and line it along the canals. At each canal add a 25mm - 3/4" - 25mm T connector and a 3/4" male - 3/4" female plastic or metal tap, 25mm - 3/4" male elbow allowing water to flow into each canal (see image 20-22). At the final canal furthest from the fish tank add a 1 X 25mm - 3/4" female elbow and 25mm tap, 25mm - 3/4" male elbow. Be sure to connect the pipes to the metal frame with plastic stripes.



## 9. Installing the air pump and stones

For this unit, the air pump is used to integrate air into the canals. The actual air pump should be placed into protected box at the highest point in the system (ideally attached to the side of the fish tank) (image 26).

Take 4-6 meters of 8mm air pipe. Attach one end to the air pump and lay the rest of the 8mm pipe along the side of all the canals. At each canal drill a 8 mm hole just below (1-2cms) the top and slot the 8mm pipe into each hole. Then Attach the air stones to the 8mm pipe and place them next to the inlet water stream to ensure full oxygen saturation in the tank, and do the same for the fish tank (image 23-26).



Connect the pipes to the metal frame with plastic stripes.

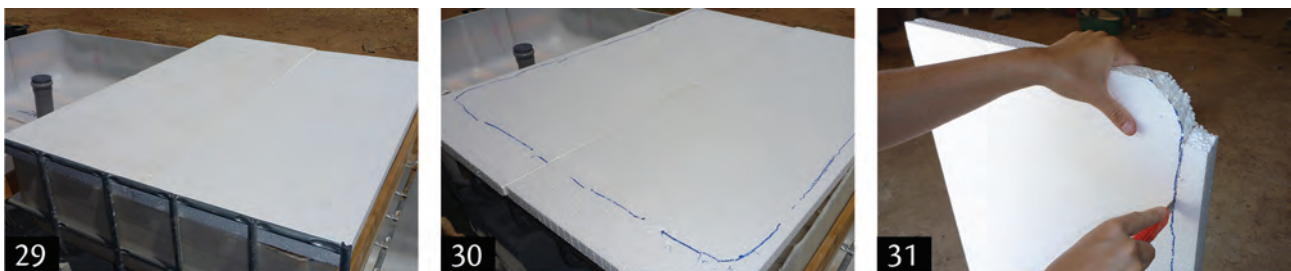


## 10. Making the Rafts

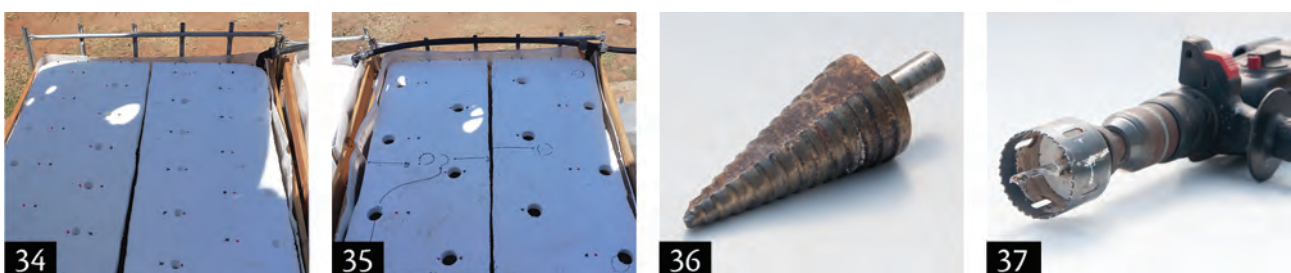
Key principles for making the polystyrene rafts:

- All water in the canals should be fully covered (no exposure to light)
- Choose polystyrene sheets that are at least 3cms thick to hold the weight of a vegetables.
- The polystyrene must not release any toxins to the water (make sure it's safe for food production).
- Plant hole sizes and spacing are dependent on the type of vegetables to be planted. The planting hole size can range from 16 mm (for planting seedlings directly into the rafts with out cups (image 28) to 30mm (depending on the size of a plant cup available (image 27).

Place the polystyrene on top of the canal and mark the edge lines. Cut with a knife the outline of the canal (image 29-31).



Drill the plant holes, using a circular drill bit (image 36-37). Besides planting holes also make one hole for the stand pipe (image 32-33).



## 11. Final checks

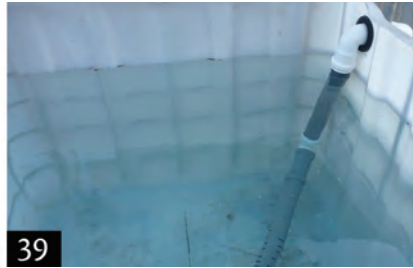
All parts of the system are now in place yet before adding ammonia, fish or plants, it is recommended to fill the fish tank, both filters and canals with water and run the pump to check for any leaks in the system. If leaks appear, fix them immediately where they arise by:

- tightening the plumbing connections
- Checking all uni-seals and taps for both filters
- re-applying Teflon to treaded connections
- making use all valves are in there ideal position
- run the swirl filter and bio filter (section 13 in the nft step by step)

Finally, check the flow rate of the water flowing into each canal is roughly 1-2 liters per minute. You can do this using a simple electric timer & an empty 1liter plastic bottle (image 44) Once all the leaks are fixed and the water is flowing smoothly through all components of the unit you can begin cycling the unit using ammonia (see chapter 5 for more details on this process)



38



39



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43



44



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46

Planting process with cups (images 47-51)



47



48



49



50



51



52

Planting process without cups (see image 52)



53