Aquaponics System Solutions

Home DIY Aquaponics

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How To Use This Manual 

Option #1 – **Recommended**, that you first read the whole ebook for a good understanding of what an aquaponics system is all about then, move on to the video tutorial and start building your system.

Option #2 - If you just can't help it then, go straight to "Chapter 7, pg 23".Read through, then watch the video and build your system. Still I would recommend you to read the whole ebook for the wealth of information herein. After all, you've already paid for it…right.

Introduction

Firstly, thank you for purchasing our Aquaponics Systems How-To - Home DIY Aquaponics, where aquaponics is made simple and easy to set up...anybody can do it!

Rest assured that you have made the right decision and a smart choice in growing your own food.

Before we go ahead with the construction of the system, let's take a minute to understand what aquaponics is all about and why this idea of producing food should be encouraged ad practiced.

What is Aquaponics?

Well, basically Aquaponics is the combination of **Aqua**culture and Hydro**ponics**, hence the word **Aqua**ponics. It is the perfect marriage that capitalizes the positive side of both systems and taking away the negative.

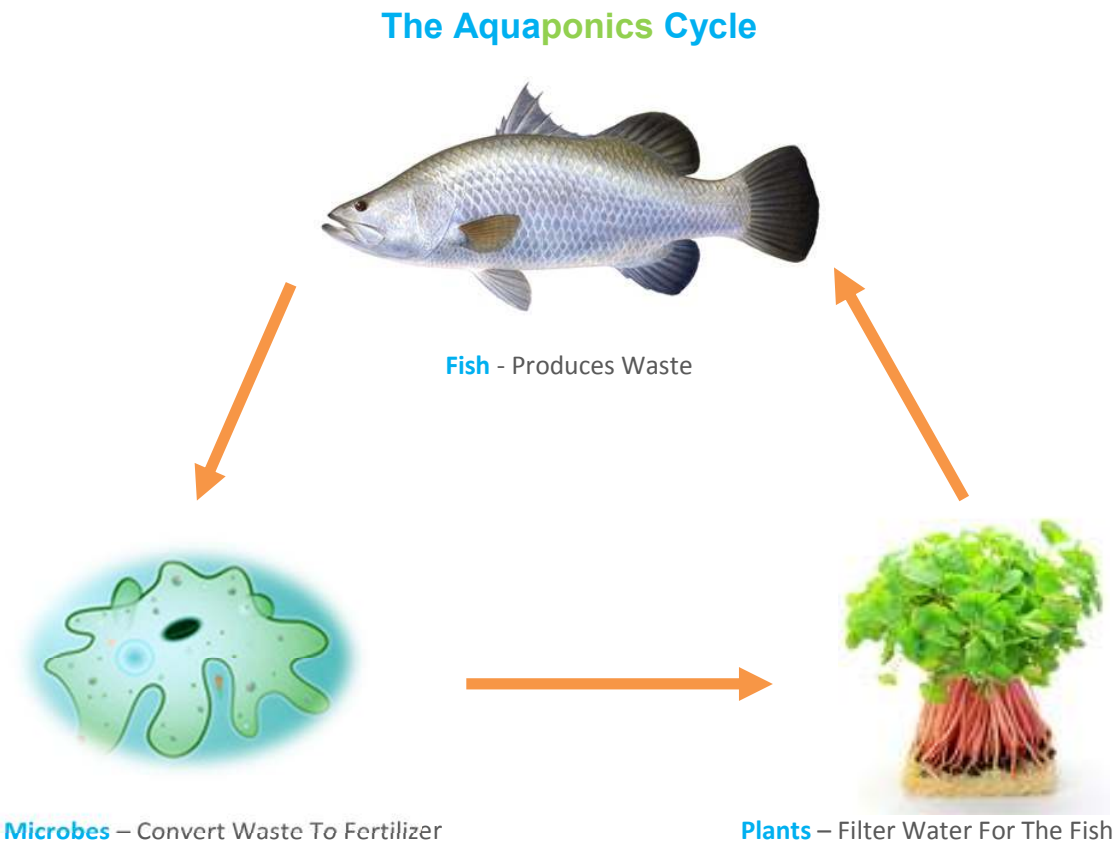
Hydroponics is basically a method of growing plants using mineral nutrient solutions, in water, without soil, while Aquaculture, is a means to harvesting aquatic organisms and plants.

Aquaponics is a revolutionary process which combines aquaculture and hydroponics to grow fish and plants together in one integrated system. The fish waste acts as

food source for the growing plants and the plants provide a natural filter that cleans up the water for the fish.

Next, comes the microbes (nitrifying bacteria) that thrive in the growing media. They do the job of converting the ammonia from the fish waste first into nitrites, then into nitrates and the solids into vermicompost that are food for the plants.

In combining both systems, aquaponics capitalizes on the benefits and eliminates the drawbacks of each.



It's an extremely effective way to produce healthy fish and vegetable, where plants can grow twice as fast and up to ten times more produce using the same amount of space as other farming methods.

That means if you're growing lettuce in 10 square feet of space using an aquaponics system, it would be equivalent to you growing lettuce in a 100 square feet of land in the conventional method.

I will elaborate more on this later in the ebook when we are constructing the DIY system.

Why Aquaponics?

Aquaponics is a natural way of producing food. Have you ever wondered why fish in a lake don't need a filter like the fish in an aquarium do? It's because their waste is needed by bacteria in the water.

These bacteria use the fish waste as food and give off other products that are food for plants. It's how lakes clean themselves. Aquaponics mimics this system and that's why it is a self-sustaining system.

Let's have a look at some of the benefits to aquaponics;

- Saves up to 90% of water usage compared to traditional methods of soil grown plants.
- Plants grow significantly faster, bigger and healthier.
- There is no need to add fertilizers as the system feeds itself.
- There is no need to dispose of fish waste or provide an artificial filtration system.
- Less land area is required to grow the same crops as traditional soil methods.
- It's easier to setup for year round use compared to traditional gardening methods.
- You get delicious, healthy food.
- Reduced damage from soil grown pests and disease.
- No weeding or bending down on the ground required.

Types of Aquaponics Systems

There are numerous types of systems and designs in existence. Your imagination is the limitation really. In any case, there will be;

1. At least a grow bed (where the plants will be)

2. A Fish tank (of course where the fish swims)

3. A means to transfer water from the fish tank to the grow bed (normally a pump), and

4. A means to drain water from the grow bed back to the fish tank (standpipes or siphons are commonly used).

When a good balance between water, fish, bacteria and sunshine is achieved, you will have a successful, self-sustaining aquaponics system that you can rely on.

Let's get to know some of the basic aquaponics systems….

Media-Filled Bed

This can be said to be the simplest form of aquaponics, they are made out of containers filled with rock medium of expanded clay pebbles or small river rocks.

Water from a fish tank is pumped over the media filled beds, and plants grow in them. This system can be run in two different ways. A continuous flow, flooding and draining the grow bed, or a flood and drain or ebb and flow cycle.

Nutrient Film Technique (NFT)

Nutrient Film Technique is more commonly used in hydroponics environment as compared to aquaponics. In NFT systems, nutrient rich water is pumped down the small enclosed gutters.

Plants sit in small plastic cups allowing their roots to access the water and absorb the nutrients. NFT is only really suitable for certain types of plants, generally leafy green vegetables. Larger plants with big roots are not suitable for lightweight growing gutters.

Deep Water Culture (DWC)

Deep Water Culture, works on the idea of floating plants on top of the water allowing the roots to hang freely in the water. This method is one of the more commonly practiced in commercial environment.

DWC can be done by floating a foam raft on top of the fish tank, however a more common method is to grow the fish in a fish tank and pump the water through a filtration system, and then into long channels where floating rafts filled with plants float on the water surface and extract the nutrients.

With Aquaponics Systems Solutions - Home DIY Aquaponics, you will explore the different types of media-filled beds and decide which is most suitable for you.

Running The Systems

We have now covered the different types of aquaponics system out there, let's take a look at the different methods you can run the systems.

1. You can flood and drain it by using a timer on the pump to switch the pump off and on, while a standpipe in the grow bed controls the flooding level.

2. You can flood and drain it using an auto siphon within the growbed and running your pump continuously.

3. You can also run the system with a continuously flooded grow bed using a standpipe in the bed.

Hey listen, I know the above information can be a little intimidating, especially if you are a newbie. Don't worry if you can't take it all in now. Once you start working on the system, you'll have a better picture.

Let's get started…

Getting Started

I recommend starting with the minimal set-up as described here in our DIY package. Get your hands dirty first, so to speak, then slowly work your way up to a bigger scale when you are ready. We will show you how.

The system that you will be working on includes, one 50 gallon media-filled grow bed and one 100 gallon fish tank. I will elaborate further on this in the following chapters.

I can understand if you are all excited to get started, especially if this is your first venture into aquaponics. I will take you to explore the limitless possibilities on how you can design and create your own aquaponics system.

But…before you can do that, you need to understand and learn the basics and foundation of aquaponics. Once you understand how it works and it's philosophy, the rest is simple.

Now the system that we are introducing here is as easy as it comes. This is a good beginner's system for you to get the hang of aquaponics.

Factors To Consider

Following are the points you would need to consider when starting your aquaponics garden…

Where Should I Locate My Aquaponics System?

That's a valid question. Bear in mind though, that the Aquaponic System Solutions - Home DIY system takes about 20 square feet of space or less depending on the type of grow bed support you choose to use. We'll go more in to this later, not to worry.

Moving on, please take these into consideration when deciding on where you want to set-up the system;

1. **Access to sunlight** - You need at least 4-6 hours of good sunlight for your plants to grow well. You don't need direct sunlight on your fish tank as this will lead to algae growing. But if you can't help it, cover the fish tank or have some floating plants on the surface of the fish tank.

2. **Access to power** – You need that to run the water pump and possibly an air pump. Make sure there's a power point is nearby.

3. **Access for planting** – Make sure you have access to planting, harvesting and perform maintenance. You may not see it now, but once your grow bed is flourishing; you'll know what I mean.

4. **Access to fish tank**–Make sure you have sufficient space to catch the fish. If you follow our system design, this would not be a problem.

5. **Surrounding conditions** – Make there are no hazard in your surrounding that could cause harm to your plants and fish.

6. **Pets & children** – Now we don't want your fish to be pet food, so cover up your fish tank if possible. This would also prevent curious children from feeding the fish with…well, other than fish food. If you know what I mean.

7. **Climate conditions** - I don't get winter where I am, but if you do you may want to consider having your system set-up in the garage or indoor where there's sufficient sunlight or build a green house. We'll cover more on this later.

Things To Consider When Locating Your Aquaponics System Indoors

All the points for consideration remain unchanged as above with the exception of climate conditions, since it's indoors.

But you need to pay extra attention to air ventilation and lighting if your system is located indoors;

- **Air ventilation** – It's important to ensure sufficient ventilation, especially if you decide to put it in a small room. Leaving the door or window open slightly will help to do just that.

- **Lighting** – If there's insufficient sunlight, You will most probably need supplementary lighting as there will not be sufficient lighting indoors. *"T5 Fluorescent Lights"* is a good choice. They don't consume much power and don't emit much heat. However their performance drop after six months or so and would need replacing.

What Plants Should I Grow?

Well, what do you like to eat? Keep in mind that almost all plants grow well with aquaponics, even papaya and banana trees are known to have been grown successfully.

Almost anything that grows in soil can be grown in aquaponics, namely;

- Broccoli
- Cauliflower
- Silverbeet
- Beetroot
- Arugula
- Basil
- Mint

- Spinach
- Pak Choi
- Any leafy lettuce
- Watercress
- Chives
- Most, if not all types of flowers

…and the list goes on and on.



Plants that have higher nutritional demands and will do well in a heavily stocked, well established aquaponics system;

- Tomatoes
- Peppers
- Cucumbers
- Beans
- Peas
- Squash

Plants that grow well side by side together in an aquaponics media bed are and not limited to;

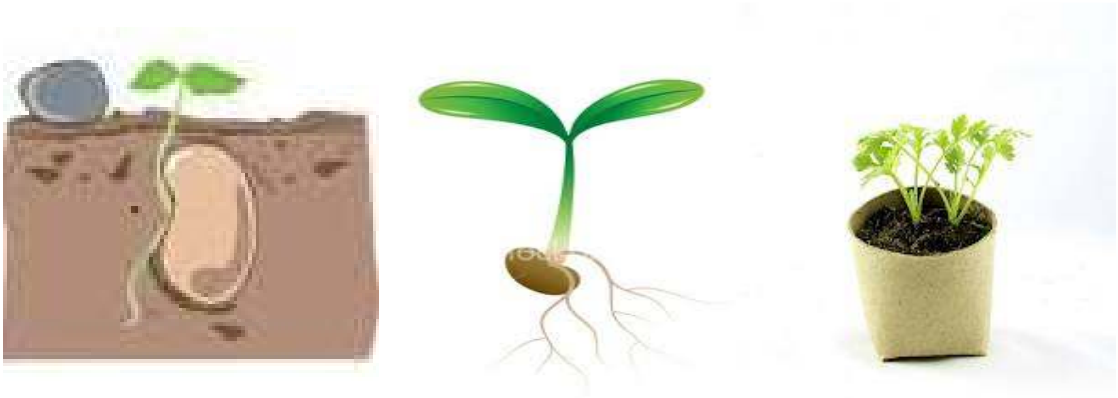
- Tomatoes
- Salad greens
- Strawberries
- Lettuce
- Peppers
- Different variety of herbs

You can source for organic seed options from sites like;

1. http://www.horizonherbs.com
2. http://www.seedsofchange.com
3. Your nearby organic store

Subterranean plants and root vegetables like carrot or potato can be grown very efficiently in aquaponics, but final matured shape may not resemble its usual physical form. However, they taste just as good if not even better.

Preparing Your Seedlings



Once you have decided on what plant/s you want to grow, you can start preparing them for your grow bed now depending on which option you choose to obtain them. There are various ways you can do this;

1. **Broadcast your seeds** - Since Aquaponics System Solutions- Home DIY Aquaponics uses media filled grow bed, you can actually sprinkle the seeds, evenly right on it. The seeds will get settled in between the pebbles and start to grow with the nutrient-rich aquaponics water.

2. **Germinate your seeds** – Start your seeds by placing the seeds on a wet paper towel or soaked cotton wool. Then seal them in a large zip-lock bag. Keep an eye on them frequently and when their roots grow about to 25mm/1 inch or more gently put the seeds in the media bed at a level where the root is in constant contact with water.

3. **Cardboard egg cartons & seed raising mixture** - Make a hole for drainage at the bottom of each egg cup, add the seed raising mix, moisten the mix and plant a seed into each egg cavity. Then cover the seed with more seed raising mix and press it down evenly. After that cover the tray with a plastic bag to retain moisture. When seeds are ready to plant out, normally after 2 to 4 weeks, remove the seedlings from the cups, clean the raising mixture thoroughly off the if, then put them in the grow bed.

4. **Or do it the easy way** – Once your aquaponics water chemistry is stable and good, buy the seedlings from your nearby garden store, clean the soil off the roots and plug them into the grow bed.

5. **Combine options 1 and 4 together** – So that as your *Option 4* seedlings are ready for harvest, you would have the seeds from *Option 1* already growing then, you can start broadcasting your seeds again and the cycle goes on like so, you can have a continuous supply of greens.

I would highly recommend *Option 4* & *5* for the beginners, mainly because you would have your hands full once we start constructing your aquaponics system.

You can always indulge yourself with the other options once you are comfortable running the system. But then, of course the choice is yours to make.

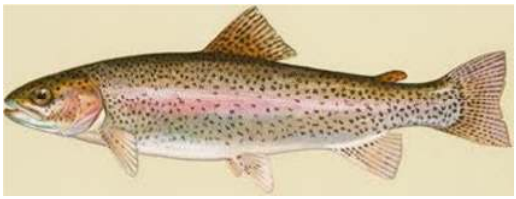
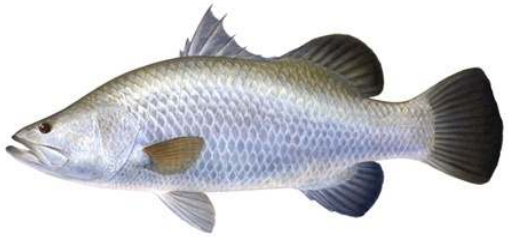
What Kind Of Fish Should I Grow?

When deciding on the kind of fish for your aquaponics, you need to take into consideration whether you're raising fish for food or just to run your system.

Another important step you must do is to check with your local University or AG extension office to identify which fish are illegal to be grown and avoid those.

There are many different types of fish species used for aquaponics, climate conditions and available supplies are two important points you need consider. The two more popular species include; Trout for colder geographical locations and Tilapia for hotter climates.

Let's take a look at a few more popular aquaponics fish species and some details about them.

Tilapia 	*Is an extremely hardy species, taste good, fast growing. Lives happily in temperatures between 74 – 78 degrees F. Grows to plate size in about 6 – 9 months (ideal conditions). Omnivorous and eats pellet fish, veggies from the system& duckweed and can be stocked in high densities.*
Trout 	*They like colder water, 64-68 F. A great tasting fish but need pristine water conditions to grow healthily. Extremely fast growth ratios and is sensitive to pH changes. Reaches plate size in 12-16 months.*
Barramundi 	*Is one of the more majestic species of edible fish. Grow in warmer temperature and is a delicacy especially if grown in an aquaponics environment. A good choice for summer. Buy mature stock and harvest them by the end of the season.*
Crappies 	*One of the favorites for aquaponics as they develop really well in a closed loop system and they are very good to eat.*
Cafish 	*Cat fish is a popular species among fish farmers in the United States and Australia. Their meat is so smooth and tasty especially when steam cooked. Is more sensitive to temperature, pH and water quality. Can be harvested in 5-10 months.*

Silver Perch 	*A hardy native Australian fish. They can survive in high temperature variants. The downside is that they take a comparatively longer time to grow from fingerlings to adult size.*
Gold Fish 	*Is generally pretty tough and can stand hard water conditions. Enjoys hot climates and are very suitable for aquaponics. A good choice if you do not intend. Downside is you can't eat them. Gold fishes produce a lot of waste, which is good for aquaponics.*
Koi 	*Another ornamental species that will thrive in the aquaponics environment. Koi is a durable species and have strong resistance against common parasites. Koi can be eaten but not a favorite choice of dish as they have big scales and very bony.*
Murray Cod 	*A great tasting native Australian fish and good for aquaponics system. They grow to huge sizes in their natural environments. The downfall is that they must fed well or they would cannibalize each other.*
Largemouth Bass 	*A popular freshwater game fish. Their diet include snails, water birds, snakes and other small mammals. They taste better when they are smaller/younger, however in an aquaponics environment, even adult fish taste good. Grows to plate size in 15-18 months.*

Crayfish 	*Is a freshwater crustacean of the lobster family that feed on living or dead animals and plants. They like fresh clean water.*

Keep in mind the fish species you choose for your aquaponics will also determine the type of plants you would have for your aquaponics system and vice-versa.

If you pick Trout as your fish of choice you would choose plants that grow well in cold weathers because Trout need colder climate. You get where I'm driving at right?

Next would be to buy your fingerlings. Personally, I would recommend that you buy fingerlings instead of fry. Well, fingerlings cost more but they would grow and mature faster hence, contribute to more waste or excrement production.

That equates to more nutrients supply to your plants and an earlier start to optimizing your plant's growth, and this means you get to eat your produce earlier too.

Fish Health Management

Always exercise good hygiene and biosecurity prevention, avoidance selective access and common sense when it comes to your fish's health.

Quarantine your fish from other facilities before stocking them in your system. It's a good practice to monitor them for several days to ensure they are healthy.

The best defense against diseases is your fish's own immune system. Provide low stress environment and your fish will maintain good health.

Try talking to your fish and plants if you can. Yeah well, you may think I'm going…but this has proven to have positive effects on your produce as well as on you, seriously.

Fish Feeds

The quality of your feed choice, not only determines the health of your fish, it also has direct effect on your plants.

The old saying "GIGO" (Garbage In Garbage Out) definitely applies here on your aquaponics system. So choose your feeds wisely.

Commercial fish feeds contain exact protein, carbohydrate and other vitamin requirements for specific fish. You can get these in pet or fish shops for most common fish.

Plant based proteins can include soy meal, corn meal or wheat meal. Most commercial feeds are between 10-35% protein.

Alternative feeds that should be considered include, duckweed, insects, worms or black soldier fly larvae.

Avoid fish meal based feeds as this source is not sustainable. Reason being fish meal come mostly from fishery wastes associated with the processing of fish for human consumption and is not necessarily suitable for fish.

Feeding Your Fish

Fish tolerate a wide range of feeding schedules. They have the ability to adjust their metabolism to match food availability. If you have fewer than the recommended fish and need to produce more food for your plants, feed them more.

However, if you have a matured aquaponics system, the rule of thumb is to feed your fish as much as they can eat within five minutes and then remove the remaining food from the fish tank after five minutes.

Soon you will be able to judge how much food to toss in depending on your fish's behavior at that moment. This is valuable time to understand and observe your fish for abnormalities.

As time goes by you will be able to know if something has likely gone wrong from their feeding and swimming behaviors.

Fish may stop eating due to changes in the water chemistry or temperature. All these are easily corrected if detected early.

Fish feeding procedures will differ during the initial start of your aquaponics system though. I will cover this later in the Chapter 8, "Adding Fish Into The System".

Water Chemistry

The Basics

Let's get back to the basics. There is no need to review or know any formulas, but you should understand the basic process and what makes your aquaponics system work, and specifically, the following:

1. Fish excrete ammonia in their waste and through their gills.

2. One type of bacteria (nitrosomonas) converts ammonia into nitrite

3. Another type of bacteria (nitrobacter) converts nitrite into nitrate.

4. Both these bacteria are ubiquitous in the environment. They will naturally come to flourish as long as ammonia is present (no need to add them to an AP system)

5. Nitrate is plant food and is consumed by plants in aquaponics systems. This step completes the process of removing what would otherwise be toxic ammonia produced by fish from the water in a way that is beneficial to other organisms - plants, all while recycling the same water in the system. One way to look at it is, fish produce plant food, and plants produce clean fish water.

In a balanced aquaponics system, ammonia, nitrite, and nitrate levels should be at its optimum level. This is because ammonia is quickly converted into nitrate and nitrate is consumed by the plants.

Checking Water Chemistry

There are mainly 3 main parameters to be concerned of in your aquaponics system's chemistry and they are your pH, ammonia/nitrite/nitrate and DO (Dissolved Oxygen).

Get yourself a simple aquarium kit for this purpose. You will need to do the testing more regularly during the initial start-up phase of the system.

Sample Water Test Kit

pH - You should keep a close eye on the pH of your system. This reading will tell you how much nutrient is available for your plants to uptake, and can also warn you if your fish are in danger.

Generally, a pH of between 6.0-8.0 is acceptable though an ideal pH for aquaponics is 7.0.

Nevertheless, I do not recommend purposefully reducing or increasing the water pH. It is always advisable to leave the pH alone and get the fish and plant that suite your natural water pH.

This is because it's difficult to maintain a manipulated pH. It will eventually creep back to its original pH and you will be fighting a losing game. Ok…so, remember don't beat yourself up over the ph levels.

Too many beginners make this mistake and end up throwing in the towel unnecessarily.

Ammonia/Nitrites/Nitrates - You want to control your ammonia and nitrite of not exceeding 6 ppm as this is toxic to your fish.

Try to keep ammonia of less than 1ppm and nitrite at or below 1ppm. As for nitrates, a range of between 40-80 ppm is acceptable. But having said that, you need to monitor how your fish behave at any given range.

DO - Is essential to the health of your fish, and can be impacted by the temperature of your water. The colder the water the more oxygen the water can hold.

Low DO can suffocate your fish.A good aeration system would solve this problem. This is covered in Aquaponics System Solutions- DIY System Aquaponics design.

Just follow the instructions herein. The goal here is to strike a 80% saturation or not less than 4 ppm.

Temperature–It's crucial to keep this in check if you experience high temperature fluctuations where you live.

This is because nitrifying bacteria slow down their processes in cold water, and many fish eat less or can even die if the temperature drops too low.

The ideal temperature range would be between 77-86 F (25-30 C) for the nitrifying bacteria to flourish.

We'll get into more detail on how to prepare the water and bacteria (cycling) later in Chapter 8, "Balancing The Water Chemistry".

Building The Aquaponics System Solutions Home DIY Aquaponics

Ok…this is how I will be going through this section. I will start with the hardware and setting up of the tanks, piping work, fish pumps then adding the water, fingerlings and the seedlings alright. Let's get going then.

I have prepared a material's list at the end of the ebook.

In Home DIY Aquaponics, I will show you how to build three different aquaponics systems;

1. **System #1** *(Continuous flood system with Media Filled Baskets)* – this is by far the simplest of the three and recommended for beginners. In this system, plants are anchored in baskets filled with media in constant circulating water.

2. **System #2** *(Media-filled bed with timed flood & drain system)* – uses grow bed medium like expanded clay pebbles or small river rocks to anchor the plant roots with water constantly flooding and draining from the grow bed.

3. **System #3** *(Media-filled bed with flood & drain system with a Bell Siphon)* – similar to the above set-up but using a bell siphon instead to automatically drain the water of switching the pump on and off with a timer. I'll explain all the three systems in more detail below.

.....you then, choose the system you like best to go with or try them all out ☺

Step 1 – Getting The Hardware Ready

Depending on the system you choose to build, the basic hardware consists of the following:

1. 1x 50 gallon grow bed.
2. 1x 100 gallon fish tank.
3. 4 pieces 1.5" x 2.5" slotted angle bars .
4. 1x water pump (pump capacity varies with different system and tank sizes. I will elaborate on this further down the ebook).
5. About 3-4 feet of ½" flexible hose.(Depending on the grow bed's distance from the pump).
6. Approximately 6' of 1" schedule 40 PVC.
7. Approximately 6' of ½" schedule 40 PVC.
8. 1x (1" Bulkhead/Tank Connector)
9. Support for the grow bed – we recommend using blocks for our purpose.
10. Plant Baskets – (for System #1 only).
11. Timer – (for System #2).
12. Siphon &valve – (for System #3).

The tanks can be ordered online (the website will be provided in the Material List in Chapter 13). Alternatively you can source them from your nearby stores or make use of unused tanks that you may already have.

I will show you how to determine a tank's volume in the Chapter 10. Don't worry it's easy. You just need to do some measurements on the tank, fill in some blanks. Hit enter and you'll get the answer ☺.

Alright, the rest of the stuff in the list you can buy from your nearby hardware store or from ACE, Home Depot and the like.

Oh…yes you will also need a pipe cutter, a hack saw or the sort to cut the PVC pipes to size. Put on your safety gloves when necessary. Remember, safety always comes first. You will also need a sand paper to de-bur the pipes after cutting them.

Step 2 – Setting Up The Tanks

Next, we need to get the tanks set up. In order to minimize the use of floor space, we will place the 50 gal grow bed on top of the 100 gal fish tank via a support or rack (refer Diagram 1 and 2). This layout will take up less than 12 square feet of space.

For the purpose of our illustration, slotted angle bars will be used to support the grow bed over the fish tank. Alternatively, you can also use 16x8x8 cinder blocks (Diagram 2), specially manufactured support or any unused and strong counter top or a desk for this purpose.

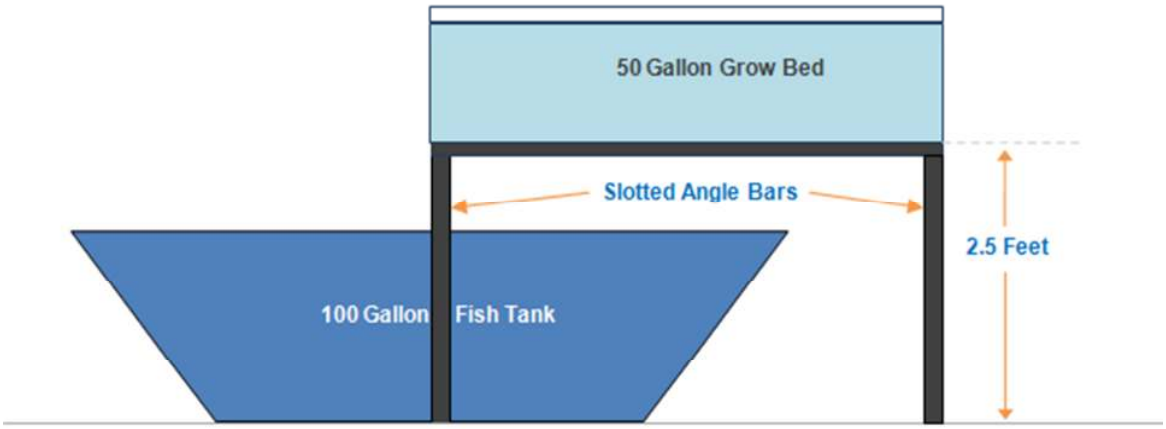


Diagram 1

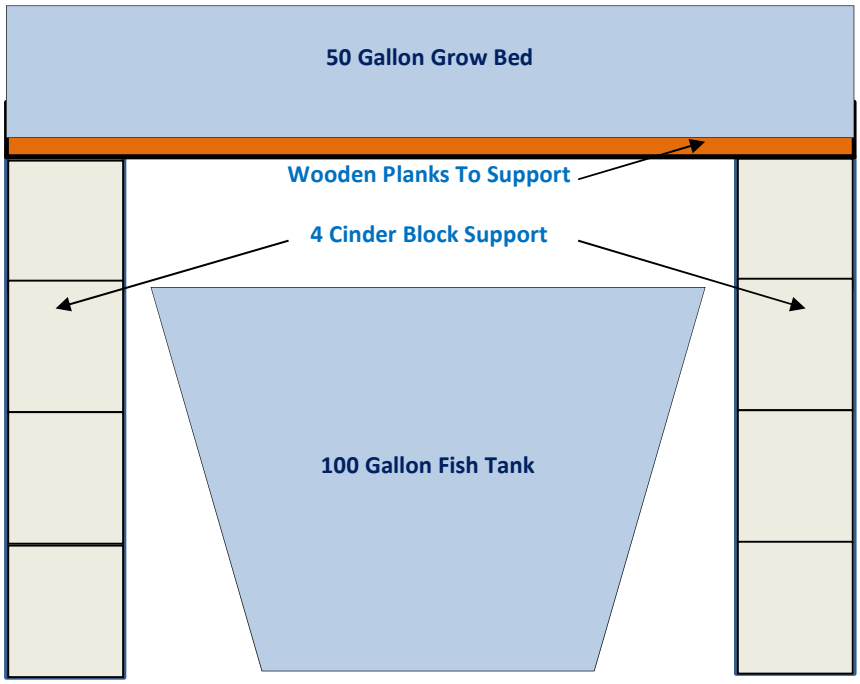


Diagram 2

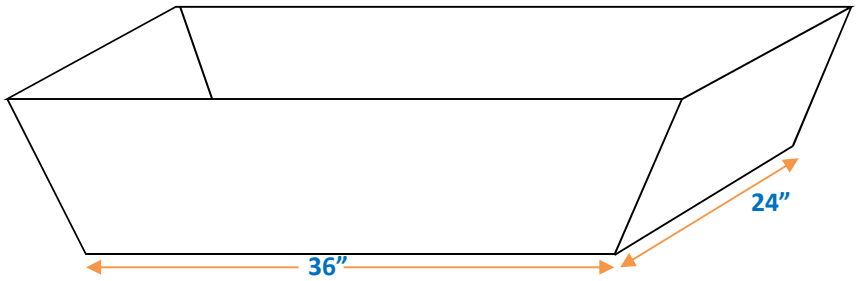
The grow bed weighs about 300 lbs after it's filled up with 8" of water. Whatever your choice of support may be, do take the weight into consideration.

Constructing The Slotted Angle Bar Stand

The first thing you need to do here is getting the right measurements for your grow bed. Please note that you should measure the base of the tank **NOT** the top, as this is the part that sits on the rack.

(Tip: The tank dimensions normally go smaller from top to bottom).

The measurement for the grow bed tank that I'm using is 36" x 24". The height of my fish tank is 2 feet (24 inch).



Grow Bed Tank

So, I need to build a rack that is 36" long, 24" wide and at least 28" tall so that I could slide the fish tank under rack and allow space for the drain line. But I will keep the height at 30". You'll find out why later.

Slotted angle bars normally come in a 10 feet piece and in various sizes. I have opted for the 1.5" x 2.5" angle bars for this project. I would also need:

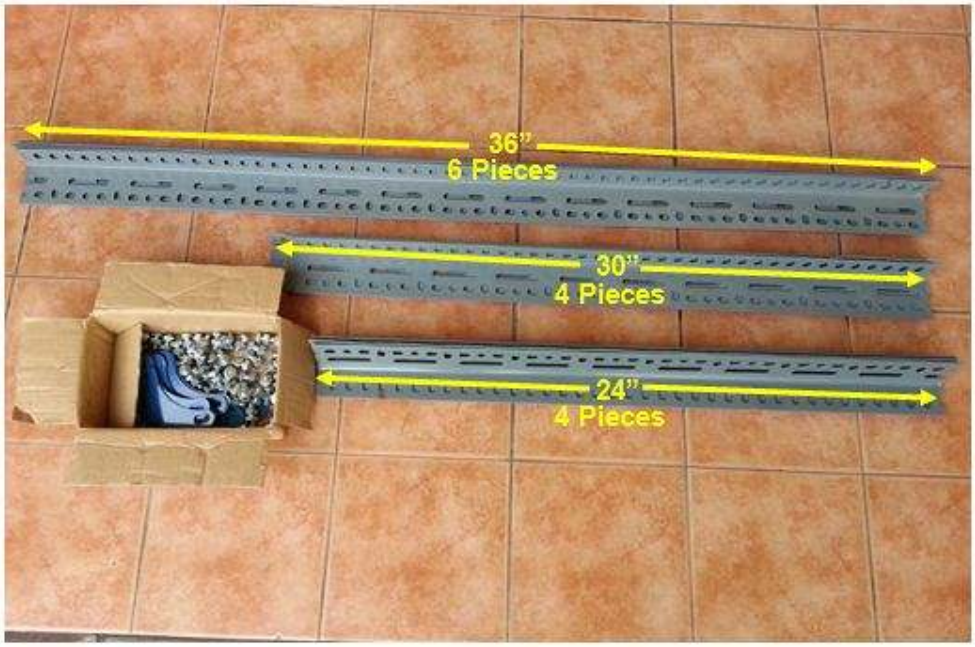
1. 4 pieces of the 10' slotted angle bars cut to, (36" six - pieces, 24" four - pieces & 30" four – pieces as shown in the photo below).

2. 14 pieces of corner angle plates.

3. 60 sets of 5/16 x 1” bolts and nuts (or optional size that could fit the slotted angle bar holes).

4. A pair of 13mm combination spanners (or the size that fits the bolts and nuts size that you are using).

5. A pair of safety gloves. There are sharp edges on the angle bars. You can’t be too careful ;)



Slotted Angle Bar Support Hardware

To safe on material, I have arranged for the 4 pieces of 10 foot slotted angle bars like so:

- ✓ 2 bars to be cut to => 36”. This will leave two 24” bars as balance.

  36” + 24” = 120” (10 feet). You know what I mean?

- ✓ 1 bar cut to => 4 pieces of 30” in length.

  These are for the legs. I really need a 27” cut for the legs, but then I’ll be wasting the material right?

- ✓ The final bar is cut to => 2 pieces of 36” portions.

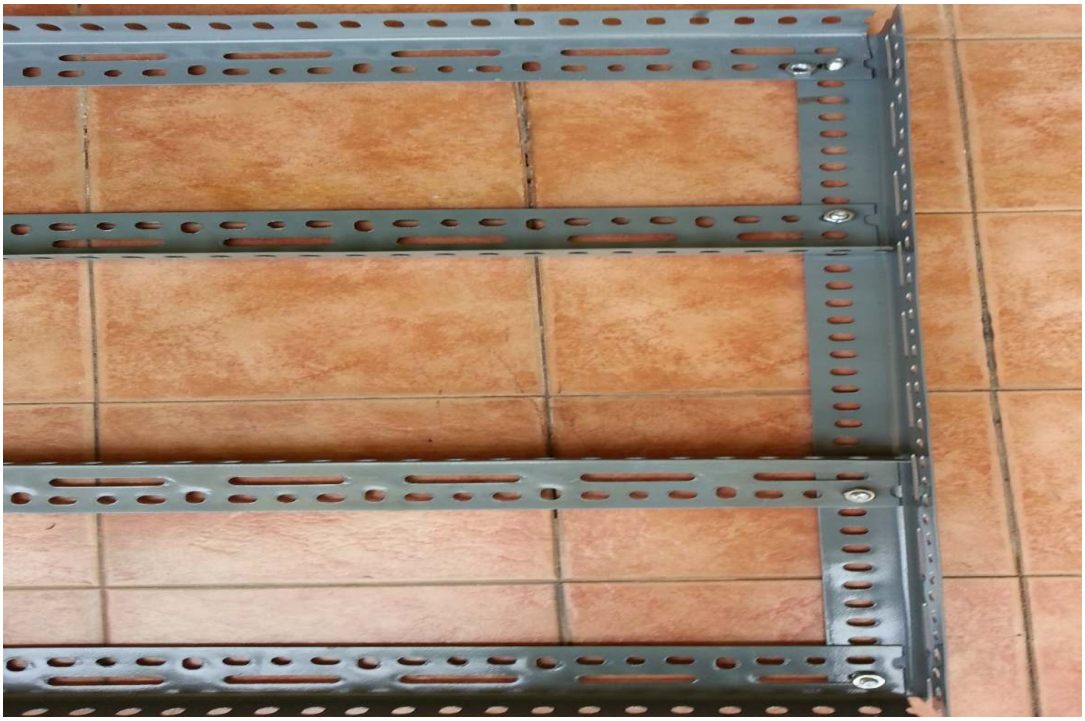
All this will leave us with 6 pieces of 36”, 4 pieces of 24” and 4 pieces of 30” slotted angle bars with a 48” as balance.

You can either cut them yourself using a grinder (put on eye protection if that’s the case) or get the hardware shop folks to do it for you for a minimal fee.

Now that we’ve got the materials ready, let’s start building the rack top (where the grow bed sits on). The easiest way to do this is from the down side up.

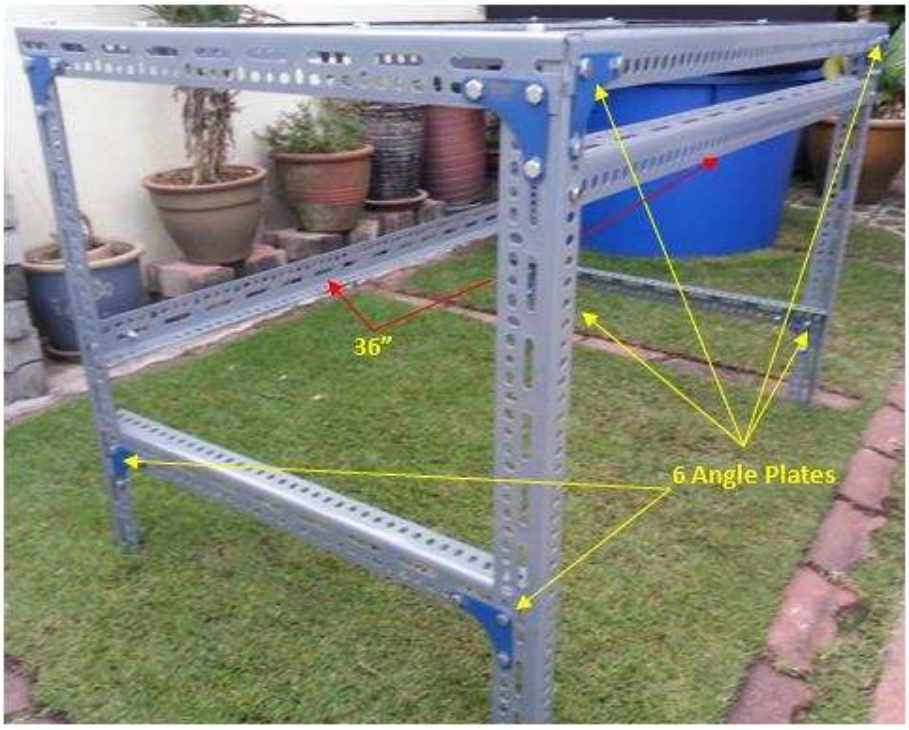
Ok now, gloves on…then take 4 pieces of the 36” bar and 2 pieces of the 24” bar and lay them out in the orientation as shown in the photo. This is the side of the rack top that will be facing the fish tank when it’s done.

Then insert 8 sets of bolts and nuts with the nuts facing you like so and tighten the rack top assembly all together.



Next, let's get the legs up. You need all the four 30" bars and the remaining 2 pieces of 24" bars with 8 corner angle plates and set them up as shown in the photos below.

After you have installed the legs, turn the rack right side up and fix the remaining 2 pieces of 36” bars and 6 corner angle plates like so:



Tip: ***Make sure there’s sufficient clearance to slide the fish tank under it.***

Cutting “The Hole” In The Grow Bed

The next thing you need to do is to drill a 1” hole at the base of the grow bed tank with a hole saw. This where we will fit the bulkhead and channel water from the grow bed to the fish tank.

Where should the hole be?

Well, here are the few points to consider:

- ✓ Not directly below where the water is entering the grow bed
- ✓ There’s access for the 1” drain line connection to the fish tank,
- ✓ There’s easy access to the standpipe/siphon/
- ✓ On a smooth surface of the tank (look under the tank).

The picture above shows the grow bed (turned over). Cut on a surface that is free from stamping and lines. This will ensure a good sealing when you connect the bulkhead later.

Caution:

Don't get a 1" hole saw. You will need a bigger one than that. I use a 35mm hole cutter and the bulkhead threaded end fits in beautifully. This is because its outer diameter is greater than 1". The size may differ for different parts of the world. It's always a good idea to ask your local hardware store folks for assistance if you're not sure.

The hole saw looks like this

Good indication if the size is right

Once you've identified the spot for the hole, cut it.

Now that we're done with the grow bed and the rack, let's put everything in place.

I have chosen a cylindrical tank for the fish this time.

Step 3 – Connecting The PVC Pipes

Now that you've got everything in place, it's time to link up the system. I will elaborate on the PVC connections for all the three systems below. Let's start with the obvious….System #1.

A) System #1- Continuous flood system with Media Filled Basket

- This system has a continuous water filled grow bed with expanded clay pebbles (Hydroton) filled plant basket. You can buy these baskets or convert your existing or unused plastic/fiber pots by drilling holes in them like so.

Well, this may not look pretty but you're making full use of your resources and most importantly it works.

- *Connecting the Feeder Line* – This part of the system is from the pump to the grow bed. Connect the feed line (3-4 feet depending on the distance from the pump outlet to the inverted “U”), ½” PVC pipe from the pump outlet to the inverted “U”. As shown below and in Diagram 3.

I use Teflon tapes to secure the connection from the pump outlet to the ½” feeder line and this works perfectly. Wrap the tape around the outlet enough to create a firm hold when you connect the pipe.

Alternatively, you can use a ½" water hose and a connector on the pipe end.

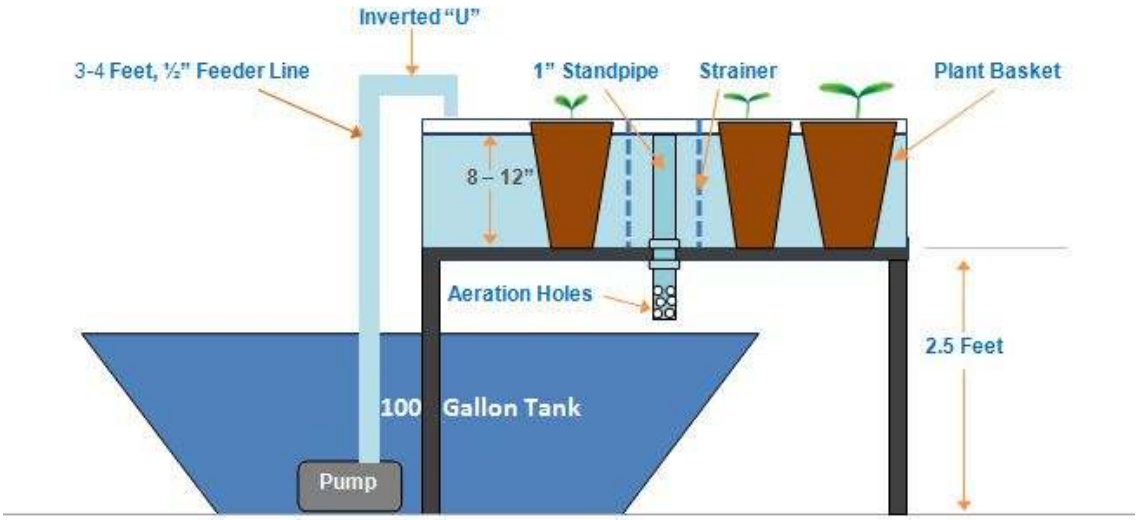


Diagram 3

What is the inverted "U"? Basically, this is the connection that directs the water from the pump into the grow bed, and due its shape helps to hold the feeder line in position.

It is made out of two 90 degree ½" PVC elbows connected to an about 2' long, ½" schedule 40 PVC feeder line as shown below.

Inverted "U"

- *Preparing the Return Line* – Now that you've completed the feeder/supply line to the grow bed, next will be to install the gravity flow return or drain line.

Water level is determined by the height of the standpipe. Water fills the grow bed from the feeder line and drains back to the fish tank again when it overflows the standpipe.

Get the bulkhead and fit it into the hole that you've cut in the grow bed earlier on. Connect a 1" PVC into the top side of the bulkhead then measure the desired height from the base of the grow bed to the pipe like so.

Then, cut it off accordingly and you would have made a standpipe that maintains the water level in your grow bed.

8" to 11" of water level is recommended for this system, 11" being the better option.

The water level should always be an inch or so below the top level of the media. This is to prevent wetting and algae growth here.

Assuming you have opted for the 11" growbed water level, your plant basket should be at least 12" in height and fully filled up.

It's now time to get the plant basket ready for the grow bed. Be sure to rinse the basket and Hydroton with water before you do so. The Hydroton is dusty right from the bag, but they are easy to clean.

If the plant baskets seem to float, add river stones in to them. You can fill half the basket with hydroton and the other half with river stones.

Good thing I had help from my ever faithful assistance…. ☺

That's my little angle filling up the plant basket*.."shy she is"*

And that's my little prince getting the Hydroton filled plant basket set up

It's always great to involve your family in Aquaponics…..

The last thing to do now is attach a 1", threaded female coupler to the threaded male end of the bulkhead.

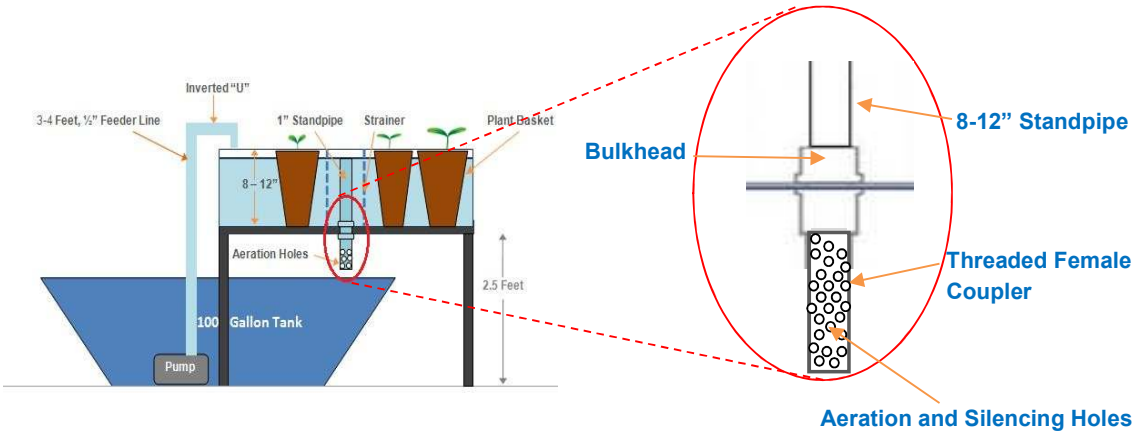


Diagram 4

You can also drill multiple holes in the coupler to allow more effective aeration and silencing effect if you want to (Diagram 4). The size of the hole is not significant. You can pick any reasonable drill bid size that you have.

Or the other option is to cut a 3” long, 1” pipe. Drill the aeration holes here then connect it to the coupler instead like so:

And….whoa..la! There you have it. You have just finished constructing your aquaponics system.

Next, fill the fish tank up with water then start the pump and fill the growbed up with plant baskets in or you can put them in later. Water will then overflow through the standpipe and gravity drains down to the fish again.

Assuming you are using municipal water. You will then need to keep the water cycled in the system for at least 2 days.

There’s chlorine in the municipal water and it needs about 2 days for the chlorine to completely vaporize naturally from the water or you can dissolve it instantly with Sodium Thiosulfate before you can put the fish in.

This is the best time to check for leaks. Don’t bother too much about minor leaks.

A small 360 gph or 6 gpm capacity across 5-6 feet of head aquarium submersible pump is sufficient for this system. A small note the head pressure capacity though…a rough figure would be the height from the base of the fish tank (or submersible pump outlet) to the highest end of the inverted “U”.

If the height is say, 4 feet then you’ll need a pump with a head capacity of 4 feet or more. Well, more is always better in this case. We’ll touch on this again further down the ebook.

And you’re done. Congratulations! You’ve just built yourself an aquaponics system.

System #1 Pros and Cons:

Pros:

1. Easy and simple to set up.
2. Basically worry free.
3. Plant basket makes planting, harvesting and maintenance easy.

Cons:

1. Constant removal of the plant basket may effect a healthy bacteria culture in the system.
2. Continuous flood system could affect optimum growth of plants.

Do I need to glue the pipes together?

Now this is a valid and a popular question…and the answer is yes and no ☺

Well you see, this would very much depend pipe your fitting. If they fit together and don't leak badly or come off during operation, there's no need to glue them.

I don't and this actually makes rectification or modification work easier if you ever decide on one. Let's say, you're starting out with System #1 now and somewhere down the road you want to change to System #2 or #3 instead.

You can easily do so without hassle (you'll see what I mean after you've watched the video).

But you need to give the fittings a good "muscle press" from after they are joint like so…

But having said that, if it makes you feel better then glue the fittings, it's ok too. Test-run the system first before so doing.

B) System #2- Media-filled bed with flood & drain system with a timer

- This system has a similar set up with the previous one with the addition of a timer for the pump, one or more drip hole/s in the standpipe and an extra pump, aeration pump with an air stone.

The submersible pump comes on and off repeatedly. The aeration pump is required here to provide sufficient oxygen for the fish since the return line flow is not consistent.

In this system, water in the grow bed is filled when the pump is running, and drained via the drip hole when the pump cuts off. So, the filling and draining goes on in cycles hence, the name flood and drain system.

We do not use plant baskets for this illustration, on the other hand we'll fill the grow bed with Hydroton up to 8" to 12" high. But if you choose to use the plant basket you can too.

- *Connecting the feeder line* – This is similar to System #1 above. With the addition of a timer to start and stop the pump at intervals (refer Diagram 5).

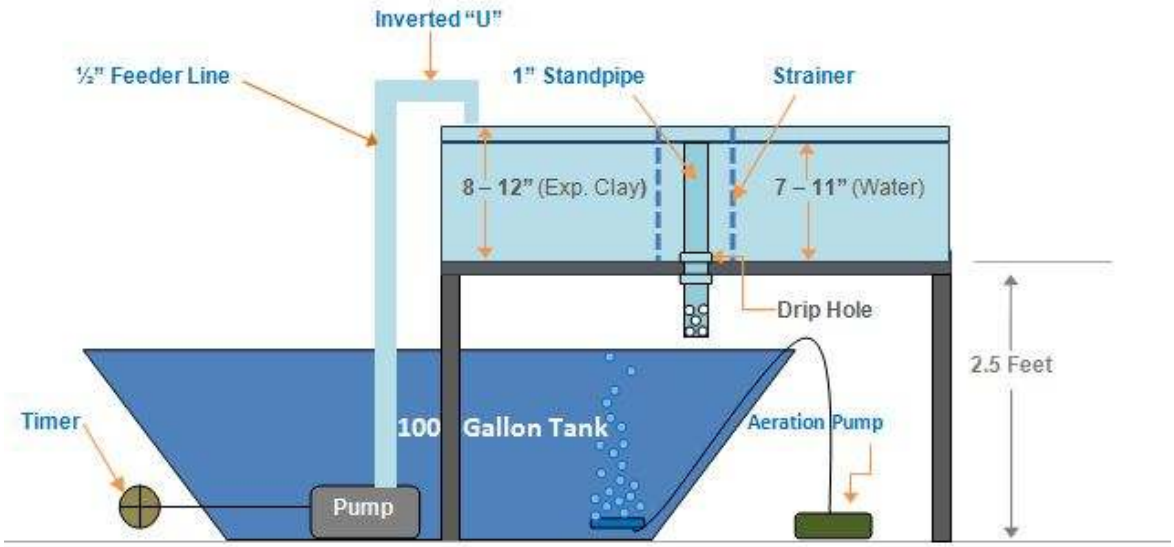


Diagram 5

The water level is determined by the length/height of the stand pipe and will overflow through the top of the standpipe when the pump is running.

After the pump stops, water gravity drains slowly back to the fish tank via the leak hole until the grow bed is emptied out. As the timer cuts in and starts the pump, the grow bed will be flooded again.

TIP: The overflow drain is set at 1 inch below the surface of the grow bed media. The aim is to keep the top layer dry. This is to avoid the bottom leaves of the plants from becoming moldy and to avoid an algae bloom on the wet media surface.

- *Preparing the return line* – It's construction is the same as in System #1 with the addition of two 5mm drip holes at the base of the bulkhead and a strainer.

The measurements are like so. If your media is 12" tall, the standpipe should be 11" long and your strainer at 13" high. (For this illustration we assume this is a 12" Hydroton filled growbed).

Get hold of the 110 mm PVC pipe and cut it to at least 1" higher than your grow bed media's height. Connect the end cap to it, then drill multiple 7mm holes to the side of the cap and all over the 110 PVC pipe and you would have made yourself a strainer.

Drill a hole in the center of the 110 mm PVC end cap (use the same hole saw drill for the growbed). This is where the threaded end of the bulkhead will run through later.

Optional

Additional Holes

For Better Water Flow

Then connect the standpipe to the bulkhead. Now, run the threaded part of the bulkhead through the end cap hole, secure the rubber under the end cap. Connect the whole assemble in the growbed hole and lock the strainer to the end cap.

Next, secure the whole strainer and standpipe assembly by locking the bulkhead with the 'bulkhead nut' & gasket/o-ring from under the grow bed then connect the coupler and drain line.

The strainer hole size must be smaller than the size of the media so that they will not flow through. Hydroton measures at about 8-10 mm.

This is so that the media, especially if you're using Hydroton (which are light), would not spill over of strainer and into the standpipe.

The strainer's main purpose is to prevent the hydroton from being sucked into the standpipe and to protect the standpipe.

The idea for the draining is so that air will be drawn down into the media as the water level goes down to provide oxygen for the bio-filtration process and air for the plant roots.

Recommended media height is 8 to 12" with 12" being the best choice for a media filled grow bed with a flood and drain aquaponics system.

For our Home DIY System we will be using *Hydroton (expanded clay)* as the grow bed media. You can also opt for river stones if you want to. They come with a cheaper price tag but with a heavier weight.

The next thing to do is to set the timer when to stop and start your submersible pump. A normal electrical timer would do a good job here. They work well and rarely fail.

A popular question here is, how often a bed floods and drains, how long between cycles, how fast it fills and how fast it drains. The truth is, I don't think anyone has come up with a definite "best" or optimum time.

I know people who practice flooding and draining many times in an hour and other set ups that get flooded for 15 minutes per hour and drain in about 20 minutes and sit idle for about 25 minutes before getting filled again.

Other set ups might fill for 15 minutes and take 45 minutes to drain before getting filled again. It all seems to work. This is definitely the more popular approach.

Probably because it is easy to find timers with 15 minute increments and the math is fairly easy to figure out how big a pump is needed to move the volume of your fish tank in a quarter of an hour.

So, if you are using the 15/45 method, you would set your timer to run the pump for 15 minutes and off for 45 minutes then start again after.

For this system, assuming you are using the a 50 gal grow bed, two 5 mm size drip hole, would be sufficient to drain it in 45 minutes.

The next step is to fill the growbed to 12” of Hydroton. That would come to about 4 bags of 50L bag Hydroton for a 100gal tank. Remember to give it a good water flush to clean first.

Here Are 4 Bags of Hydroton Piled Up

Flush Cleaning The Hydroton:

Tip: In System #3, just fill the growbed and the Siphon will suck the water out when it's full.

After that is done, fill up your fish tank to almost full. This will come to about 100 gallons if you're using a 100 gal fish tank. If you are not, it's alright. I will show you how to get the right amount further down the road ok!

After that's filled up, you will then need to pump water up to the growbed. Make sure your pump is connected to the feeder line then run it with the timer on.

This is a good time to take note that the pump cuts in and off accordingly and that the draining time is correct. If not you can always remove the standpipe from the strainer and adjust your hole size/numbers.

Let's not be too critical of the draining duration. A plus and minus 3 minutes is fine. It will not be the end of the world ;)

Water will overflow through the standpipe and drain back to the fish tank during the flooding duration. It's supposed to do that so, don't be alarmed alright.

The same water treatment (chlorine) procedure applies here too. Remember to run the aeration pump with air stone during this period or at least before you put the fish in.

And there you go. You've just successfully built System #2.

System #2 Pros and Cons:

Pros:

1. A solid 12" media bed promotes good bacteria culture.

2. Flood and drain system promotes optimum condition to grow strong healthy plants.

Cons:

1. Many moving parts (timer and 2 pumps). Higher probability to failure.

2. Cleaning and maintenance could be a hassle. Although not often needed.

C) System #3 - Media-filled bed with flood & drain system with Siphon

- The set-up is similar to System #2 with a siphon replacing the standpipe and an additional aeration line, less the aeration pump and the timer. The grow bed will also be filled with Hydroton.

  The difference in here is that the pump runs continuously and the siphon manipulates the draining of the system.

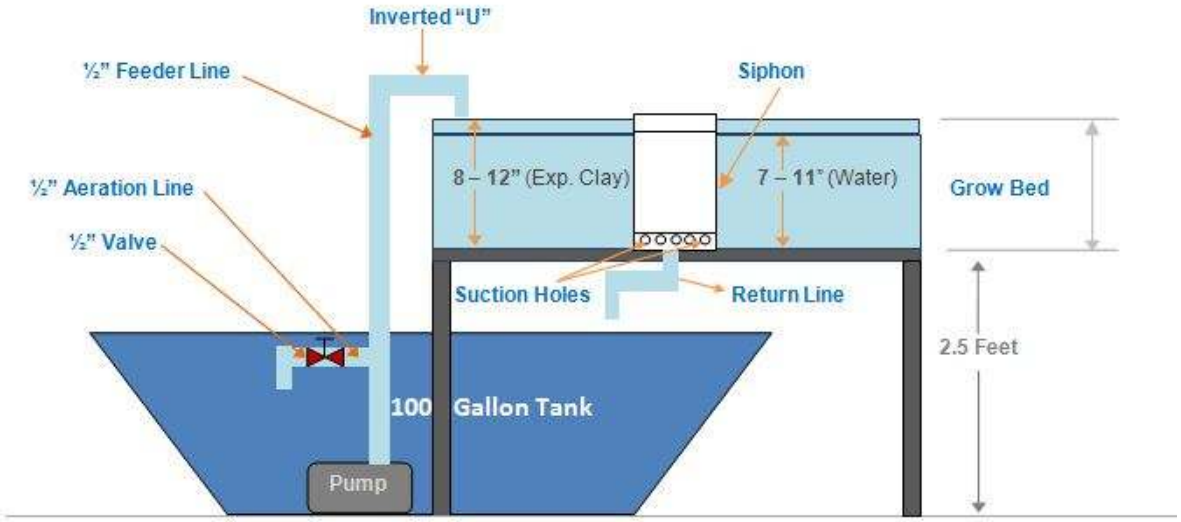


Diagram 6

- *Connecting the feeder line* – The set up here is the same as in System #2 with the aeration/return line being an additional fitting to generate continuous oxygen supply into the system.

- *Preparing the return line* – The main difference comes from here. The standpipe in System #2 is replaced with Aquaponics System Solutions "siphon design".

  The idea for this siphon design came about when I stumbled upon reducer siphons that are made popular by Afnan.

  I have however, made it simpler with less required components and easy to make. It also comes with a modified drain line and extra suction holes at the bottom end cap. I'll elaborate further as we move on.

  In System #3, the pump runs continuously so, there's no need for a timer while a forced draining is initiated by the siphon.

  When the water level in the grow bed reaches the siphon's set level of 11", water gushes through the 50 to 25 mm reducer in the siphon. This creates a sudden suction of water (Bernoulli Principle) to the return line and in to the fish tank. (Refer Diagram 7)

  As the grow bed water reaches the suction holes level at the bottom of the siphon, it cuts off and draining stops. The grow bed then starts to fill up again with the continuous feed from the pump hence, the flood and drain cycle.

- *The Siphon Design* – Now let's get down to the interesting part. Setting up the siphon.

Diagram 7 below shows the illustration of what is contained within the shell (110 mm PVC) of the Siphon and its measurements.

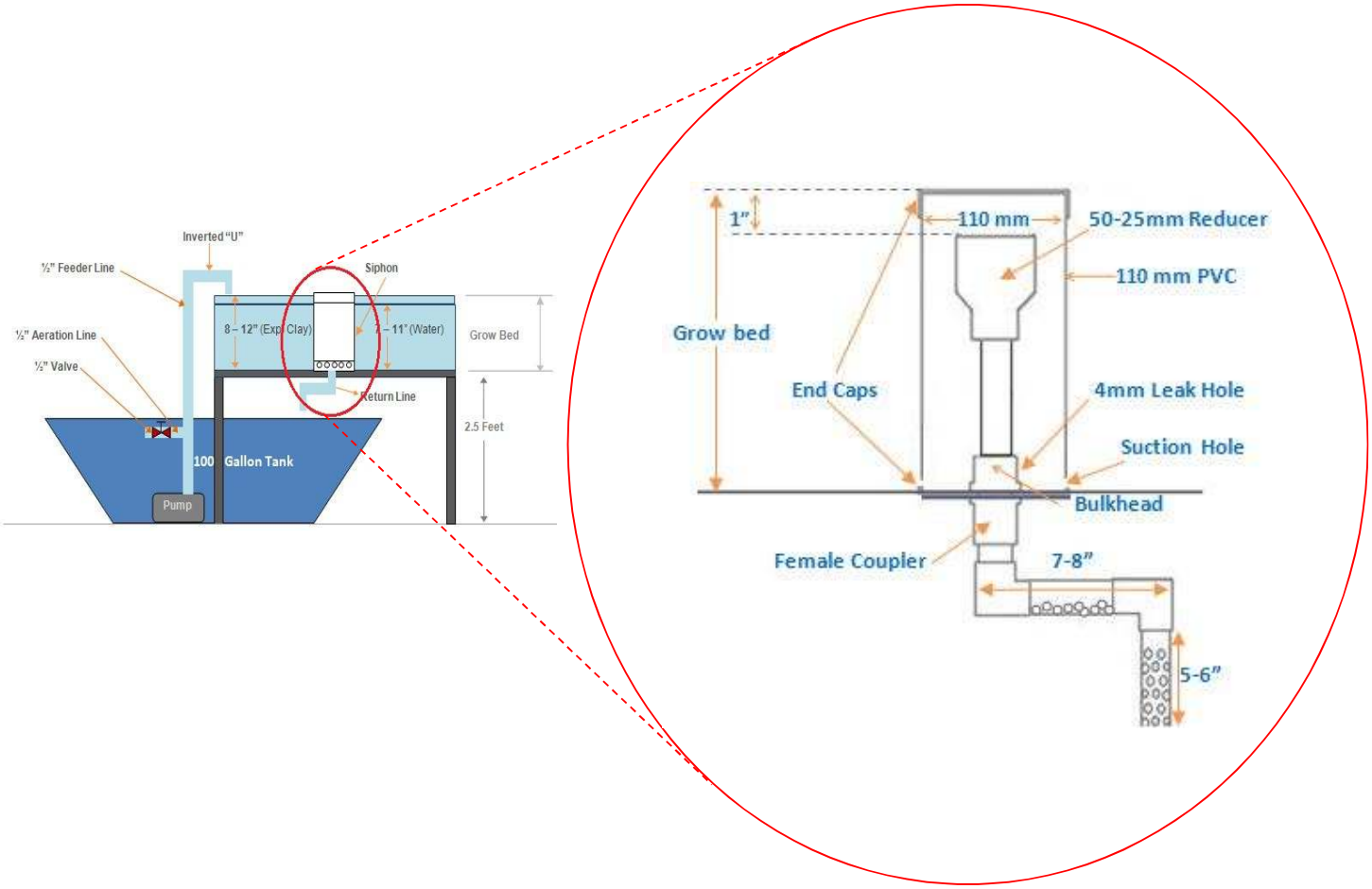
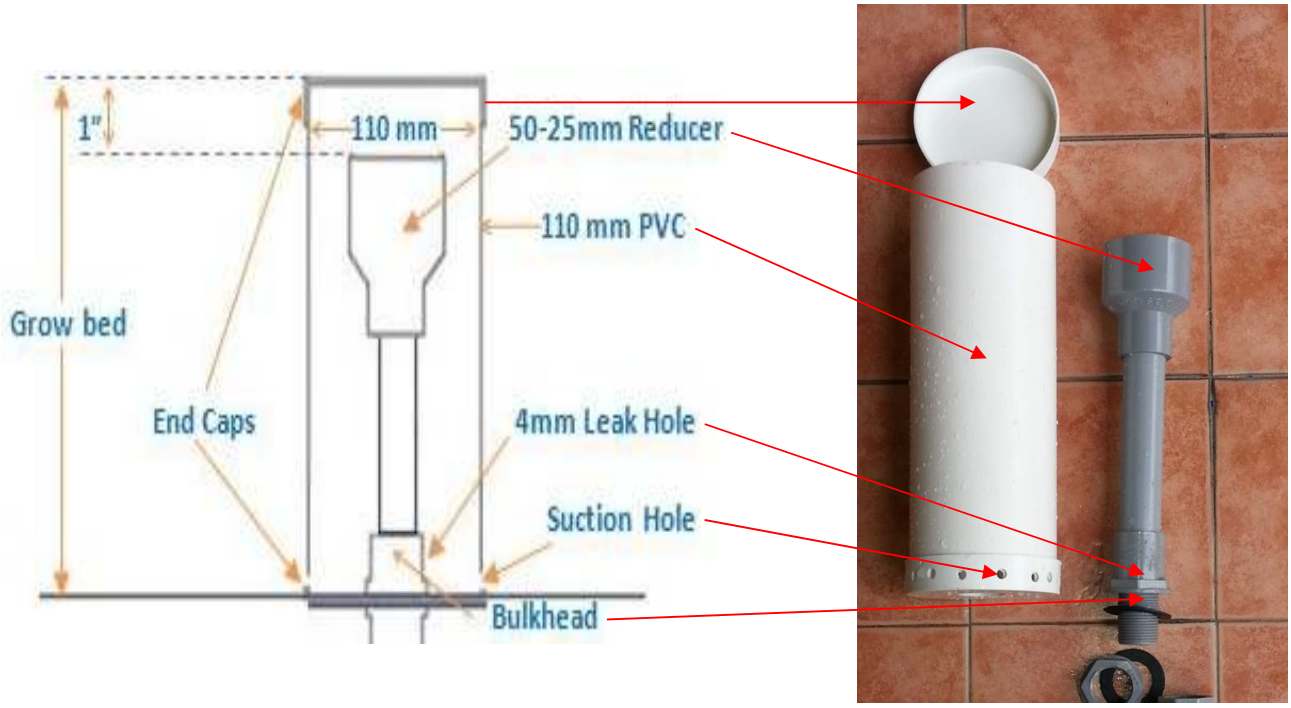
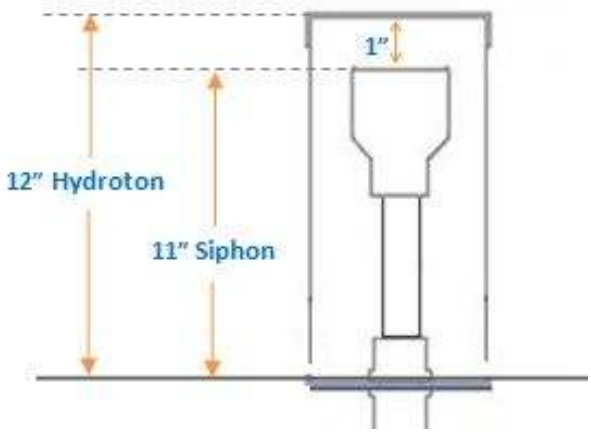


Diagram 7



The photo on the left shows the actual physical components that make up the siphon assembly. They are easily available in hardware stores like Home Depot and the sort.

For this example I will be building a siphon for a 12" deep Hydroton filled grow bed. So the measurement should be as below:



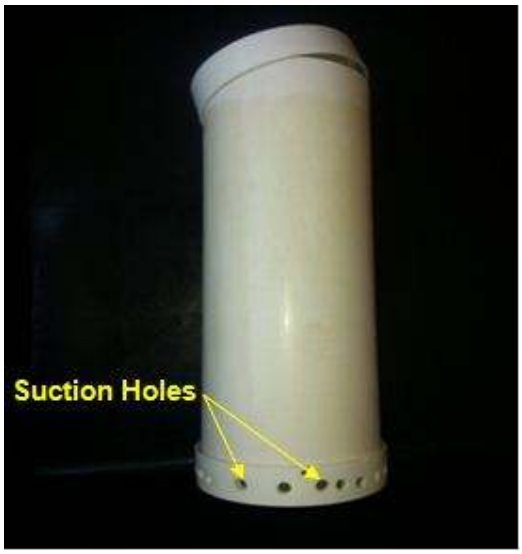
- The 110 mm PVC piping should be at least 1" higher than the siphon or it will not work properly. For this illustration I have set it to 1" higher, 12".

- The Siphon should always be at least 1" below the media and that's 11" for this set-up. As explained earlier, we want to avoid wetting the top of the media to prevent algae growth.

Firstly, let's cut the 110 mm PVC piping to 12" in length. Then drill a hole at one of the end caps (use the same hole saw for drilling the grow bed earlier) for the bulkhead to run through:

On the same end cap, drill extra 10mm-15mm suction holes around the center hole as shown in the photo:

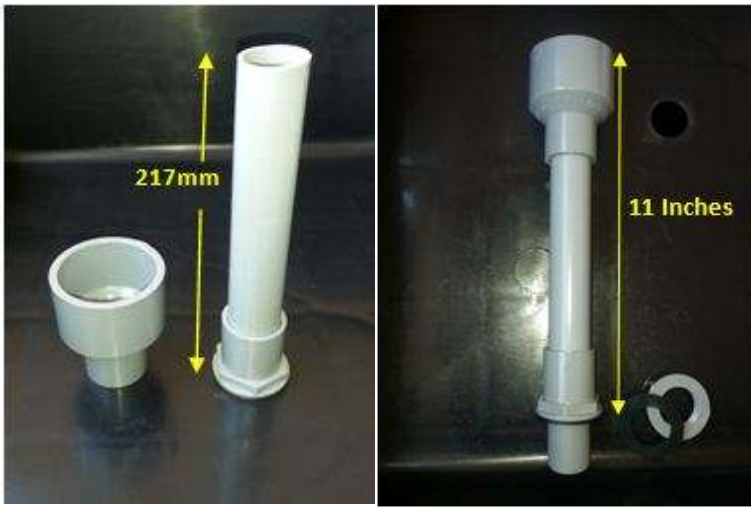
Lastly, drill 7 mm suction holes around its side with the 12” PVC connected. These are the suction holes:



The main purpose of the bottom end cap is to secure and lock the 110 mm PVC pipe in place.

Next, let’s get the siphon ready. This consists of a 1” pipe, 50-25mm reducer and the grow bed top side of the bulkhead. The total length of this assembly is 11”.

Connect the bulkhead to the 1”pipe then, cut the 1” pipe to get a total length of about 217mm. This will make up to 11” with the reducer in place.



Then drill a tiny mm hole, 2mm or so at the base of the bulkhead (at the similar location as in System #2). This is not compulsory but is good to have as it helps to drain water off the grow bed in times of power failure or when you want to switch off the pump.

Now put them all together:

Attach the drain line assembly to the siphon under the growbed:

Take Note that there are 3 rows of aeration holes (5-7mm) under the horizontal pipe above. These are IMPORTANT and I have put in many research and testing hours to come out with this design.

- These aeration holes will ensure consistent and reliable siphon operation.

You can also drill holes all around this horizontal pipe if you want to. This will actually lessen the cycle time (faster cycle time that is) but tends to spray bits of water out of the fish tank, increasing water lost. So, the choice is yours…

Next, fill up the fish tank. Place the pump with the feeder line in the tank and run it. Open the aeration valve to about ¼ turn to allow water flow and start oxygenating the system.

Now, let's check if the siphon works properly. Mark the 11" level (your pre-determined siphon height) on the tank. When the water level reaches the mark, you should hear water dripping from the drain line followed by a sudden gush a few seconds later:

At this point the water level in the growbed will start to drop significantly until it reaches the top of the suction hole then the siphon should cut-off with a “burp” sound or two, and draining stops.

(And of course your fish tank should be at a little bit lower than the starting level).

As the siphon stops, the continuous running pump, will proceed to fill up the growbed. Start to time how long it takes for the growbed to fill-up to the 11” mark and completely drains again (“blurp”). That’s “one cycle”.

Then divide this by half and you’ll get the approximate time it will take for “one cycle” with a growbed filled with 12” of Hydroton.

If it’s too fast, CLOSE the ½” aeration valve more.

If it’s too slow, OPEN the ½” aeration valve more.

The aim is to get at least 4 cycles in one hour.

For example, if you get 30 minutes per cycle, divide that by 2 = 15 minutes per cycle or less (with the Hydroton in). That means you will get 60 minutes /15 = 4 to 4.5 cycles in one hour. That’s good.

I would suggest to run the system for 2 days. For one this helps to evaporate out chlorine in the tap water and at the same time test out the system for a day or two before you fill the growbed with hydroton.

This is a thing that I do just to be sure everything works well and for ease of work in case anything goes wrong. Not that it will. I have tested the siphon and it never fails really!

Not that I’m blowing my horns ☺

Hydroton cleaning procedure is the same as in System #2, with the exception in the “System Flush”. Here, you just fill the growbed up with tap water and let the siphon cut in to suck the water out until the siphon drain line water is clear.

See pictures below:

After that is done, fill up your fish tank to almost full. This will come to about 100 gallons if you’re using a 100 gal fish tank. If you are not, it’s alright. I will show you how to get the right amount further down the road ok!

After that's filled up, you will then need to pump water up to the growbed. Make sure your pump is connected to the feeder line then run it.

Check the time for the one-cycle completion. Remember the target here is 4 cycles an hour (~ 12 to 15 minutes a cycle is good).

If it's too fast, CLOSE the ½" aeration valve more.

If it's too slow, OPEN the ½" aeration valve more

Possible causes that the siphon does not cut-in:

1. The pump flow is insufficient, you need at least a 1500 liter/hour pump with the aeration line in service (2000l/h recommended). CLOSE the aeration valve more to increase flow to the growbed).

2. The top end cap is not closed.

3. The siphon assembly is not properly connected and it came off.

4. The drain line got disconnected.

Possible causes that the siphon does not cut-off:

1. The drain line is not connected or it came off.

2. The pump flow is too high (that is if you use a bigger than recommended pump). You can resolve this opening the aeration valve more.

3. The Horizontal part of the drain line is completely submerged in the fish tank water level during draining. You can shorten the drain line or reduce the fish tank water level.

After you've test run the system and are happy with it, you can now put the Hydroton in. Again, give it a good flush first before you do so and you can introduce fish to your aquaponics system 2 days after.

System #3 Pros and Cons:

Pros:

1. Similar to System #2.

2. No aeration pump or timer to worry about.

Cons:

1. The pump could fail. (*Always have a battery operated O2 pump available. Useful also during pro-longed power failure, to keep the fish alive*).

2. Siphon could fail. (*Due to algae clogging. Recommended to do a whole system cleaning every 24 months or so*).

Commissioning The System

1. Preparing The Water

Now that you have filled your aquaponics system with water, next you need to get your system 'cycled'. This simply means establishing your beneficial bacteria populations within the system so that they can convert the ammonia wastes into nitrates so the plants flourish with them.

There are a number of ways you can do this:

1. Get some water either from an existing system, an aquarium or a pond that you or your friend may have and add it into your fish tank.

2. Introducing fish feed that you will be using to feed your fish with into the system. This fish feed will break down and release ammonia for the bacteria to consume.

3. Add Proline Nitrifying Bacteria. You can get this in your local aquarium stores. This will speed up the cycling process. You can actually put your fish in at this stage as the fish will provide ammonia for the bacteria as food.

4. One of the simplest and the method I like most is stock fingerlings of the fish species you intend to grow in the system. But feeding must be kept to a minimum in the first 2 months.

   Feeding once every two days is recommended. Don't worry about your fish starving ok…they won't be.

   After 2 months you can start increasing feed levels slowly because your bacteria would have been established. You can easily monitor this with a basic freshwater master test kit or test strips.

2. Adding Fish Into The System

The next thing will be to introduce fish into the system.

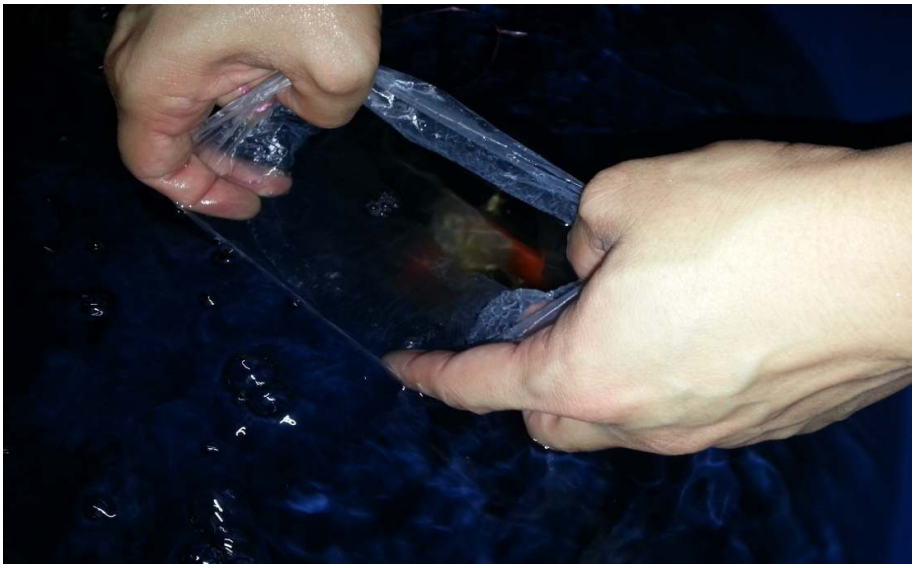
A general guide line that I always when adding fish into the fish tank is to:

1. Balance the water temperature between the newly purchased fish/fingerlings and the fish tank by placing the plastic bag where the fish is contained in to the fish tank.

   I normally leave it in there for 5-10 minutes.

   Photo below:

2. After that I would add some fish tank water into the bag for a little chemistry balance before releasing the fish into the tank:



How many fish should I grow in my system?

This is a hotly debated issue. The popular rule of thumb would be to grow 1 pound of fish for every gallon of water or 1 inch of fingerlings for every gallon. A plate size Tilapia comes to about 1 to 1.5 pounds.

That's 60 to 90 fish in a 100 gallon fish tank. That's a lot of fish for a tank that size and they'll be fighting for space.

In Aquaculture point of view, you need 10 gallons of water to grow a Tilapia to a healthy 1.5 pounds fish or else they just will not grow to their potential size.

Well, my theory is simple. If the fish is happy, the plant would be too. I always take the above as a guide for growing my Aquaponics systems.

So, for all the three systems and assuming you are using 100 gallons of water, each system can take (100 / 10) = 10 full grown fish or you can do a rough estimation of 1.5 to 1 pound of fish to every 10 gallons of water.

That equates to 10 to 15 pounds or about 12 to 15 matured fish for each system (depending on the species that you choose). Some may say that's a little conservative, but it's the best number to start off if you are new to aquaponics.

Having said that, I know of people who have successfully grown about 100 Tilapias' in a 100 gallon fish tank. So, experiment with it and see what you think it's best for you. My recommendation would as I have penned down above.

But you are free to experiment with it and by all means do that.

If you are starting out with fingerlings, which I recommend you do, you can begin with a bigger number and harvest them to the ideal ratio as they grow.

You can therefore increase the size of your aquaponics system based on these numbers. If you intend to have 2 growbeds, increase the fish tank size to a 200 gallon tank and grow 20 to 30 pounds of fish.

A good place to source for fish is at your local aquarium stores. They may not have what you're looking for but very likely they can point you to the right direction.

The other popular option is to google it and look for people or companies that raise fish for people like us.

How To Make A Simple Cover For The Fish Tank?

Now, it is uncommon for fish to jump out from the fish tank. This could be due various reasons. The bottom line is, we need to prevent that from happening and the obvious is to make a cover over the fish tank.

A simple, effective and efficient way is to use ½" plastic nets like these:

They are easy to make. Just get your fish tank measurement, go to a nearby hardware store and they'll cut it to dimension for you. Or you can cut them yourself to shape by using a pair of scissors then clip them in place using a those office paper clips like so:

3. Adding Plants

Now that the fish is in, you can start to transfer seedlings to your growbed. I like to add seeds and seedlings at the same time and as the seeds germinate and grow it will not be long before you can harvest the seedlings (*refer Chapter 5 – Preparing Your Seedlings*)

Careful to remove all the soil from the seedlings by simply dipping them in the water (use de-chlorinated water) and rinsing them should easily wash the soil off the roots. Refer Chapter 5 (Preparing Your Seedlings) for more info on how to establish your seedlings.

In aquaponics, you can plant things more densely as there is plenty of nutrient rich water to go around.

4. Balancing The Water Chemistry

The next thing to do is to establish a good balance of pH, Ammonia, Nitrite, Nitrate, and DO (Dissolved Oxygen).

A good balance here would mean happy and healthy fish and plants = healthy & yummy produce.

It would be a good idea to get yourself a “Fresh Water Master Test Kit” for this purpose. A good balance of these parameters in an aquaponics system would be like so:

- **pH** – Generally a range of between 6-8 is acceptable. Fish prefer a higher pH and plant prefer them lower. Therefore, the ideal would be a pH of 7.0. But, keeping your water NOT LOWER than 6 and NOT HIGHER than 8 would be a safe guide.

  Note: *Intentionally lowering or increasing your pH would endanger your fish. If there is no substantial change in your water’s “original” pH, it’s best to leave it alone*.

- **Ammonia** - A high level of it may damage fish gill membranes and killing them. Even trace amount stresses them. In new set-ups the level may surge up to 4 ppm or more and then fall drastically as the bacteria establish.

  The target here is 0 ppm (mg/l) or anything below 1ppm is acceptable.

  Note: *You don't want to exceed 6ppm here as this is considered toxic.*

- **Nitrite** - Nitrosomonas bacteria, eats ammonia and releases Nitrite. Excessive Nitrite causes respiratory difficulty to fish. Its level tends to spike in new systems but will gradually come down once the biological filter is established in about 4-6 weeks.

  The ideal Nitrite level is 0 ppm. Anything below 1ppm is acceptable.

  Note: *Do not exceed 6ppm as this is considered toxic. If it does, carrying out a 20% water change would be sufficient to lower the nitrite level. If Nitrite remains high after the water change, do another 20% change until the Nitirte level drops.*

- **Nitrate** – Nitrate is consumed by Nitrobacter bacteria and produces Nitrate in the process and this is nutrient for the plants. However, if its level is too high in the system, could kill the fish.

  A normal acceptable operating range is between 10-40 ppm, as it is more tolerable by most the fish. Koi and Marbled Goby can go up to 80ppm from my experience. Stop feeding if it's on the high trend.

- **Dissolved Oxygen** (**DO**) – For optimum nitrification rate, an 80% or 4 ppm saturation is the goal.

Typical Water Chemistry Behavior In A New Set-Up

The first 3 to 4 weeks is a critical period for a new system. This is called the "Cycling Period". A cycling period is the period when your new aquaponics system is establishing its bacterias':

1. **Nitrosomonas bacteria** - converts ammonia into nitrite, and

2. **Nitrobacter bacteria** - converts nitrite into nitrate.

This is when you need to carry out more regular testing. Observe your fish carefully. If they behave strange or swim funny check the system immediately.

Important: The scenario below is true only if you follow my Golden Rule of feeding your fish once a week and reading taken at least 24 hours after feeding. Include fish and plants during the "Cycling Period".

Again don't worry about starving your fish. Fish can go weeks without food alright…so don't worry.

1st Week – Ammonia tend to be high, pH on the higher side (depending also on your source of water) don't worry too much about your pH, with "0" Nitrite & Nitrate. This is because you do not Nitrosomonas nor Nitrobacter bacteria in your system yet.

2nd Week – pH mostly on the higher side, Ammonia will start to reduce and Nitrite would start to increase, Nitrate should still be zero. This is when the Nitriting bacteria is building up converting Ammonia to Nitrite. And Nitrating bacteria is not present yet to convert Nitrite into Nitrate.

Do a partial (20%) water change if Ammonia goes up to 5ppm.

3rd Week – pH should remain similar, Ammonia starts to reduce or even zero. Nitrite should be on the high side. Nitrobacter should be present and building up by now. You should see signs of Nitrate.

This is the period when the "Nitrite Spike" normally cuts in. This simply means the Nitrite level goes high. Depending on the type of fish you are growing, you need to do a partial (20%) water change if the Nitrite level reaches 2ppm.

Cat fish are pretty sensitive to Nitrite, 2ppm could kill them. Koi, Tilapia and Marbled Goby are quite tolerant to Nitrite. They are still comfortable with a Nitrite level of 5ppm. But still, do the partial water change.

Important thing here is stop feeding and do a water change when you detect a high Nitrite level.

4th to 5th Week – Ammonia and Nitrite should be zero, pH should be lower than the initial stages and your Nitrate high. Congratulations! This is when your system is "Fully Cycled". That means your system's bacteria are fully developed and your systems own little eco-system has been developed.

This is a good time to add more plants and fish to your growbed.

What you can do here is, seed your nursery tray, the same time when you seed your growbed. By the time you are fully cycled, you will have ready plants to add into your growbed.

Koi, Tilapia and Marbled Goby can stand up to 80ppm of Nitrate without harming them. Do some research on the type of fish you intend to grow or experiment it yourself with close observations and in no time you would have got the hang of it.

From here on, all you need to do is balance your Nitrate level (how much you feed your fish) to the number of plants you have in your growbed.

The more you feed the more Nitrate will be produced, hence you will need more plants to filter out the Nitrate into fresh water the fish need.

If you do not have many plants yet or if they are still in the juvenile stage, feed less, and as the plants grow bigger, feed more. This is when you need to do some tests and find a balance.

Do expect a less quality looking, first batch of greens from your aquaponics system. That is quite normal. When your system is about 3 month old, you will notice a significant difference.

Go for easier to grow greens in the beginning like, Pak Choy (Green), Kai Lan and or Cabbage. After the 3rd month it will be like magic. Sprinkle seeds into the growbed and they will flourish quickly and healthily you won't believe it!

My practice is, always do a 10% water change at least a day or two after feeding for the first 4 weeks (during the cycling period).

Alternatively, there are solutions and tablets that you can buy from you local aquarium store to help neutralize these chemical build up. But I would always advice to stick to what is natural and you would build a strong system.

Remember, the secret is in the feeding. The more you feed the fish, the more ammonia will be produced. Control the feed and you control the system.

Think about it. The fish will only produce as much ammonia as the amount of food you feed them. I always observe the plants and fish to achieve optimal result.

If you find that your plants are showing signs that they lack nutrition, feed the fish more. They will then produce more ammonia which will be converted to more nitrite and eventually more nitrate to be fed to the plants as nutrients.

I subscribe to Dr Wilson Lennard, a PHD in Aquaponics research as a guide. He has proven that by limiting 16mg of feed to a certain number of Tilapia, he could maintain a stable system that runs 1 square meter growbed of 30 Lettuce.

You may have 10 or 20 fish in the tank, but they can only produce 16mg worth of Nitrate. Having too many fish and the 16mg of fish food will not be enough to go around. A good balance here is important

This research serves as a very good yard stick in growing your aquaponics system.

Additives

- Calcium carbonate and potassium carbonate, provide extra potassium and calcium when needed and help to raise the pH as well.

- Iron chelate, should be added when there's iron deficiency in the system. The symptom is yellowing plants.

Redundancy Plan

Now that you've got your aquaponics system set up an running, it's good to have look at the safety and back-up plans to go with it. As explained in Murphy's law…If something can go wrong, it will go wrong. So, be prepared when/if that happens.

Power Failure

Pumps stop running when that happens and aeration stops as well. So, it's essential to have a battery powered aeration pump available to keep the fish alive during this period.

General Safety

- Always switch off the submersible pump and power off before dipping your hands in the pond or tanks where the pump is. Also, keep the aeration pump or any other electrical components away from the fish tank/pond to avoid possibilities of shorting from occurring.

- Keep your water test kits away from the reach of children as its contents are poisonous.

- Cover the tanks or ponds when necessary to avoid the possibility of children falling in.

Determining Your Tank Volume

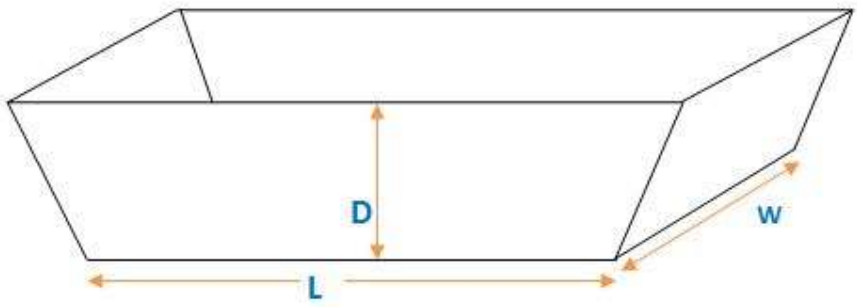
Now, if you have existing or extra tank/s lying around the house and you want to use it/them to start your aquaponics system with but not sure if the size is/are right, I will show you how to determine that.

The first thing you need to do of course is to determine if they are suitable for growing fish and plants and that they don't leak. The other question is what has been in there before?

You don't want to use tanks that were previously used for stocking oily products or harmful chemicals…not a good idea.

Square & Rectangular Tank

Ok…let's start with a square or a rectangular tank. You can find out the volume by multiplying its Length, Width and Depth (L x W x D) like so (keeping in mind that all the illustrations in this ebook are in U.S. Gallon) :



If you measure in **Inches** the result will be in **L" x W" x D" = Cubic Inch**

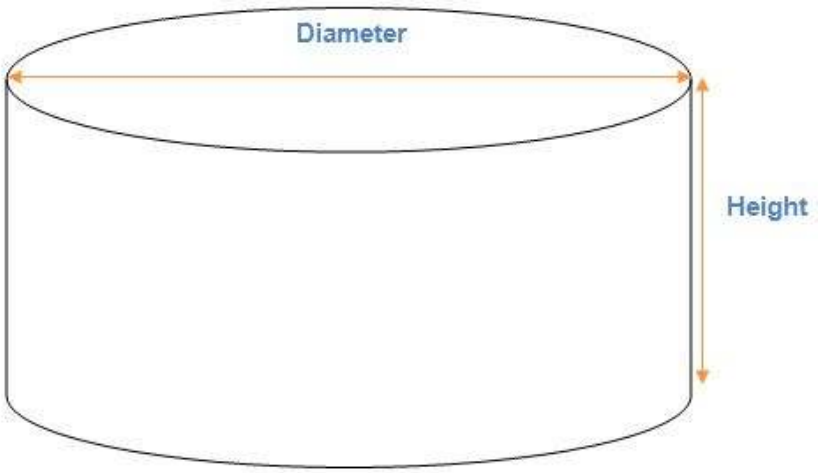
Cubic Inches x 0.004329 = U.S. Gallon

If you prefer by **"Foot"** the result will then be **L' x W' x D' = Cubic Feet**

Cubic Feet x 7.48052 = U.S. Gallon

*So, as you change **D** (i.e. your water level) you can determine the volume that you want.*

Round or Cylindrical Tank



If you measure in **Inches** the result will be in **Diameter" x Height" = Cubic Inch**

Cubic Inches x 0.004329 = U.S. Gallon

By **"Foot"** the result will then be **Diameter' x Height' = Cubic Feet**

Cubic Feet x 7.48052 = U.S. Gallon

*As you change the **Height** (i.e. your water level) you determine the volume that you want*.

There you go. Easy right?

The Easy Alternative…

Well, to make this even easier go to the website below. Fill in the blanks, hit enter and all the calculations will be done for you:

http://www.ifocas.org/calculator.htm

Growbed to Fish Tank Ratio

This is another popularly debated issue ☺

The rule of thumb here is 1:1, meaning for example if you use a 50 gallon growbed you should have a 50 gallon fish tank as well. This seems to be the popular configuration that people go with as it optimizes the use of space and resources.

There are also arguments that say it should be 2:1. This normally means using for example, two 50 gallons growbed with one 50 gallons fish tank. To me, the fish tank water level tends to drop too low here for my liking, and for the fish's liking for that matter.

My preference is always to keep the fish happy and the fish will be happier with a 1:2 configuration. This means a 50 gallon growbed to a 100 gallon fish tank as is recommended in the Aquaponics System Solutions – Home DIY System.

Get a 24" deep fish tank or more if you can help it. Depth takes preference to width when it comes to fish tanks.

Submersible Pump Capacity

To determine the pump capacity for your system, you first need to know the size of your growbed.

For example, if your growbed is 50 gallons and you fill it up with Hydroton the amount of water you will need to fill it up would be 50/2 = 25 gallons of water. Hydroton would take up about half the growbed's water capacity.

For System #1 – A small 20W pump would be sufficient since it is a continuous flood system.

System #2 – You need a pump that could push at least 25 gallons of water to the growbed in 15 minutes.

That's (25 gal / 15 min = 1.66) a minimum of 1.7 gal/minute pump would be sufficient. With this number in hand, you have a good idea of what you need.

System's #3 – The siphon needs 800 to 1000 liter/hour flow rate to work and you need to add another 30% for aeration. You will then need a minimum 1000 + 30% (30 liters) = 1300 liter/hour pump for this system.

I use a 2000 liter/hr pump. I like to keep the fish happier. After all, these pumps come cheap. The 2000 l/hr pump cost me just a little over $20. Bigger is always better in this case. Always get a little bit bigger capacity than you need. Pumps last longer that way.

Remember to take the head (distance between the pump to the inverted "U") into consideration as mentioned earlier.

The pumps normally come with the flow rate with a certain 'Head' written on the box and on the pump tag as well.

Building Your Own System For Less Than $35

Ok…you now know how to determine tank volumes…you know about growbed to fish tank ratio, and you also know how to determine the pump capacity you'll need for a given GB and fish tank size…you are actually equipped to design your own aquaponics system.

To build your own system for less than $35, you just need to use what you already have for your disposal. Old unused tanks that you can use, or you may already have a fish tank that you can add a growbed to.

The $35 is really for you to buy a pump and the piping you'll need to set your system. Be creative about it…you already have the knowledge.

It will cost you less than $35 in fact, if you already have an aquarium. All you need to do is add a growbed and divert the water that is going into the filter, to the GB instead.

It's that simple…

Material List

Tanks

You can get the 50 and 100 gallons tanks from any of the stores below:

- Source them locally at your nearest available stores (livestock, garden supply, aquarium store or the sort). This is definitely the cheaper alternative.

- Southernstates.com (Growbed and Fish Tank) I've found some reasonably priced oval shaped tanks you can use for GB & FT here. If the links does not work, download the "Materials List pdf" file. They'll work…if not, just drop me an email and I'll get back to you.

- www.plastic-mart.com
- www.usplastics.com
- www.aquaticeco.com
- Use existing tanks that you may have lying around.

Growbed Support

1. **Slotted Angle Bar Support**
    - 4 pieces of the 10' slotted angle bars cut to, (36" six - pieces, 24" four - pieces & 30" four – pieces as shown in the photo below).
    - 14 pieces of corner angle plates.
    - 60 sets of 5/16 x 1" bolts and nuts (or optional size that could fit the slotted angle bar holes).
    - A pair of 13mm combination spanners (or the size that fits the bolts and nuts size that you are using).

2. **16x8x8 Cinder Block Support**
    - Eight 16x8x8 Cinder blocks
    - Two 5" x **L**" wooden planks to support the growbed. (**L**" will depend on the length of the growbed and the fish tank that you are using).

Fish

A good place to source for fish is at your local aquarium stores. They may not have what you're looking for but very likely they can point you to the right direction.

The other popular option is to google it and look for people or companies that raise fish for people like us. www.Graiglist.com is also a good place to look...

System #1

- **Schedule 40 (Class 6) 1 inch PVC**

- Approximately 16 inches of PVC pipe (assuming your standpipe is 11" and your silencer drain line is 5").

- One Bulkhead fitting/Tank Connector (may need to be pre-ordered).

- One female threaded coupler (threaded on one end & smooth on another).

- **Schedule 40 (Class 6) ½ inch PVC**

- Approximately 4-5 feet PVC pipe (Depending on the distance from the pump outlet to the top of the growbed).

- Two, 90 degree elbows (for the inverted "U").

- **Pumps**

- One Submersible Pump, 6 GPM (Gallon Per Minute) capacity with 4-6 feet of head is sufficient. There's a compatible one available at www.aquaticeco.com if you choose purchase it online. (The model is: Danner Supreme Magnetic Drive Pump, MD5)

    - Or alternatively, source it from your local aquarium store. 6 gpm pump is what you're looking for.

- Teflon tape or ½" female one end threaded coupling for the pump outlet.

- One Aeration Pump with an Air Stone (*Optional*).

- A standby battery operated aerator/air pump and an air stone to keep the fish alive in case of pro-longed power failure.

- **Water Chemistry**

- Proline Nitrifying Bacteria, Chlorine Neutralizer, Sodium Thiosulfate and Ammonium Chloride tablets (assists initial bacteria start-up) if you want to speed things up.

- Water Chemical Master test kit or individual test strips for pH, ammonia, nitrites and nitrates you can get these at the same location where you buy the fish. (www.aquariumguys.com)

- **Tools**

- PVC pipe cutter or a hacksaw.

- Drill with 32mm Hole Saw for the growbed. (Get the size that is right for the threaded end of your bulkhead as explained earlier).

- 5-7mm drill bit for the construction of the drain line silencer.

- **Miscellaneous**

- Plant Baskets (Net Pots) of various sizes (same height) can be found at www.hydroponicgarden.net, your nearby gardening supply store or google for a store near your location.

- Expanded Clay Pebbles (**Hydroton** – TheAquaponicStore.com). *Type hydroton at the search box located at the top right hand side of the website*.

- Fish Food

- Nursery Tray

- Working gloves

- Sand paper (fine)

- Medium strength clear PVC glue if you intend to glue up your PVC pipes.

Click Here! To download System #1 Materials List

System #2

- **Schedule 40 (Class 6) 1 inch PVC**

- Approximately 16 inches of PVC pipe (assuming your standpipe is 11” and your silencer drain line is 5”).

- One Bulkhead fitting/Tank Connector (may need to be pre-ordered).

- One female threaded coupler (threaded on one end & smooth on another).

- **Schedule 40 (Class 6) ½ inch PVC**

- Approximately 4-5 feet PVC pipe (Depending on the distance from the pump outlet to the top of the growbed).

- Two, 90 degree elbows (for the inverted “U”).

- **Schedule 40 (Class 6) 110mm PVC Pipe**

- 9”-13” depending on the height of your growbed media (at least 1” taller than the media).

- One, 110 mm end cap at the bottom to lock the strainer (the second one to cover the strainer top is optional).

- **Pumps**

- One Submersible Pump, 6 GPM (Gallon Per Minute) capacity with 4-6 feet of head is sufficient. is sufficient. There’s a compatible one available at

www.aquaticeco.com if you choose purchase it online. (The model is: Danner Supreme Magnetic Drive Pump, MD5)

  - Or alternatively, source it from your local aquarium store. 6 gpm pump is what you're looking for.

- Teflon tape or ½" female one end threaded coupling for the pump outlet.

- One Aeration Pump with an Air Stone (***must have***).

- A standby battery operated aerator/air pump to keep the fish alive in case of pro-longed power failure.

- **Water Chemistry**

- Proline Nitrifying Bacteria, Chlorine Neutralizer, Sodium Thiosulfate and Ammonium Chloride tablets (assists initial bacteria start-up) if you want to speed things up.

- Water Chemical Master test kit or individual test strips for pH, ammonia, nitrites and nitrates you can get these at the same location where you buy the fish. (www.aquariumguys.com)

- **Tools**

- PVC pipe cutter or a hacksaw.

- Drill with 32mm Hole Saw for the growbed. (Get the size that is right for the threaded end of your bulkhead as explained earlier).

- 7 mm drill bit for the construction of the growbed strainer and for the drain line silencer.

- 5 mm drill bit for the two "Drip Holes" in the bulkhead.

- 10mm-15mm drill bit for the holes in the bottom end cap (*optional*).

- **Miscellaneous**

- Plant Baskets (Net Pots) of various sizes (same height) can be found at www.hydroponicgarden.net, your nearby gardening supply store or google for a store near your location.

- Four 50L bags of Expanded Clay Pebbles (**Hydroton** – TheAquaponicStore.com). *Type hydroton at the search box located at the top right hand side of the website*.

- Fish Food

- Nursery Tray

- Working gloves

- Sand paper (fine)

- Medium strength clear PVC glue if you intend to glue up your PVC pipes.

- Timer

Click Here! To download System #2 Materials List

System #3

- **Schedule 40 (Class 6) 1 inch PVC**

- Approximately 26” inches of PVC pipe (assuming your standpipe is 11” and your silencer drain line is 5”).

- One, Bulkhead fitting/Tank Connector (may need to be pre-ordered).

- One, female threaded coupler (threaded on one end & smooth on another).

- One, 50mm-25mm reducer.

- **Schedule 40 (Class 6) ½ inch PVC**

- Approximately 5.5 feet. (4-5 feet PVC pipe depending on the distance from the pump outlet to the top of the growbed and two, 3" pipe for the aeration line.

- Three, 90 degree elbows. (2 for the inverted "U" and 1 for the aeration line outlet).

- **Schedule 40 (Class 6) 110mm PVC Pipe**

- 8"-12" depending on the height of your growbed media (at least 1" taller than the reducer).

- Two, 110 mm end caps.

- **Pumps**

- One Submersible Pump 2000 liter/minute (about 530 gal per hour) capacity with 4-6 feet of head is sufficient. You can source for a compatible one at www.aquaticeco.com or source it from your local aquarium store. 2000 liter/minute pump is what you're looking for.

- Teflon tape or ½" female one end threaded coupling for the pump outlet.

- One Aeration Pump with an Air Stone (Optional).

- A standby battery operated aerator/air pump to keep the fish alive in case of pro-longed power failure.

- **Water Chemistry**

- Proline Nitrifying Bacteria, Chlorine Neutralizer, Sodium Thiosulfate and Ammonium Chloride tablets (assists initial bacteria start-up) if you want to speed things up.

- Water Chemical Master test kit or individual test strips for pH, ammonia, nitrites and nitrates you can get these at the same location where you buy the fish. (www.aquariumguys.com)

- **Tools**

- PVC pipe cutter or a hacksaw.

- Drill with 32mm Hole Saw for the growbed. (Get the size that is right for the threaded end of your bulkhead as explained earlier).

- 7 mm drill bit for the construction of the growbed strainer and for the drain line silencer.

- 10mm-15mm drill bit for the holes in the bottom end cap

- **Miscellaneous**

- Plant Baskets (Net Pots) of various sizes (same height) can be found at www.hydroponicgarden.net, your nearby gardening supply store or google for a store near your location.

- Four 50L bags of Expanded Clay Pebbles (**Hydroton** – TheAquaponicStore.com). *Type hydroton at the search box located at the top right hand side of the website*.

- Fish Food

- Nursery Tray

- Working gloves

- Sand paper (fine)

- Medium strength clear PVC glue if you intend to glue up your PVC pipes.

Click Here! To download System #3 Materials List

And we have reached the end of this ebook. I hope you have enjoyed the learning as much as I have enjoyed preparing this ebook. Here is to your success and don't hesitate to contact me if you have questions on the package that need to be answered at: (stevenfu@aquaponicssystemsolutions.com)