THE IBC OF AQUAPONICS

Edition 1.0

Backyard Aquaponics

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PO Box 3350 Success Western Australia 6964
www.backyardaquaponics.com enquiries@backyardaquaponics.com

Editors: Joel Malcolm & Faye Arcaro
Graphic Design: Sarah Upravan

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Updating and revisions

We will be constantly modifying and updating this document so to make it simple for you to know whether you have the most up to date version we will update it in the following way. If you have version 1.X then you will have all the latest information, if for example you have 1.0 and you see that we are up to 1.3, the changes will only be cosmetic changes or perhaps very small changes. We will only change to 2.0 when there is a major update of content, then as very minor modifications happen we will change it to 2.1, 2.2, etc. But it's not really worth updating from 2.0 up to 2.2 as the changes will only be slight. Best to wait till version 3.0 is release with major changes. If you would like to know when further releases will be coming out then please sign up to our newsletters and forum, we will be informing people via our newsletters and the forum as new releases become available. Subscribe here.

Thanks & Acknowledgements

Thanks go out to the members of the Backyard Aquaponics forum, whose inventive minds have provided most of the content for this manual. Without all these members who are so willing to share and take time out to contribute to the forum and help others, this wouldn't have been possible.

If this manual is of some use to you please come and join the forum. Join in and help contribute to help others set up their own aquaponics systems.

Introduction

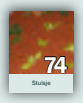
Ok, so you've downloaded, borrowed, been given or stolen this electronic manual from somewhere. Only joking, it's free. So pass it on, email it, send it to your friends, put it on your thumb drive and take it home to show others, do what you like with it. This is a free document, and yes you can pretty much pass it on to whoever you like. If you are involved with aquaponics at some sort of a commercial level and you'd like to share this document with people then please check our copyright details, we are happy for this to be distributed through forums, workshops, as parts of information packages etc, just so long as the document isn't changed in any way, and it's redistributed in its entirety giving full credits where credits due.

Now we have that stuff out of the way the first thing you really should do is check that it's the most up to date version available. Well, you don't have to, but perhaps this is just the first edition (actually it is), and perhaps there's a much later edition available with twice as much information, new pictures and all the latest bells and whistles. We will be adding to this document and releasing new editions as more and more people are building new systems incorporating IBC's into new designs of their aquaponic systems. You don't want just half the information available, and seeing it's free anyway, you may as well just Click Here, it will take you to our online discussion forum where you will find links to the latest version of this document.

While we are on the subject of the discussion forum.... The forum is where all of the pictures and information within this document has come from. Well it either comes from us directly here at Backyard Aquaponics, or it comes from the crazy, inventive, informative, generous members of the BYAP forum. If you've never been to the BYAP forum you can just Click Here, come and have a look, join up, it's free and there are lots of like minded members who can help you with questions about aquaponics and building different systems. Better to ask and learn from someone who has already made the mistakes before, so that you don't make the same ones, plus as you read through this document I'm sure you'll come to appreciate the wealth of information from the combined knowledge contained both in this document and also within the forum.

I should probably give you a little bit of information about some of the features within this document, it's not just a straight pdf, it's an interactive pdf, this means that there are a few added features to make this document both easier to read and navigate through, and also to make links outside the document a lot easier as well.

How to use & read this document

	Firstly there's an interactive menu on the contents page which will take you directly to a particular system later in the document, you may also find a few links within text like in the paragraphs above where we have some links directly to the forum where you will find the latest version of this document.
	At the bottom of each page you will see this icon, clicking on this icon will take you back to the contents page from where ever you are within the document.
	At the beginning of each system you will find this icon. Clicking on this icon will take you directly to the BYAP forum thread for that members system. If you like a particular system and want to read more about it, find the latest information about whether the system has been modified or changed, then by clicking and visiting the forum you will learn a lot more about that particular system.
	Just to make things even more interesting and useful for people, we have selected over 20 of the systems within this manual and we've constructed 3 dimensional Google Sketchup models of these systems. If you don't know what Google Sketchup is, it's a free 3D modeling design tool, you can download it. In no time you can start creating your own 3 dimensional aquaponic models to be sure they fit within the space you have available. So if you see this icon anywhere in the document, click on this, and it will take you to the Sketchup 3D warehouse website where you can view the model in further detail and download it to play around with it and make your own changes so that you can adapt systems to suit your own situation. Once you're at the 3D warehouse website you can scan through all of the 3D models we have created. If you are having any issues with how to use Google sketchup, there are some simple informative tutorials that will have you creating like a pro in no time. So if you see this icon within the document, why not give it a go.
	Click on this link to view the Youtube video of the system.

We expect that this manual will spread fairly widely among people who may or may not know about aquaponics. We have created a **Glossary** towards the end of the manual, so if you read a word or find an acronym you are unsure of, you can quickly click at the base of the page to return to the index, then click on glossary within the index, look up the words definition, then back to the index and back to the system you were reading.

There's also the issue of units within the manual. We wondered about whether we should use imperial units or both imperial and metric units of measure everywhere that length and volume are mentioned, but after a little thought it was decided that no we'd go with metric. The rest of you are just going to have to catch up with those of us in the world that have already switched to the only logical system, the metric system. Ok, that may be a fairly contentious statement. Although I was born and brought up with metric I still find myself using imperial measurements all the time, it's a lot easier to say and to think of "2 feet" rather than "60 centimetres". Still the decision was made, so to those of you still using imperial measurements my apologies, however we have provided a conversion table towards the back of the manual. Once again, it's a simple case of a few clicks, back to the index, check to the conversion table, back to the index, back to the page you were reading.

The adverts within the documents are all for Backyard Aquaponics products and services, they are all interactive and will link you to our websites where you can purchase our goods and services, as well as learn more about aquaponics in general. Yes that's right, interactive adverts I'm afraid. But take a little look at the information contained within this document, we have put an enormous amount of time, effort and money into producing this 100% free information package to help people get into aquaponics as cheaply as possible. If we manage to make some sales of products through links within this document then it will encourage us to produce more of these free informational products, a win-win situation for everyone.

We have also started working on a similar document to this one which is based on aquaponic systems built predominantly from plastic barrels. Once again another recycled material that people have been using to great effect in making aquaponic systems.

We hope that you enjoy using this manual, we hope that it's useful and helps people build their own aquaponic systems or at least motivates someone with ideas and possibilities. Hey, if it stimulated your grey matter in any way then at least it's done some good. If it encourages you to use some recycled materials you can find around your local area to build an aquaponic system and start growing your own fresh fish and vegetables in your own backyard then it's succeeded beyond my wildest dreams.

As a last reminder before diving in, please if this is useful to you, go and join the Backyard Aquaponics forum and help contribute or ask questions, it's through having a wide and diverse mix of ideas and cultures that the forum has become a community able to help thousands of people over the years.

Contents

where would you like to go?

What is Aquaponics?

Aquaponics is essentially the combination of Aquaculture and Hydroponics. Both aquaculture and hydroponics have some down sides, hydroponics requires expensive nutrients to feed the plants, and also requires periodic flushing of the systems which can lead to waste disposal issues.

Re-circulating aquaculture needs to have excess nutrients removed from the system, normally this means that a percentage of the water is removed, generally on a daily basis. This nutrient rich water then needs to be disposed of and replaced with clean fresh water.

While re-circulating aquaculture and hydroponics are both very efficient methods of producing fish and vegetables, when we look at combining the two, these negative aspects are turned into positives. The positive aspects of both aquaculture and hydroponics are retained and the negative aspects no longer exist.

Aquaponics can be as simple or as complex as you'd like to make it, the simple system pictured above is made from one IBC (Intermediate Bulk Container). The top was cut off and turned upside down to become a growbed for the plants.

Water is pumped up from the fish tank into the growbed. The water trickles down through the media, past the roots of the plants before draining back into the fish tank. The plants extract the water and nutrients they need to grow, cleaning the water for the fish. There are bacteria that live on the surface of the growbed media. These bacteria convert ammonia wastes from the fish into nitrates that can be used by the plants. TThe conversion of ammonia into nitrates is often termed "the nitrogen cycle". This will be dealt with in more detail in the next chapter.

Growbeds filled with a media such as gravel or expanded clay pebbles are a common method of growing plants in an aquaponic system, but there are many different methods that can be used. In fact any method of hydroponic growing can be adapted to aquaponics. Plants can be grown in floating foam rafts that sit on the water surface.

Vegetables can also be grown using NFT (Nutrient Film Technique), or through

"research has shown that an aquaponic system uses about 1/10th of the water used to grow vegetables in the ground."

various other methods using a “run to waste” style of growing. This is done by removing a percentage of the fish water each day and watering vegetables planted in different media such as coir peat, vermiculite, perlite etc.

Many different species of fish can be grown in an aquaponic system, and your species selection will depend on a number of factors including your local government regulations.

Quite high stocking densities of fish can be grown in an aquaponic system, and because of the recirculating nature of the systems very little water is used. Research has shown that an aquaponic system uses about 1/10th of the water used to grow vegetables in the ground.

An aquaponic system can be incredibly productive. I’ve produced 50kg of fish, and hundreds of kilograms of vegetables within 6 months in an area about the size of your average carport, 8m x 4m. This is a system that requires no bending, no weeding, no fertilizers, and only uses about the same power it takes to run a couple of light globes. ●

Guide to aquaponics

Running of the system

There are a few common methods of running a media bed aquaponic system. You can flood and drain it by using a timer on the pump to switch the pump off and on, and a standpipe in the grow bed. You can flood and drain it using an auto siphon within the growbed and running your pump continuously. You can also run the system with a continuously flooded grow bed using a standpipe in the bed.

We have been running some trials of these three different methods here at Backyard Aquaponics and you can follow the results on our forum if you'd like to compare the different systems. **Click here to visit forum**

At the time of writing this our trials have been running for over 6 months and in reality there's been little difference at the end of the day between the three different systems. There were some differences in the early period but after 6 months there really is very little difference between them. This being the case I would recommend running your IBC system continuously flooded as we have set up our IBC system in this manual.

There are possibly a few other advantages to running your system as a constantly flooded system depending on your system design. In a CHIFT PIST style of system your sump tank doesn't need to be as big as it has to be if you are flooding and draining. When you flood and drain by either timed pumping cycles or using autosiphons, you must have enough sump volume to hold large amounts of water. There will be times when the growbeds are flooded and then times when they have all drained into the sump tank all at once.

When designing and building a flood and drain CHIFT PIST system, the general rule of thumb is that your sump should be about the same volume as your growbeds. If you are running a CHIFT PIST system constantly flooded your sump tank can be much smaller, because there won't be such large fluctuations of water volumes.

Startling a system

If you ask 10 people how to start an aquaponic system you'll get about 9 or perhaps 10 different answers, with each person insisting that their method is best. The idea is that you need to get a system 'cycled' which means establishing your beneficial bacteria populations within the system so that they can they can convert the ammonia wastes into nitrates so the plants can use them. Anyway, there are a number of different ways you can get your system started. It's always good if you can 'seed' your system from an existing system or from someone who has an aquarium or pond. Aquarium filters will be filled with the beneficial bacteria you want growing in your aquaponics system, so will pond filters or even just the pond or aquarium water. So if you can collect some of this, it will help your system to establish even quicker. If you can't find any, or don't know anyone you can source some bacteria from, don't worry, they will establish themselves naturally, it will just take a little longer.

You may want to get yourself a test kit so that you can follow the cycling of your system, especially when using fishless methods requiring addition of different sources of ammonia. A test kit which tests pH, ammonia, nitrite and nitrate is best.

Methods of Cycling

Peeponics.
Yes, it is as it sounds, some people get their system started and cycled by adding urine to the system. Urine contains urea and urea breaks down to ammonia, once you have ammonia this can be a useful source of food for beneficial bacteria populations. It's a good idea to age your urine for a few days to a week in an open well ventilated area before adding it to the system, but not totally necessary, you can just add straight from the source if you wish. If you are taking any type of medication it's not recommended that you try this method.

Urea Fertilizers
Another method to add an ammonia source to help establish the beneficial bacteria is to use Urea fertilizer, generally available from agricultural suppliers, hardware stores and nurseries. This is a fairly straightforward method of cycling a system, however you must be careful of your dosing, regular water testing is recommended.

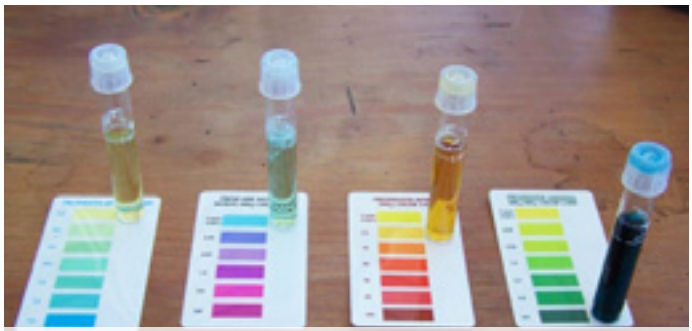
Ammonia
Household ammonia can be sourced from many different places. As with urea, care is required to ensure you don't overdose the system. Also when sourcing your ammonia make sure that you only use food grade ammonia, there are plenty of cleaning and industrial ammonia sources but they often have perfumes and other additives.

The dead prawn or fish
Yep a method of cycling practiced a fair bit within some aquarium circles over the years. By placing some rotting fish or crustacean in the system you are inducing a source of ammonia for the bacteria to feed on.

Fish feed
You can start cycling a system by introducing the fish feed you will be using to feed the fish into the system, as the feed starts to break down on the bottom of the fish tank and in the growbeds it will release ammonia for the bacteria to feed on.

Feeder fish and/or fingerling
Possibly the simplest method of starting a system and the method we recommend so long as you follow a few simple golden rules. Your system can be cycled by adding feeder fish, usually cheap bronze comets or goldfish to start the system before adding your final fish species. You can also stock the system with fingerling of whatever type of fish you plan on growing in the system and this is the way we start our systems and the method we recommend people start theirs.

But feeding the fish must be kept to a strict minimum for the first 2 months. No more than one tablespoon of feed, per day, per 500L of media. If you get an algal bloom, stop feeding until the algae clears. 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.



Freshwater master test kit

Locating your system

There are a few things you may want to keep in mind when it comes to locating your system. For some this may not be an issue, you might only have one place it can go. But, if you have some choices as to location, one of the first things to consider is sunlight. You need at least 4-6 hours of good sunlight a day for your plants to grow well, however, your fish do not need sunlight, and in fact you're better off not having any sun on your fish tank at all if possible. Sun on your fish tank leads to algae growing. If you can't help but have your fish tank in the direct sun, you might like to think about having some floating plants on the surface of your fish tank. Floating plants in your fish tank offer shelter and hiding places for your fish and fish are far happier when they feel protected.

The water's surface can be a food production area as well as a good place to grow invasive plants like mint and water cress which will take over your media filled growbeds if you plant them in there.

Growing Media

There are many different types of growing media you can use in your aquaponic system, though there are a couple of things to watch out for. Firstly there's the rock or particle size, we prefer to use a media that is between 8mm and 16mm, there are some disadvantages if you go very far out of this range. If the media is a lot smaller then there's not a much air space between the media when it's in your bed. If the media is a lot larger, your surface area is markedly reduced, plus planting becomes a lot harder. Your choices are to go for a hydroponic expanded clay or alternatively you can use a local crushed rock media. You want to be a little careful with the rock you choose as some can have high levels of limestone and other high pH minerals within them which can lead to nutrient lock out.

Some people have found that their local crushed rock or gravel media can have a high ph level. High pH can be a bit of a problem in an aquaponic system so if you are unsure, a quick way to check any rock you are thinking of using is to do the vinegar test. Get a handful of the media you want to use, drop it into a jug of normal household vinegar, if the rocks appear to be visibly bubbling, releasing bubbles from the rock, then chances are it has a high pH and best if you can look at an alternative.

Rock media or gravel is also very heavy so you need to plan to have enough support for it when building your growbeds and their stands and supports. The advantages of rock media is that it's readily available and usually very cheap.

Expanded clay is extremely light, pH neutral, comes in handy bags, it's easy to plant in, easy to clean and sterile. However it's downside, usually very expensive. You will need to weigh up the pros and cons yourself, if you want quick and money is

Locating your system

Access to power. You will need to pump water and possibly have an air pump as well, these need power to run so you need to be able to run your power lead to a power point.

Access for planting, harvesting and maintenance. I've seen many systems that people have set up where there's been little to no allowance for access to the whole system. Keep in mind that although you may think you can get to most of it, once your growbeds are full of plants, getting to that back corner of the growbed might not be as easy as it was when everything was new and empty. Also plants hang out over the edge of the growbeds, we normally allow at least 70cm between growbeds. Even this isn't enough sometimes when plants are growing really well. Access to the fish tank is also important. I've seen many system built from IBC's where there is only a very small access point into the fish tank, not really big enough for a fish net to catch your fish.

Seasonal differences. If you are building your system in summer, there's a good chance the sun will actually track a different course in the sky come winter time. What may have been good sunshine during the summer could perhaps be no sunlight at all during winter, and vice versa.

Surrounding vegetation. It's not great to have a system directly under a deciduous plant of any type, or any plant with heavy blossom drop. I've known of plants contamination from some shrubs and trees which has caused fish deaths. This can sometimes be one of the harder fish death causes to pin point as it may only take a few leaves or flower of a plant to affect fish if the plant happens to be highly toxic. Fish deaths from this is not a regular problem we hear of, but keeping the tank and growbeds clean can be difficult with large quantities of leaves or flowers dropping from above.

Pets and Children. You may have one or you may have both; you need to be sure when planning and constructing your system, that your system is child friendly and pet friendly.

Different types of growing media

not the most limiting factor, then expanded clay is the go, if you are more concerned about cost and you're willing to spend a lot more time on constructing stronger supports and moving and cleaning your media, then go for the rock.

Some people like to take the middle road, you can fill the bottom of your bed with gravel/rock then fill the top half with expanded clay, this cuts the costs significantly, also cuts the weight, and makes sure that you have a nice media for planting and harvesting in.

Plants

In any and all of the above methods of cycling a system we recommend that people plant their beds as quickly as possible with plants. Personally I like to use a combination of seedlings and seeds. You can sprinkle seeds over the top of your growbed media then plant seedlings throughout the bed. As you are digging in the seedlings to plant them, the assorted seeds will get buried in the media and before long they will germinate and fill your growbed.

When planting seedlings we strongly recommend washing the soil or potting mix off the roots of the seedling before planting. I know some people don't do this, but it's adding unnecessary contaminants to your system in the form of organic matter, sand and slow release fertilizers. You can very simply get a bucket and put a couple of inches of water in the bottom of it, you may also like to add some seaweed extract to this or worm juice, these will aid the new seedlings in establishing well.

Now simply remove the seedling from the punnet, swish it in the water and the soil should easily wash off the roots. You don't have to be too careful to get it all off, just the majority of the soil.

When planting in your growbeds, plant everything very densely, you can plant things a lot closer together than you would in the soil because these plants with have as much water as they can want. Try and make use of areas where plant growth can expand and extend, if your system is located near a shed or wall or fence, erect something for the plants to grow up, and plant climbers like beans peas, tomatoes, cucumbers etc so that they can grow up things. Other plants you may want to let ramble, you can plant a pumpkin in one corner of your growbed, then let it spill over the side and ramble over things. Vacant unproductive land with poor or no soil is fine because the pumpkin plant gets all of its nutrient and water from the system, yet collects sunshine from where ever its long tendrils grow.

Seeds and seedlings

What plants can I grow in my system?

I know people who have grown just about everything, from trees through to potatoes. You can pretty much grow anything, though a few things to keep in mind when deciding what you will plant. Firstly, you want to grow things that you will eat, there's not much sense in growing lots of cabbages if you don't really like them or eat them. You also want to be sure that you always have things growing in your system. Say perhaps you only have a simple system made from the one IBC like our sample system in this manual, one growbed above the IBC fish tank. You never want to pull out all of the plants at once, otherwise there is nothing left to extract the nutrients from the system. It's always best if you can have a broad mix in the system at any one time, mature plants, half grown plants and seedlings all at once, that way you are able to cycle through plants, removing the mature ones and planting new ones to replace them, while leaving many plants in there using up the nutrient.

Fish Stocking

Every system is different and peoples environmental conditions can vary quite a lot, but there's has to be some guidelines as to what will work well for the majority of people.

We recommend stocking around 20-25 fish for every 500L of growbed media in your system, this is assuming you have growbeds that are around 25-30cm deep. Ultimately the amount of fish you can safely keep in your system depends on many factors, feed rates, water flows, oxygen levels, number of plants, pumping rates, fish species and water temperature, to name a few of the major factors.

So let's say perhaps that you are looking at making a very simple system like the example system we have built in this manual, made from the one IBC cut into two pieces to make the growbed and fish tank. This growbed has 250L of media in it, perfect for around 10-12 fish. This is allowing for them to grow from fingerling up to a plate size of around 400-500g. If you double the growbed by adding another one the same, then you can pretty much double the amount of fish you have to 20-25 fish in the system.

We've found with experimenting that you can grow a lot of plants with only a fairly lightly stocked system, and a lightly stocked system is more resilient if things happen to go wrong.

Getting my fish home.

You should speak to your fish supplier first, fish transporting can often depend on the size of the fish and the distance you are travelling with them, or the amount of time they will be spending in transport. Often suppliers will bag small fingerlings in clear plastic bags with oxygen added to the bag, this can allow them to be transported for long periods of time with only a slight chance of losses. Sometimes you may be required to take an esky or similar to the fish supplier, this is good so long as you take along a battery aerator with you to supply them with air for the trip.

Feeding the fish

We recommend that you use a quality aquaculture pellet to feed your fish, you can supplement this with alternate feeds like worms, maggots, black soldier fly larvae and plenty of other different types of alternative feed, however it's always good to have the basis of a pellet feed there as an essential component of the fish diet. People often ask about keeping a system completely closed loop, producing all the feed you

need within the system and from system rubbish and scraps. This works to a minor extent, however you must have external input into the system if you are removing nutrient from the system in the form of food to eat.

Backup

Having a backup system is very handy, bordering on essential. If and when the power goes out, you want to be sure that your fish are not going to die. A well stocked system filled with fish will not last long as they consume the available dissolved oxygen within the water, so you need a way to get oxygen into the water that doesn't rely on mains power. There are a few ways you can go about this, you can keep battery operated aerators or a generator handy for when the power goes out so that you can implement your contingency plan when things go wrong. But, generally as Murphy's law would have it, if the power is going to go out, it will be when you are not home, so

AC/DC airpump

you will be unable to react to the power failure.

This means you will need to have your backup system already thought out before hand, and it will need to be automatic. There are a couple of simple ways you can do this. We like to use AC/DC aerators, these are air pumps with internal rechargeable batteries in them. Normally they run while plugged into the power, pumping air through air lines and air stones in the fish tank. When the power goes out they switch automatically over to their internal batteries and continue to pump air into the water keeping the fish alive for the life of the battery within the unit, often up to 10 hours. When the power comes back on, the internal battery is recharged.

Another method used by some is to make their own back up using either water pumps or air pumps, using batteries, something like a car battery, an inverter, a trickle battery charger and a power fail switch. Essentially this does the same thing as the AC/DC air pump above, but it's larger and in an individual components form. This type of system can be chopped and changed, you can leave out the inverter and use 12/24V DC components if they are readily available. There's a lot more information about backup systems on the Backyard Aquaponics forum.

Monitoring the system

It's good if you can keep a daily check on your system most of the time, a very quick visual check that the water level in the fish tank looks right, the fish are acting as they normally do, and the plants look healthy and happy will be enough. As you become used to your system, you can tell quite a bit from a quick look at the system, fish behaviour can change markedly when there are issues and it's worth doing a little more research into unusual fish behaviour to watch out for. A typical example of this is when fish are "flashing". Flashing is when fish rub their sides of their bodies on the base of your tank, this is generally because they are trying to dislodge something, often it's can be a parasitic problem and one of the most typical causes of flashing can be Ich, a quick search for Ich on the BYAP forum will help you with further information on this.

Some people like to test their water regularly, this is a good idea however you must be careful not to over react to readings. Most people who have trouble with their systems tend to be having troubles because they are often over reacting to test results. Extreme changes to a system can cause a lot of stress to the fish. For example, if you have a low pH, don't react quickly by adding lime or other alkaline buffering agents. Firstly before adjusting anything you might want to be sure of your other levels in the water, high ammonia levels are not as toxic to fish when the pH is low and the temperature is low. So if you raise your pH you may be putting your fish at risk of toxic ammonia levels.
CLICK HERE TO SEE AMMONIA CHART

Over time and dealing with many beginners in aquaponics, here at BYAP we have found a minimalist approach works best for the majority of people in the majority of situations. Next

General safety around your aquaponic system

Power supplies. Ensure that power safety is a priority at all times. Any pond pump you are using must have its power supply protected by an RCD for safety. Whenever dipping hands into the water that contains the pump, you should turn the pump off at the power supply first. Keep all leads well protected and out of the way of general access. Keep any electrical items like air pumps out of rain and away from water, never have an air pump sitting above your fish tank where it may get knocked into the water.

Water risk. Be sure to have any open water protected in some way so that small children and pets cannot get into the water. Generally IBC's are easy to protect because the IBC tank is square so it can be as simple as some heavy mesh covering your fish tank.

Fill up water supply. It's a great idea to have a timer on the tap where you fill your system, there have been many stories on the forum of people putting the hose in the tank and turning on the tap to top up the system, then forgetting about it. Often this can lead to fish deaths because of the extremely low oxygen levels in the water from the tap, very large amounts of chlorinated tap water can also lead to killing off the bacteria populations which have built up in your growbeds. Tap timers are cheap and readily available and they can save a lot of heart ache.

Keep things safe. If you have a test kit, keep it up out of the way, this also goes for any other associated things including fish feed, keep it locked up, vermin and child safe. Not just because of the safety of the children, I've heard of some people that have lost their fish though small children tipping all the fish feed into the system. Just helping of course, but if you don't spot it straight away it can lead to trouble.

we will deal with some of the most common problems people may come across and how we recommend you deal with these problems if they arise for you.

Dealing with pests and diseases

There are a few different methods of dealing with any pests and/or diseases in your system, of course most of these require no petrochemical based sprays as these are generally very toxic to fish and also possibly the beneficial bacteria within the system. Caterpillars are easily controlled by applications of Bacillus thuringiensis, this is a natural soil borne bacteria which is available around the world under a number of different brand names. Often organically certified the spray is safe for aquaponic systems. For sap sucking insects you can use chilli and garlic sprays, these are often available commercially now a days, however they should always be used in moderation, as excess and overspray is never good. For moulds and fungus on plants you can use potassium bicarbonate sprayed onto the effected plants. Potassium bicarbonate is available under a number of different brand names around the world. It also can help a system by adding potassium, something often lacking in a system and the bicarbonate helps to keep the pH up, as most of the time pH goes down in mature systems. If slugs are a problem, a small saucer filled with beer will attract them and they easily drown, making disposal simple and effective. Coloured sticky traps work well for thrips, aphids and whiteflies and are a good way to monitor visitors to your aquaponic system.

Dealing with deficiencies

We have found that generally supplementing for plant deficiencies is not necessary when using good quality aquaculture feeds, our systems here at our display centre rarely receive any supplements, perhaps once or twice a year we might dose our systems with seaweed extract if we see some deficiencies. Deficiencies can be difficult to diagnose, thankfully there are a number of sites online which can help you diagnose particular deficiencies with images. One of the simplest ways to deal with any deficiencies is by the addition of seaweed extract. Seaweed extract is available under a number of different brand names around the world and seaweed has very high levels of a lot of micronutrients and minerals. Some other things you may want to add if the relevant deficiencies are showing in your plant growth. Chelated Iron, readily available in powdered and liquid form. Potassium bicarbonate for potassium deficiencies, so long as your pH is not high already. Be sure your pH is not high before you try and add elements to fix a micronutrient problem,

Slugs can't resist beer

IBCs an introduction

The humble IBC, disposable industrial packaging that's become the cornerstone of many aquaponic system designs, they are a multipurpose, recycled, cheap, modular way to build an aquaponic system.

An aquaponic system can easily be built in an afternoon with an IBC, a pump, a handful of fittings and a couple of regular power tools. IBC's along with blue 200L plastic barrels have enabled thousands of aquaponic systems to be built where normally people may not have the resources or the means to build a system any other way.

IBC aquaponic systems have even proven themselves to be a marketable product, with many different complete aquaponic systems available for sale through classifieds.

No matter how you look at it, they have a crucial role to play within aquaponics, the aquaponics community and the growth of aquaponics worldwide.

What makes them so special? The ability to use them in such a variety of ways, and their self supporting outer stand. One IBC can be cut and turned into one aquaponic system, or alternately, multiple IBC's can be plumbed together and incorporated into extremely large systems..

What is an IBC or tote.

IBC or Intermediate Bulk Container, also often termed as an IBC tote, is a large industrial container used to carry, store and transport liquid products. They range in sizes from 500 litres – 1200 litres, though other sizes can also be found they are not as common. Without a doubt the most commonly available IBC is 1000L litre. These 1000L IBC's are generally around 1.0m x 1.2m x 1.2m tall, this cubic shape makes it ideal for efficient transporting of bulk liquids.

The basic construction of an IBC consists of a steel, plastic or wooden base that includes 4 way forklift lifting points for ease of moving around. This base provides a sturdy foundation to support an outside cage made from steel. The outer steel cage is generally constructed from either a reasonably thin gauge almost steel mesh cage, through to a welded tubular steel grid, welded tubular grids are probably the most commonly found IBC construction types. These cages are welded as one solid piece, then screwed onto the base at a number of points. The thin plastic liner is then slid down into the into the cage, then generally two tubular bars are bolted across the top to hold down the inner plastic container.

Because of the strength offered by the outer welded frame and solid base the inner plastic vessel that actually holds the liquids is only quite thin. Screw attachments on the base and butterfly valves are common attachments and can come in a range of size, D50, D80, D150 depending on manufacturer. The top contains a large screw cap. generally between 6 inches and 12 inches across, these lids contain an inner 2 inch NPT threaded bung.

IBC's not only vary in size but they also vary in colour, most of the inner plastic containers are white, however you can find blue or black ones.

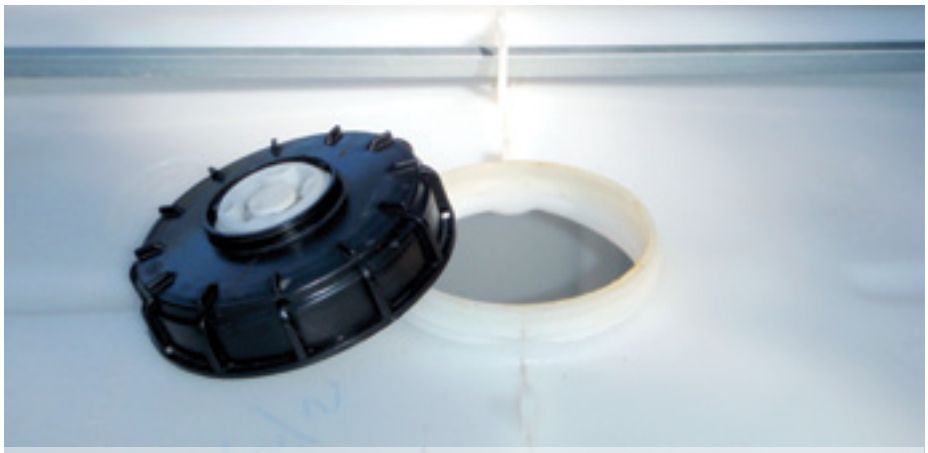
IBC's are reasonably cheap to buy, even new here in Australia you can buy brand new containers for about $350 + GST, quite reasonable considering that many other containers that might be used in aquaponics systems of a similar size usually cost a lot more. Then of course they are readily available second hand through drum recyclers, salvage shops, through classifieds, by knowing the right people, or if you're lucky it can be as simple as driving past an industrial area where companies might put them out with "for sale" signs on them.

Second hand IBC's generally come in a couple of different ways, "single use" are often a little more expensive, $100-$150 each. These containers have been used once to transport a liquid from one place to another, and then discarded. Usually these are in very good physical condition because they've had such little use. Then there's "used" IBC's, these may have been used many times over by numerous companies over time.

Using an IBC

It's highly preferable to know the history of your IBC when buying for your aquaponic system, this is for a two fold

IBC distributed by SCHÜTZ DSL Group Pty Ltd



Screw Cap

Philips screw

Advantages

Cheap
Readily available worldwide
Extensive design possibilities
Stackable
Modular

Disadvantages

Square
Most not UV stabilized
Not designed for a long life
Very industrial looking
Thin plastic

reason. Firstly, fish are sensitive creatures and there are many liquid products that can leave residues, residues that might be harmful to your fish. Secondly, there may be residues that could be harmful to yourself or your family, so it pays to know what's been in your IBC, or in knowing that it's been professionally or properly cleaned.

Often IBC's will contain information on the name plate on the side of the cage, from this information you can use the internet to find out about the substance that's been stored in the IBC. Generally if you type in the name of the product and "MSDS" you should get a "Material Safety Data Sheet" on the product, this will let you know if it is dangerous. This should also help you understand the best way approaching cleaning the IBC.

It's almost impossible to know the complete history of these containers and what liquids they may have stored over that time. Used IBC's may often have physical damage especially to the bases, they can sometimes have corrosion and missing taps or lids. They are usually reasonably cheap costing between $50 and $120 depending on their quality. Lastly refurbished IBC's are often available through drum recyclers. These IBC's are cleaned and pressure tested and often have had maintenance or repairs made as required.

One of the best ways to find used IBC's it to keep your eyes open around industrial area or in your local paper, often businesses consider them to be a waste product, just packaging to be discarded after they are finished with their contents. Ask friends, you might be surprised at the various industries that use IBC's as part of their day to day operations.

Another advantage of the IBC is their stacking ability and the fact that they are very modular and their square form saves space when space is at a premium. On the downside square tanks are not the optimum shape for higher stocking levels of fish.

Washing an IBC

Often if you've bought your IBC in used condition then you will need to give it a good wash. A handy point to remember if you are going to cut your IBC, is to cut it first so that you can clean it more easily. Because there's such a small opening in the top cleaning can be quite difficult while it's still whole. Best if you can at least remove the inner plastic container from the frame, this is an easy thing to do as most IBC's have only two bars across the top, these are easily removed, then the inner plastic can be slid out.

Washing your IBC can often be a two step process depending on how dirty it is. I highly recommend initial rinsing to remove any larger amounts of material before washing out with a dilute mix of bleach and water. Then a further rinsing before leaving the IBC in the sun for a couple of days. UV

helps to break down residues and remove any lingering odours that may remain.

Check the BYAP forum for further ideas of cleaning methods relating to different types of contents.

Cutting an IBC

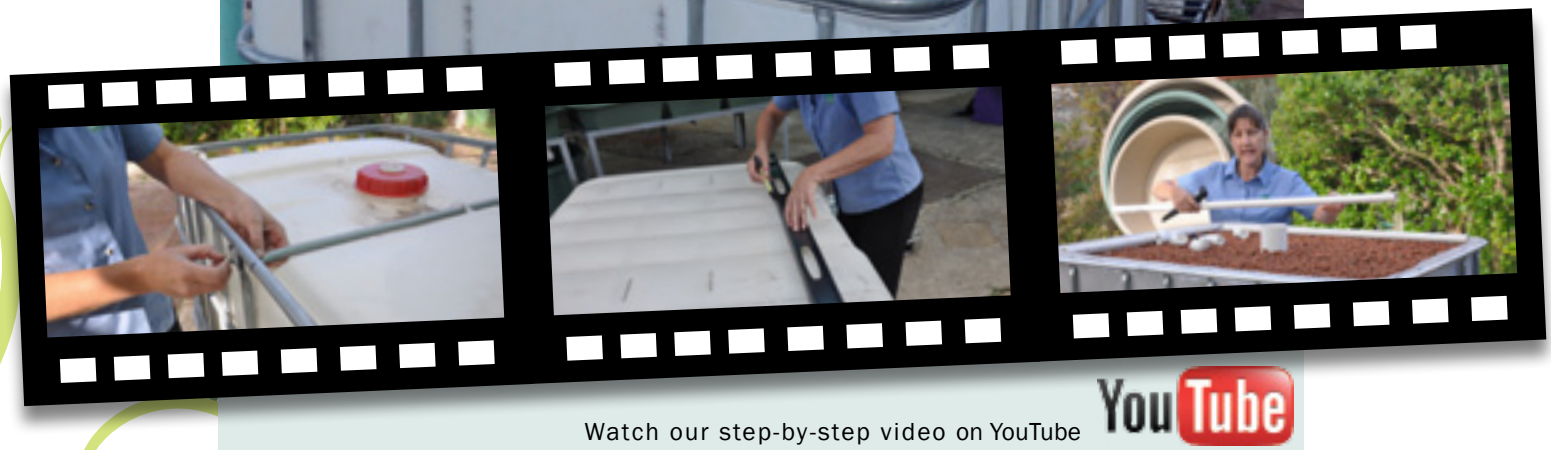
Without a doubt the simplest means of cutting an IBC is by using power tools. Possibly the best way of cutting the outer metal cage is with an angle grinder, if you don't have an angle grinder a sabre saw with metal cutting blade will also do a great job. Be sure to use all personal protective equipment when using power tools. The inner plastic liner can be cut with almost anything including a manual handsaw. I've found hand held circular saws and jigsaws to be the most useful for this job. Be sure to mark where you want to cut before hand with a marking pen.

Plumbing an IBC

Ultimately it's great to be able to use the existing external fitting that all IBC's generally have on the base. This is not always feasible depending on your design and on what the purpose is that you have for the IBC or part there of. When plumbing through the side of the IBC plastic wall, it is advisable to use a tank fitting. Tank fittings ensure that there is a large surface area clamping onto the plastic, so this is by far the safest means of plumbing through. There are other ways people use to plumb through a system that work quite well. This method works sufficiently well for many people, but personally I prefer the added safety of a larger flange, just in case, the few extra dollars is worth the peace of mind.

Tap Fitting

Building an IBC system



Watch our step-by-step video on YouTube

The following pages contain step by step instruction for building a simple aquaponic system made from a single IBC. The basic idea of this system is to cut a section off the IBC and to use this for a growbed, while the other larger section becomes the fish tank. Fairly simple and straight forward, but with a twist here and there...

What you'll need to build the IBC system

WATCH the Video

YouTube

Parts

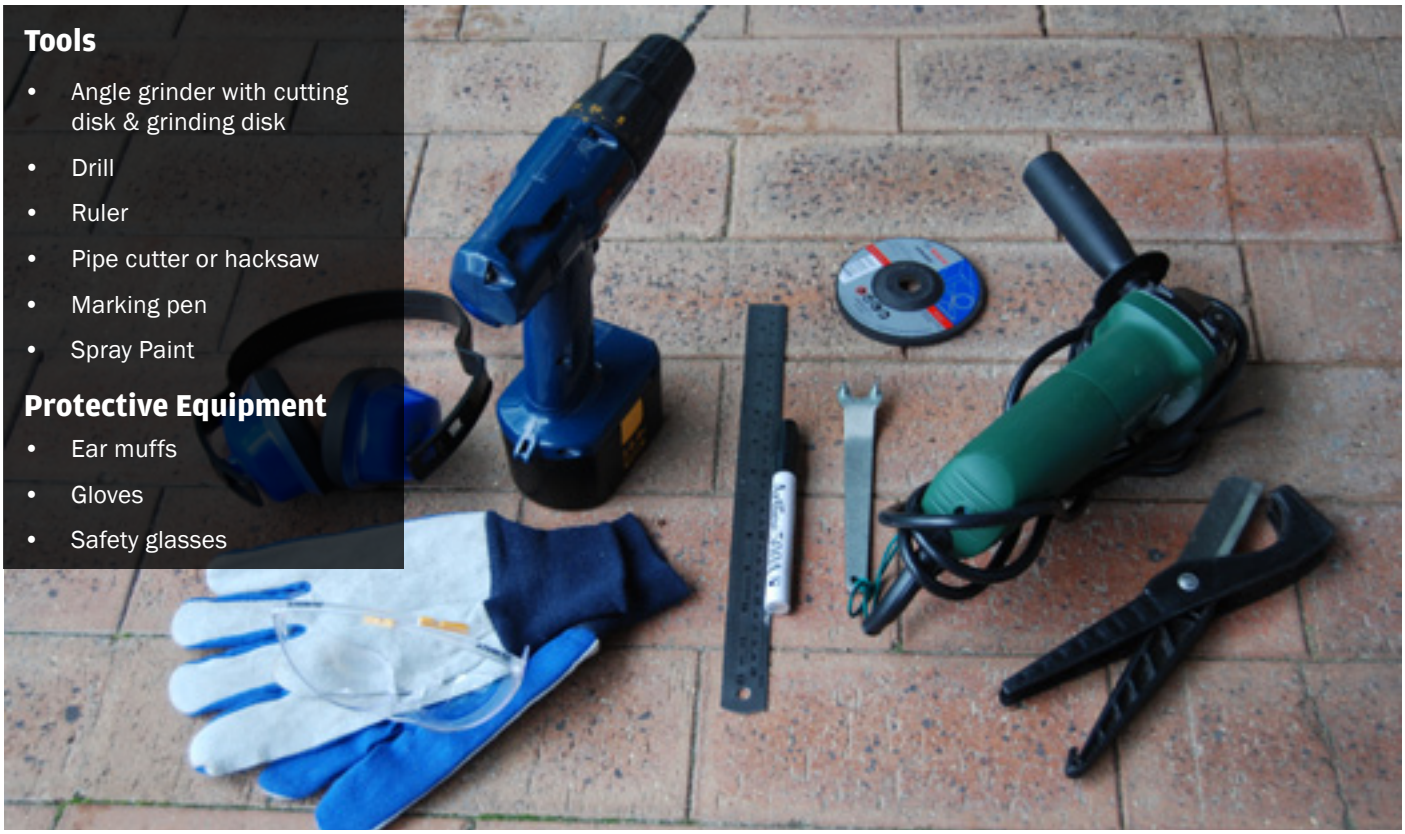
- Pump
- 1.5m flexible pipe
- barbed threaded elbow
- threaded 25mm T piece
- 4 x 25mm elbows
- 4.5m of 25mm pipe
- 20cm of 40mm pipe
- 40-25mm reducing coupling
- 50mm valve socket
- 30cm piece of 90 storm pipe
- 200L of media

Tools

- Angle grinder with cutting disk & grinding disk
- Drill
- Ruler
- Pipe cutter or hacksaw
- Marking pen
- Spray Paint

Protective Equipment

- Ear muffs
- Gloves
- Safety glasses



How to build the IBC system

This is a simple step by step guide to building an aquaponic system using an IBC. There are about as many different ways this can be done as there are different types of bread. Everyone seems to have their own preference as to how they build their system, this is how we built ours. It's not necessarily the best way depending on your requirements, but this was a way to build a system very simply, using the IBC as best as we could and a minimum of tools. The only tools you will need are a grinder and a drill. Thats right, just a grinder and a cordless drill and you can build your own aquaponic system, you don't need any fancy tools, this is about simplicity.

The beginning

To begin with you should be sure your IBC has been thoroughly drained and had an initial rinse. Have you checked what was in the IBC before hand? Have you looked up the contents MSDS (Material Safety Data Sheet) to ensure that the previous contents aren't going to cause your fish or yourself any issues? This is extremely important, some IBC's may have had contents which make them unusable. The IBC we are using used to contain clean new heavy motor oil. Not the nicest of substances but at least we know that it will be reasonably straight forward to clean and the contents weren't toxic.

One other aspect to this, there are many different IBC's made by different manufacturers and not all of them are the same. Some have wire mesh cages, some have wooden or plastic pallet bases they are many and varied, however this IBC we are using is one of the most commonly found IBC's a fairly standard design, the one we used is made by Schuts, one of the biggest worldwide manufacturers of IBC's.

First step to making your system is to remove the top two bars which hold down the inner liner. These generally require an unusual star shaped driver called a Torx head. Not everyone has these available as part of their standard tool set, however a flat head screwdriver can fit into it, you just need to have the right size which should be reasonably easy.

Remove the two top bars holding the liner in the frame

Working on the liner

Once you have unscrewed the two top supports and removed them, you can now remove the inner liner from the outer frame. It's time to cut the frame to size for the growbed.

For this system we are going to use the base of the IBC frame as the growbed support, here we will be cutting the frame off just above the first horizontal support. Be sure to use a thin cut off disk on your grinder for this, also be sure that you have all of your personal protective gear on when using power tools like grinders, accidents happen when you least expect them.

Be sure to cut these all at the same level, just above the horizontal as the top section of frame will ultimately become the fish tank surround and the stand which the growbed sits on. Once you have cut off the bottom section of frame you may want to clean up the edges of the cuts, you can either do this with a file, or you can swap your cutting disk to a grinding disk and take off any sharp bits with your grinder.

Remove the liner from the frame

Cut the frame at the required height for your growbed

Now you may want to cut the IBC into the fish tank and the growbed sections. For this you will need to mark out where your cut will be first. With this system we will be using the top of the liner as the growbed. We will be making the growbed about an inch taller than the growbed frame, this makes it around 23cm deep, anywhere between 20 and 30cn will give you a nice growbed which will grow most plants. Our life was made easy by the fact that there is a mark on the IBC liner from the frame, at exactly the point where we want to cut. If you don't have any mark on your IBC, then you can measure up from the base to where you want the top of your growbed. Probably the easiest way to do this is to put the IBC liner top down into the frame, as it will be ultimately set up. Then you can see how high you want your bed to be, this is where we recommend about an inch above the horizontal frame support.

Use a straight edge to mark out your cut off point, once marked, use your angle grinder to carefully cut the top growbed section off the liner. Be sure to use a thin cutting blade for this.

Now we want to cut the hole in the base of the IBC frame for the growbed drain. Remove the 50mm central plug from the lid of the IBC, place the growbed liner into the frame, now use a pen to mark the cot out hole that is needed in the base. Using the grinder with cutting disk again, cut out a large square that will allow enough space for a 50mm fitting to poke through the hole, you may need to begin by cutting from the top, and then turn the base over to cut from the other side. When you think you have a large enough hole cut in the base, screw your 50mm fitting into the lid, turn the bed upside down and drop it into frame to be sure it fits through your new hole.

Once the IBC liner has been cut, you can now give it a good clean easily because you can access the whole inside surface, since ours contained oil we needed to give it a good wash out with a strong detergent and hot water. We ended up giving it 2 good washes with detergent to remove all the oil residue, after the second rinse it was nice and clean.

Cut the hole in the steel base large enough for the drain fittings

Cleaning the IBC sections is easier once you have cut it open

Place the growbed frame on top and insert the growbed

Now we place what was the upper section of IBC frame on the ground in the place where we want the system to be finally located. We then used two pieces of wood 30 x 50 timber from an old timber pallet to provide supports for the growbed frame. You can use a variety of different timbers for this purpose depending on what you have locally available in your area. You could just place the growbed onto the top of the metal frame, but by using timbers we are able to push the growbed back a bit further to allow for more access into the fish tank.

Once your timbers are in position, place the growbed on top as you can see in our photographs Notice that the growbed has been twisted sideways 90 degrees, this also helps provide more access to the fish tank.

So now your growbed is on top of the fish tank, you will need a standpipe surround, we use 90mm storm water pipe with many 6mm holes drilled in it, this keeps the media away from the stand pipe and drain, and allows an access point for you to check the drain is free of plant roots. The 90mm pipe section sits nicely in the red cap of the IBC.

Once you sit your stand pipe surround in the cap you can now fill the bed with media. We are using expanded clay for our media because it's simple and light. Pour your bags of expanded clay media into the growbed, be careful that the standpipe surround sits still as you pour the bags in, now you need to wash the red dust out of the media.

Making the standpipe which controls the water level in the growbed

Fill the growbed with media

You can attach a hose to the 50mm fitting in the base of your growbed so that the dirty water is run off into a garden, or alternatively you can just open the tap in the bottom of your fish tank and let the water run away. Hose down the media in your growbed for about 5-10 minutes, until the water starts to run fairly clear. Once the water is running clear you can stop washing the clay and fill up your fish tank.

Now we just need to install the pump and pipe work then the system is done. First let's look at installing a standpipe, a standpipe like this will allow you to run the system in a couple of ways, you can run it as a constantly flooded system, using the stand pipe to set the height of the flooding water in the growbed. Or alternatively you can use a timer on the pump to make your flood and drain as often as you like. The standpipe is made from a 32-25 reducing coupling with some 32mm pipe and a couple of 6mm holes drilled near the bottom. The 6mm holes allow the bed to drain if you set it up as flood and drain, they also allow the water to drain out of the bed if you have it set up as a constant flood system and the power goes out.

It's a good idea to keep your stand pipe a bit longer to begin with, once you start pumping you can cut some off the stand pipe and fine tune the height.

Drill 6mm holes in the standpipe and the irrigation grid pipes

We are using a submersible pump, and a flexible anti-kink hose to run water up to the growbed. We start by sitting the pump on the ground next to the system, this allows us to measure the length of flexible hose we will need to reach up to the growbed. Be sure to allow a little extra length in the pipe so that you can access it and move it around with ease. I won't go into too much detail about how to attach your pipe to your pump because every pump is different, here you will have to find the right fittings for your pump and pipe. Your pump size may vary depending on what you have available locally or also depending on your long term plans. If you are thinking of expanding your system at some stage it's probably better to get a slightly larger pump now rather than having to replace it down the track. The pump we are using in this system is 3000L/h probably a little over kill, but this will allow some expansion. You want to have at least 1000L/h for a system of this size.

The pipe then comes up to the growbed, on the growbed we like to irrigate the water around the edge of the bed, this allows any solids to be distributed around the beds. So we have 4 pieces of pipe cut to size to fit around the bed, along with a T piece and barbed fitting that will fit the anti kink hose. The pipe work around the top edge of the growbed has 6mm holes drilled in the underside of it, spaced around 150-20cm apart. This means that the water is sent straight down into the media, you don't want water splashing on the surface of the media if you can help it, this will grow algae over the surface of the media.

Pretty much done now. You can run this either as a constantly flooded system, or you can put a timer on the pump and run it as a flood and drain system.

If possible try to get some water from an established aquaponic system, or perhaps from a friend with an aquarium or a pond, this water will contain the beneficial bacteria to help get your system cycled quickly.

Install the pipe work around the top of the growbed

Measure and cut the flexible anti kink pipe

Cable tie the pipe in place in case of accidents

Start planting seedlings into the bed

Steveiscrazy's IBC system

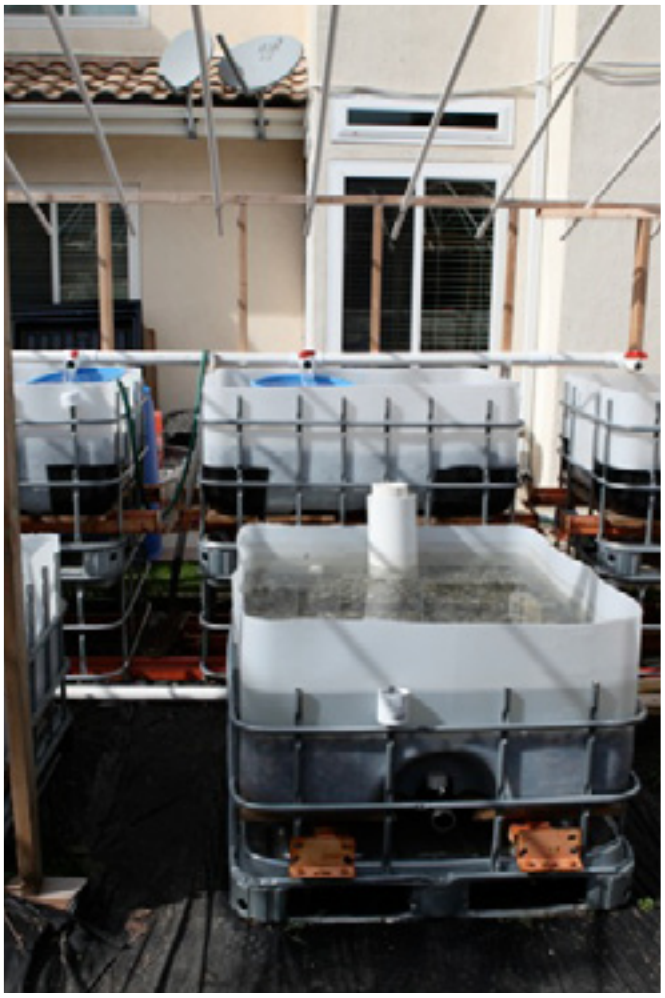
Early leaks in the systems plumbing needed fixing

All the growbeds drain into the sump tank before the water is pumped back into the fish tank

Inflow from the sump into the fish tank

Steve certainly isn't crazy as his forum name might suggest. He's built a fantastic system incorporating IBCs. His system is based on the CHIFT PIST style of system, incorporating a large raised fish tank. He uses a Solids Lift Overflow to draw water from the bottom of the tank out into the first level of growbeds; this helps get the solid waste out of the fish tank and into the beds where it gets broken down. The growbeds are made from 3 IBC's cut in half, the top halves of the growbeds are set up as the top set of growbeds. Water comes from the fish tank into these three growbeds, it then drains from those three beds into the three lower half IBC bases, the second row of growbeds. From this set of three beds it then drains into an IBC sump, water is then pumped from the IBC sump up to the fish tank to complete the water cycle.

Steve has used a rock media in the bottom section of the growbeds with expanded clay on top of the rock to make it easier when planting seedlings. After some early problems with leaks out of the base of the top halves of the IBC growbeds, Steve managed to fix this problem and now the system is starting to take off. Seeds have been planted and they are sprouting. Plans are already underway for the next system and a second IBC sump has already been dug into the ground; the plan is to use some other containers including blue barrels for the next system.



The fish tank with SLO (solids lift over flow)

System laid out and filled with rock, just need to top up the beds with expanded clay

Fishfodder's IBC system

Growbeds taking off and growing like crazy

Fishfodders system is a basic CHIFT PIST (constant height in fish tank, pump in sump tank), it uses 2 IBC's in the design, one IBC is buried in the ground and acts as a sump tank, the other IBC is above ground and is used as the fish tank. The system also uses two large BYAP 500L green growbeds. Water is pumped from the sump tank up into the IBC fish tank. From here it flows out into the growbeds, before draining back into the sump tank.

The buried IBC that acts as a sump tank has had insulation put around it to help keep the temperature constant, this sump IBC has a large section cut out of the top for access into the tank, however fishfodder has also installed a wooden cover over the top of the IBC for safety. For the outlet coming out of the fish tank to the growbeds, Fishfodder has used a black bulkhead fitting. These bulkhead fittings are great when plumbing into thin plastic like you find in an IBC. The growbeds have auto siphons in them to control the flooding and draining of the beds.

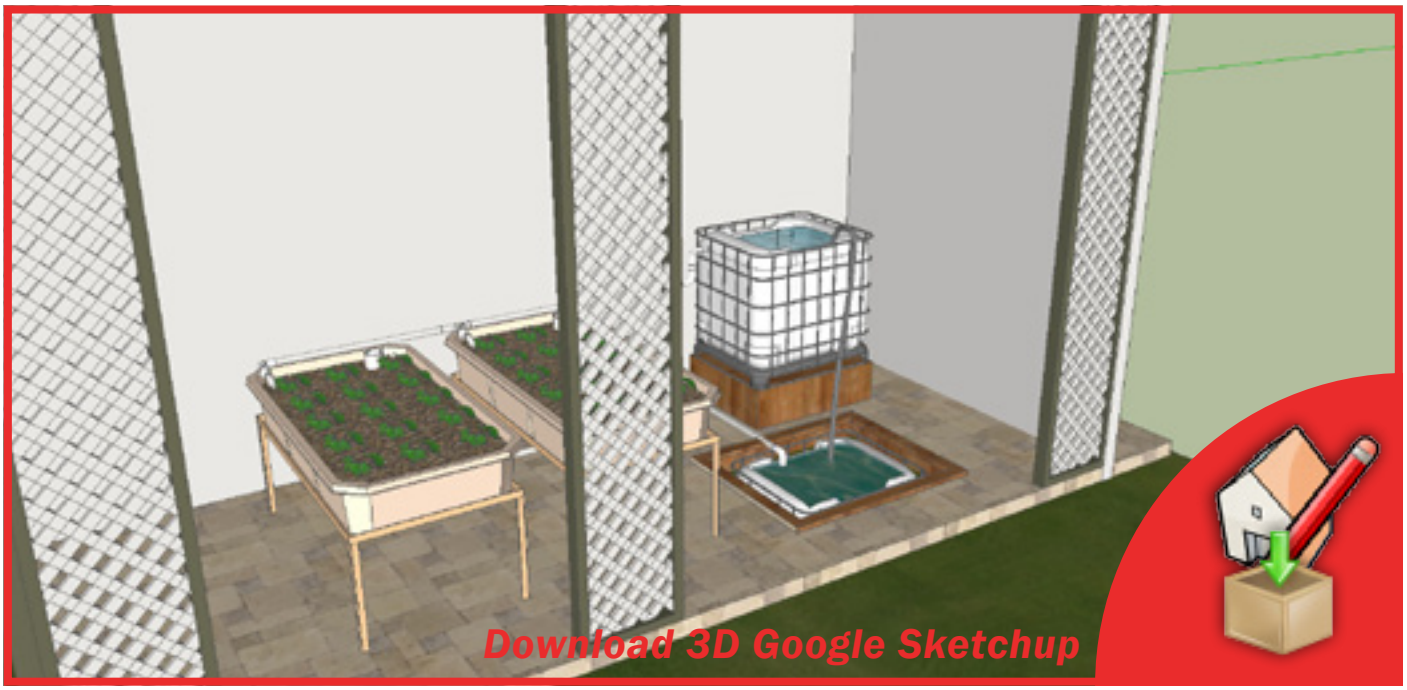
Once finished, the fish tank IBC was clad with timber. The timber has two purposes, it makes the system more attractive and also protects the IBC from degradation due to UV light.

The system also has an insulated roof added to the fish tank to try and maintain a more constant temperature. More constant temperatures maintains better fish health.

As a later addition to the system Fishfodder added a couple of yabby tanks and small growbeds that sit on top of the sump tank. He has a small pump in the sump tank, that pumps water from the sump to these extra yabby tanks and grow beds, a nice little extension added to the system to increase productivity.

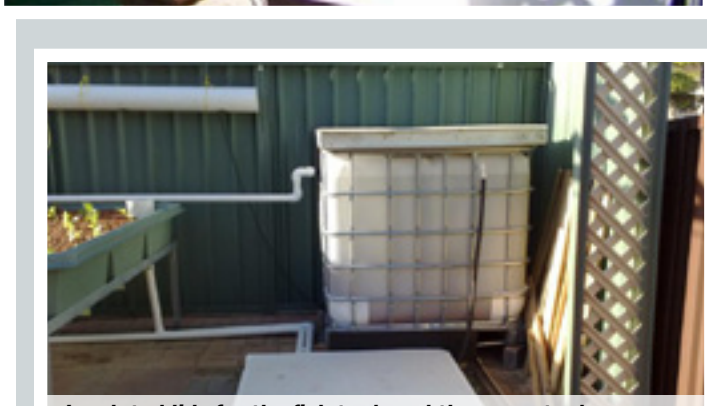
Fishfodder has created a very attractive and highly productive system using 2 IBCs and green growbeds.

This is what aquaponics is all about, fresh fish and vegetables



Bed filled with media

Notice the buried and insulated IBC sump

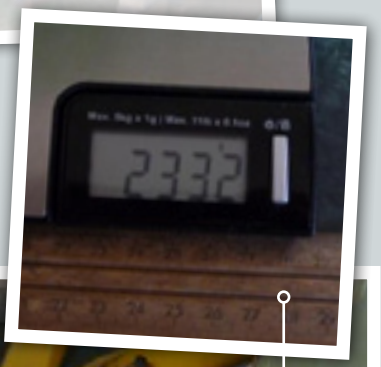


Insulated lids for the fish tank and the sump tank

The whole system neatly laid out

Yabbies ready to go into the yabby palace

The Yabbie Palace



This Armenian cucumber is 2.3kg

A great harvest of silver perch, ranging from 450g to 600g

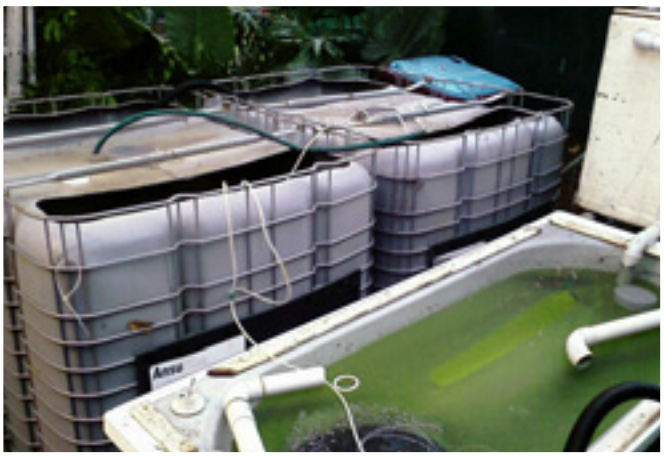
Aquamad's IBC system

Aquamad holding an enormous elephant ear plant they grew in their aquaponic systems

Aquamad is far from mad, though perhaps he's a little bit mad about aquaponics. Aquamad is a teacher in far north Queensland who has been very passionate about aquaponics since he first heard about it and joined the BYAP forum. The great thing is that his enthusiasm for aquaponics has flowed to his students and a special area was set up at the school for both Aquamad and his students to set up all sorts of different aquaponic systems.

Of course being a school they didn't have much in the way of a budget for spending on equipment, however, where there's a will there's a way and Aquamad kept his eyes peeled when driving around, and asked at different places for seconds as materials. This worked fantastically well, over time he received pumps and pipe and second hand fittings, IBC's, barrels, cable, and old bathtubs from various sources.

Aquamads enthusiasm for aquaponics really sparked the interests of many of the school students and the allotted aquaponics area began filling with a range of aquaponics bits and pieces, almost all of it recycled materials. Unfortunately because of the complications of getting permission from students parents we can't include any pictures of the students in and amongst their aquaponic systems. However, Aquamad has taken numerous pictures of their different systems over time. The systems here have changed so much over the past few years and there were so many different systems set up that I think it's perhaps best if I just let the pictures do the talking rather than trying to explain any of the individual systems and how they are set up.



Tanks in amongst the jungle

IBC's plumbed together to equalize water heights in the two fish tanks

A small recycled growbed as part of a system

Nice sized Barramundi ready for harvesting

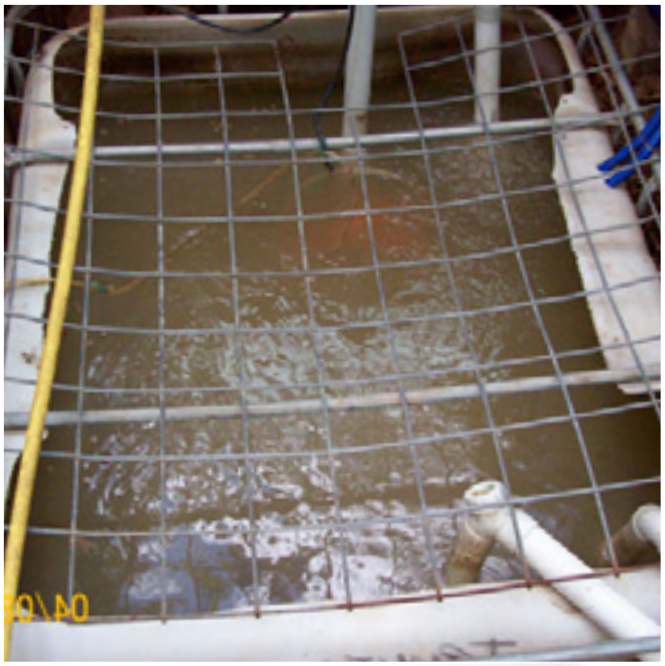
Air lift in the IBC

More barrels as part of a system

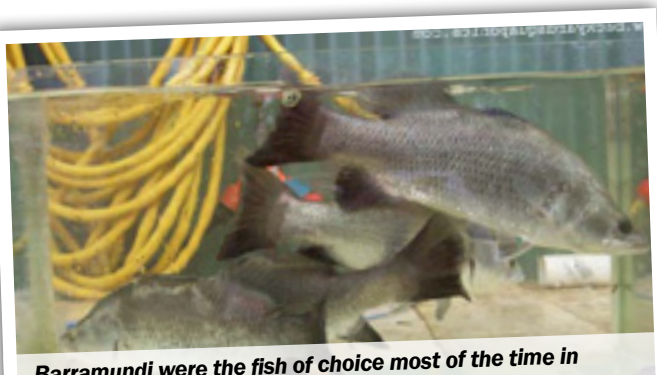
Redclaw feeding in a tank

Redclaw bred well in the system, here's one of the babies

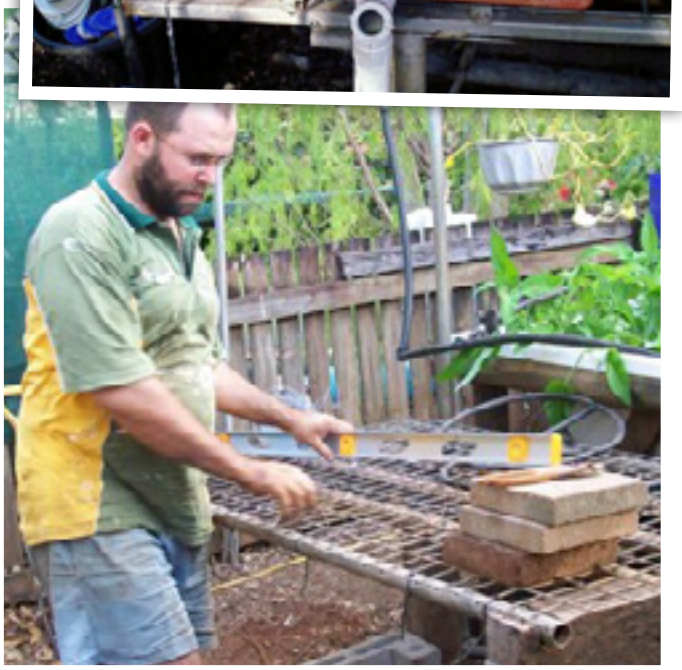
Watercress

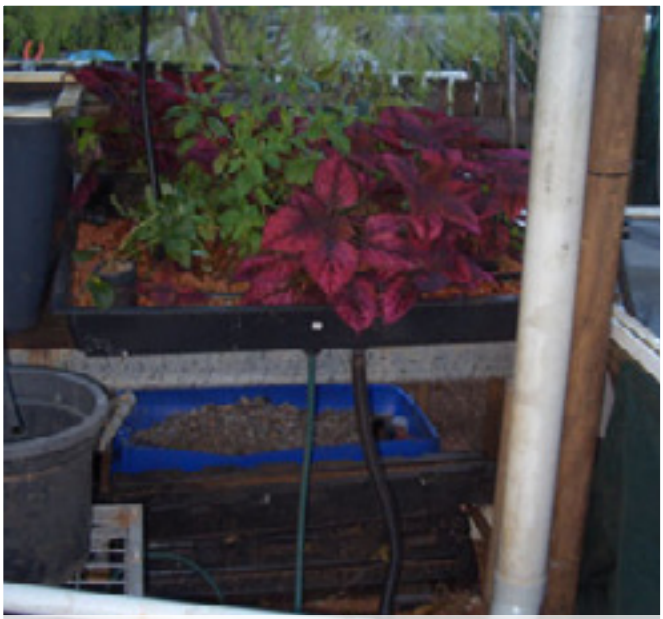


Buried sump tank with air hose dropping down through the lid



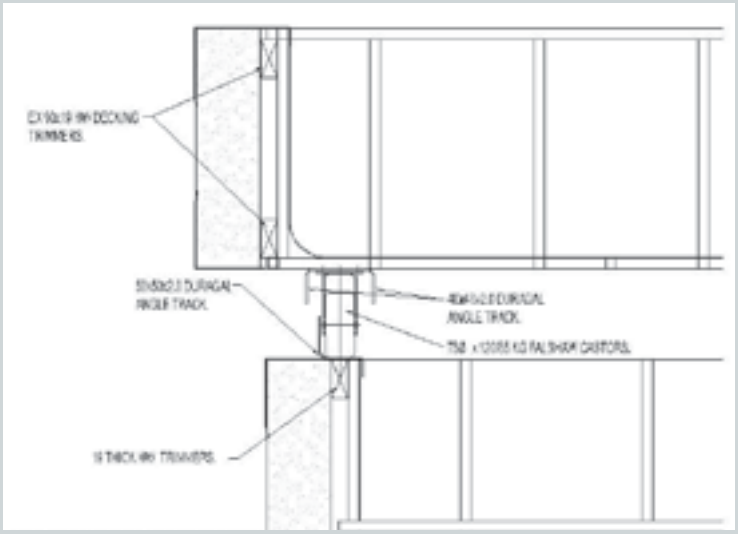
Barramundi were the fish of choice most of the time in Queensland





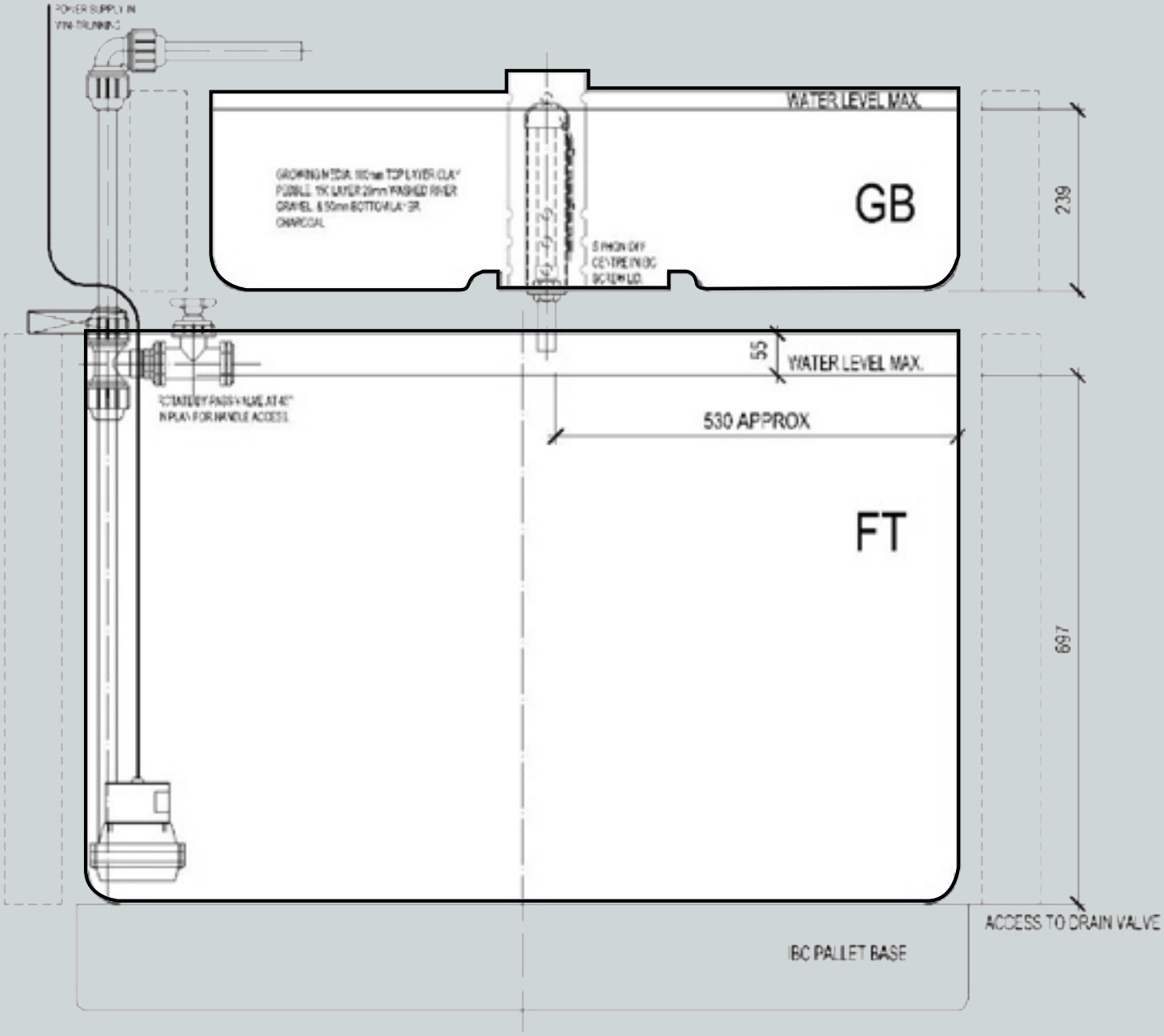
Return to tank

Kangkong and watercress

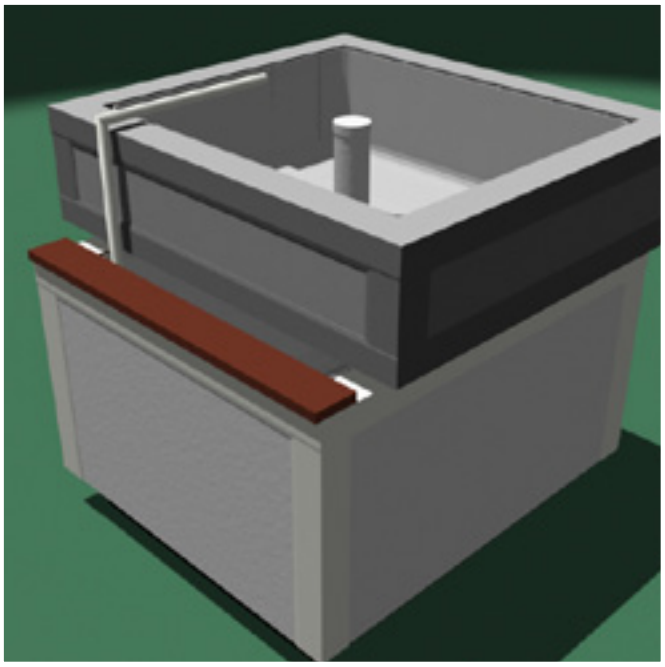


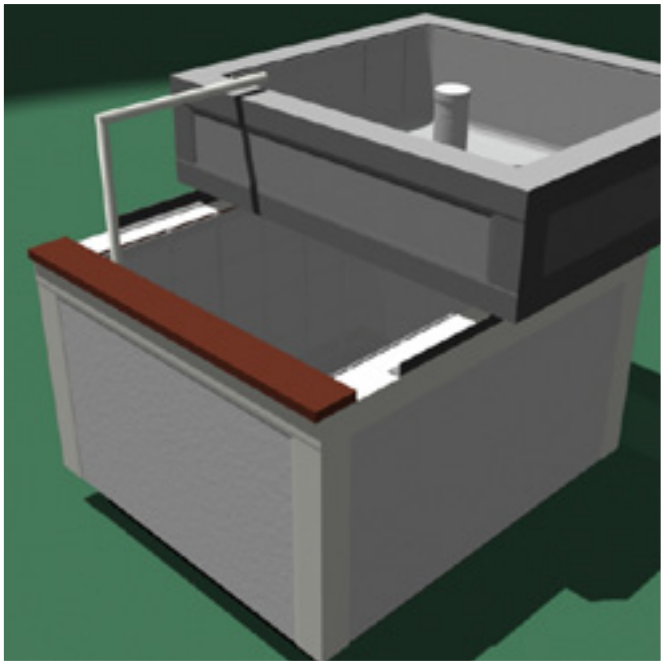
Ian's DIY IBC system

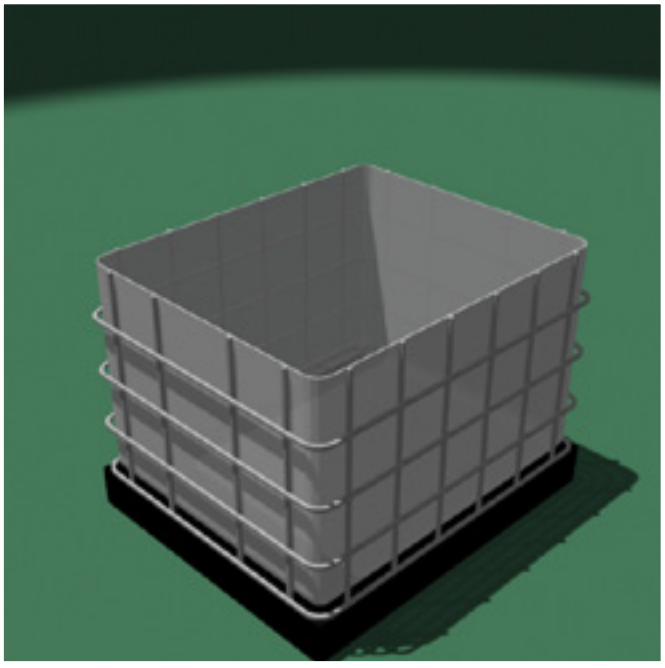
Ian's IBC system hardly needs any introduction, nor ongoing commentary. I'll leave his photographs and diagrams to speak for themselves, needless to say, if you want to build an IBC system that doesn't look like an IBC system, but rather a beautiful piece of modern equipment, then this could be the way to go. Ian has further instructions and information about his system on the Backyard Aquaponics forum; there was also an article in edition ten of the Backyard Aquaponics Magazine.



CROSS SECTION








1
110mm Angle Grinder to cut framing .


Top of IBC frame cut and removed.
Liner ready to be cut
2

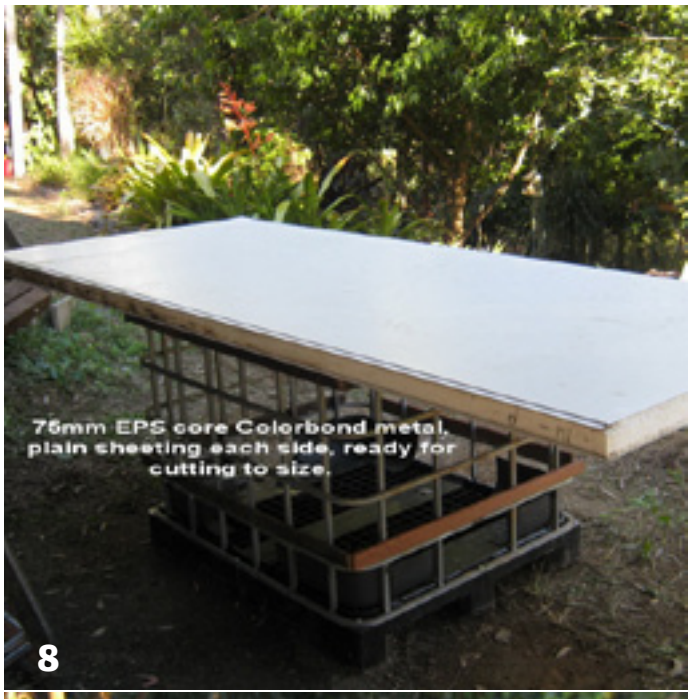

Cut GB framing, rotated to and upside down to show fit. Base bars loose fitted for illustration .
3


Don't know why everyone complains about cleaning their IBC's? A pressure spray germie works just fine
4


Liners cleaned and removed from frame. Framing ready for timber trimmers to top and bottom, screw fixed from inside framing!
5


Screwing timber packers from inside of IBC frame.
6


All packing in place.
7


75mm EPS core Colorbond metal, plain sheeting each side, ready for cutting to size.
8


Trial fit for dimensioning of Castor Tracks and centres.
9


EPS panel screw fixed (with Pan Head metal screws) through timber packing to panel internal sheeting
10


Marking centre line of bulkhead fitting on tightened screw cap for GB outlet, on Front side.
11


Marking centre of Bulkhead fitting, allowing for washer clearance on screw cap to GB.
12

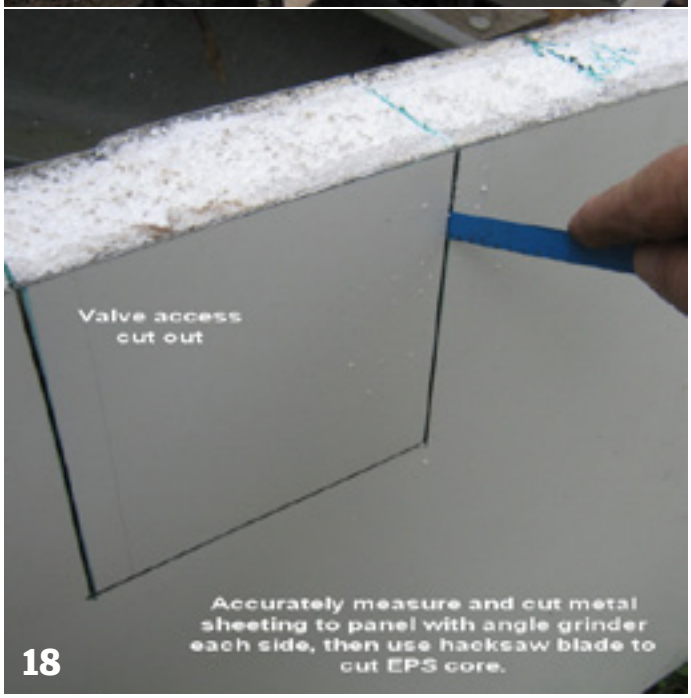
13


14


15

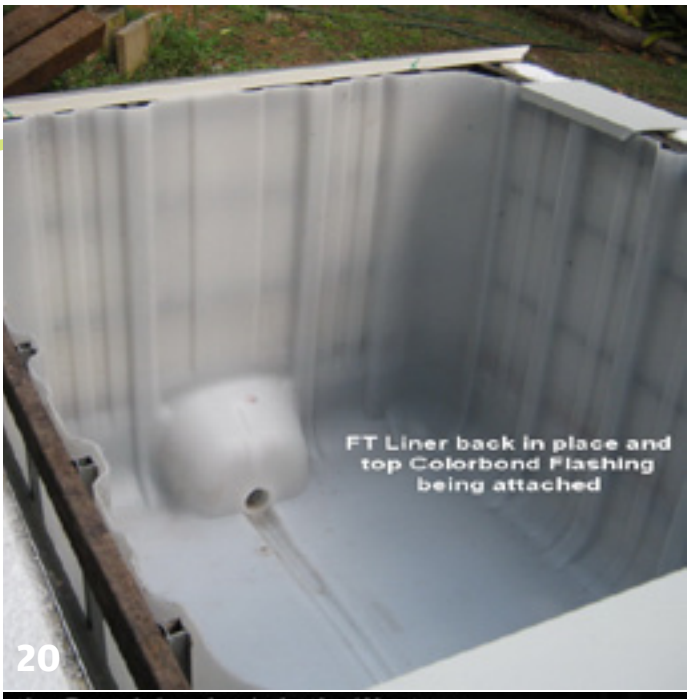
16

17



18


Screw fix EPS panel through timber packing from inside of framing.
19

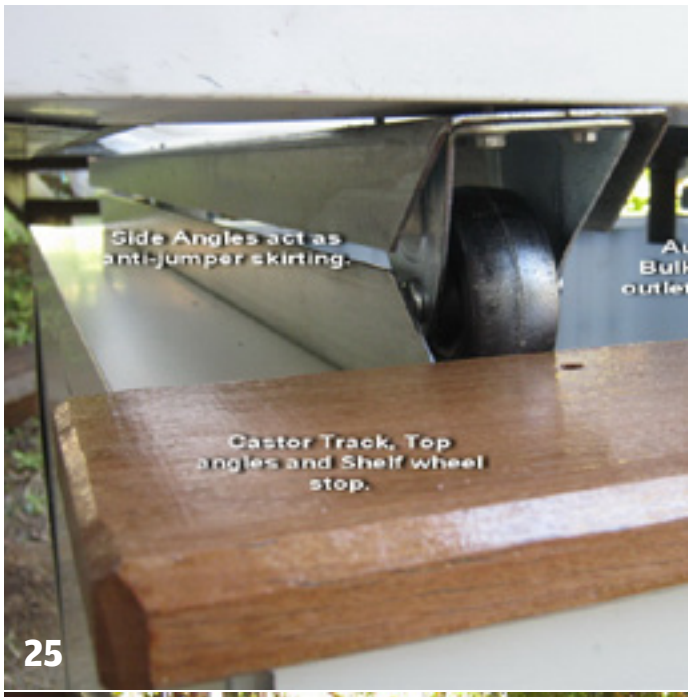

FT Liner back in place and top Colorbond Flashing being attached
20


Insulation in place over viewing panels.
Ready for Colorbond folded trims and flashings.
21


the Sun sinks slowly in the West . . .
Fish Tank finally clad, flashed and castor bottom Duragal angle tracks in loose trial fit.
22


Grow Bed underside
Turned up angle tracks for rear wheel stop.
23


Grow Bed in closed position.
Pipe work and fittings will be at rear. Gap to be filled with bristle curtain.
Turned up angle tracks for rear wheel stop.
Drain Valve access.
24


Side Angles act as
anti-jumper skirting.
Castor Track, Top
angles and Shelf wheel
stop.
25


Castor bottom track with
Countersunk Pop Rivet heads
vfor smooth Castor running.
Expanding Foam Corner filling.
To be cut flush and sanded.
Paint finish.
26


Grow Bed in
open position
27


Shelf as
wheel stop
Anti-jumper bristle
curtain to be fitted under
front edge of Grow Bed.
28


Pump pipe work in
position ready for pump.
Grow Bed in open position.
Anti-lift clamp angle to
Castor Track.
29


Bristle anti-jumper curtain
at Front edge of Grow Bed
30


Spiral hose to be used for Grow Bed supply. Allows for GB sliding and to continue operating.
Drain Valve access
31


New LED pond light.
Fish don't seem to mind it being switched on/off.
Minus: Insects aren't atracted to it!
32

Andywhite's IBC system

The security screen hinges for easy access

Fiberglass growbed filled with media provides growing space for seasonal produce

Security screen stops unwanted visitors and debris entering the container and can be opened to gain access for fish harvest

Andy lives in Brisbane and he wanted to keep things very simple by building a system with a pump, an IBC and a fiberglass growbed. He decided on a "flood and drain" style setup to fill fast and drain slowly each hour. After doing his homework each evening on the forum he was able to formulate a simple and effective aquaponic system without breaking the bank. Andy decided that he would dig the IBC far enough into the ground so that the bed would drain back into the fish tank. The growbed is about a metre away from the fish tank ensuring that there is lots of room around the bed for easy maintenance. Andy set up the plumbing so that in the main pipeline from the fish tank to the growbed, he's included a T-piece with a side pipe and valve going back into the fish tank, this helps provide extra aeration by splashing water back into the fish tank, but if he needs more water going to the growbed, he can easily shut the valve off, pushing all the water to the growbed. He's also included a removable coupling (barrel union) which makes for easy removal of the pump if required.

30 Silver perch were added to the system to provide a source of nutrients for the plants. The growbed receives 6 hours a day of full sun followed by dappled shade throughout the afternoon. Gravel media provides good support for a range of lettuces and herbs planted in the bed. A nice simple system utilizing an IBC as a fish tank.

In this picture the fiberglass growbed shows how it can be positioned around a metre away from the fish tank, which has been dug in to the ground allowing a slow gravity drain

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Tristrin's IBC system

Tristrin and her husband have a number of aquaponic systems. They have both off the shelf kit systems as well as homemade IBC systems, obviously they've been bitten quite badly by the aquaponics bug.

The first of Tristrins system was a reasonably straight forward CHIFT PIST system using three IBC's, though it had a few modifications most IBC systems may not have. They have used the frames in an ingenious way for supporting the growbeds. Most people normally cut their frames horizontally if you were looking at the IBC standing normally, however Tristrin has cut hers vertically. This vertical cutting of the IBC frame has allowed for the construction of a far better growbed support, large enough for three growbeds.

This growbed frame sits on the bottom half of an IBC that is acting as a sump at one end, while the other end is attached to the frame of the IBC that is the fish tank. As with all CHIFT PIST systems, the water is pumped from the sump tank up into the fish tank, from here it overflows into the growbeds before draining into the sump tank. Tristrin and her husband have used flanged tank fittings for all protrusions into the main fish tank, a great added safety measure. This particular system also has two feeds from the fish tank out to the growbeds.

This was the first of Tristrins aquaponic systems

System 2

The second system has a few further modifications and tweaks. Using the same style of growbed frame structure, this time they made it big enough for four growbeds. It's the same style of operation, running as a CHIFT PIST system with the pump in the sump tank, pumping into the fish tank which overflows into the growbeds before draining via autosiphons into the sump. One major difference here is that the system has 3 sumps, all bases of IBC's. These sumps are all joined together by pipe work, with the pump being in one of the sumps. Originally the pipe work between the sumps was 25mm but when two siphons from different beds emptied at the same time it caused a sump to overflow. The interconnectors between the sumps were changed to 50mm to increase the flow between the tanks and vent mesh cowls are placed on the end of the pipe to stop things getting into the pipes and blocking the flow.

Plumbing between the two different tanks

Here you can clearly see the interconnected sumps under the growbed, all three are plumbed together with a pump only in one of them, to pump the water back to the fish tank

System 3

As if it wasn't enough to have an off the shelf kit system and two IBC systems, they had to build a third system that's even bigger. This next system was going to be a combination of off the shelf fish tanks and IBC's. This is an unusual style of system with the two large fish tanks being lower than the growbeds, while there's also an IBC that acts as an additional reservoir of water. All these tanks are joined together with underground piping. Once again the same growbed support system has been used in this system as the other systems, with IBC 4 growbeds sitting in their frame, that sits on a couple of other complete IBC frames. This system is running on a timer with the pump pumping from the main fish tank it runs for quarter of an hour and is then off for one hour as the beds drain slowly. This system has enough water volume that it can have some major expansion in the future by adding more growbeds to it. The growbeds have been filled with rough scoria rock media in the bottom half of the beds, then topped up with smooth river pebbles.

Tristrin and her husband are obviously rather taken with the whole concept of aquaponics, it's great that they have shared their trials and tribulations with everyone on the forum.

Rather than the conventional way most people cut and mount their IBC beds, Tristrin cuts them in a different way which adds more support to the base of the growbed

A curve roofed structure was built to house this aquaponics system

Once the beds are in place, the drain pipework can then be plumbed in

Laying out the system

The base of the beds are filled with rough scoria rock

The beds are topped up with smooth river rock, much easier to work with

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Revisit some of the **skills** we have lost

Lungy's IBC system

Lungy spent a long time designing and working out the plan for his system. The system had to pass scrutiny of the wife and had to fit into the yard and match in without seeming out of place. He had decided early on that he wanted to use some of the premade Backyard Aquaponics growbeds, but for fish tanks, IBC's seemed like the ideal solution.

The plan was to put the IBC fish tanks into the garden shed, this would work well in keeping the sunlight off the tanks to stop degradation of the IBC and stop algal growth, as well as keeping the fish happy in darkness rather than out in the sunlight. Also the whole interior of the shed would be lined and insulated to control the temperature a little better. Temperature fluctuations in a metal shed can be quite extreme.

There was a garden bed along the back fence that just happened to be the perfect width for the growbeds, the stand were a little tall but that was fine, they could be sunk into the ground to a more accessible height. Lungy wanted the system to run as a CHIFT PIST style of system, this meant he would have to increase the volume of his sump. With 4 growbeds

filled with 500L of media in each, this would require a very large sump but he didn't really have the space for such a big sump. The plan then evolved to not only have a 1000L main sump at the end of the row of beds, but also to have a 200L sump under each individual grow bed, then link all of them together, almost doubling the sump volume.

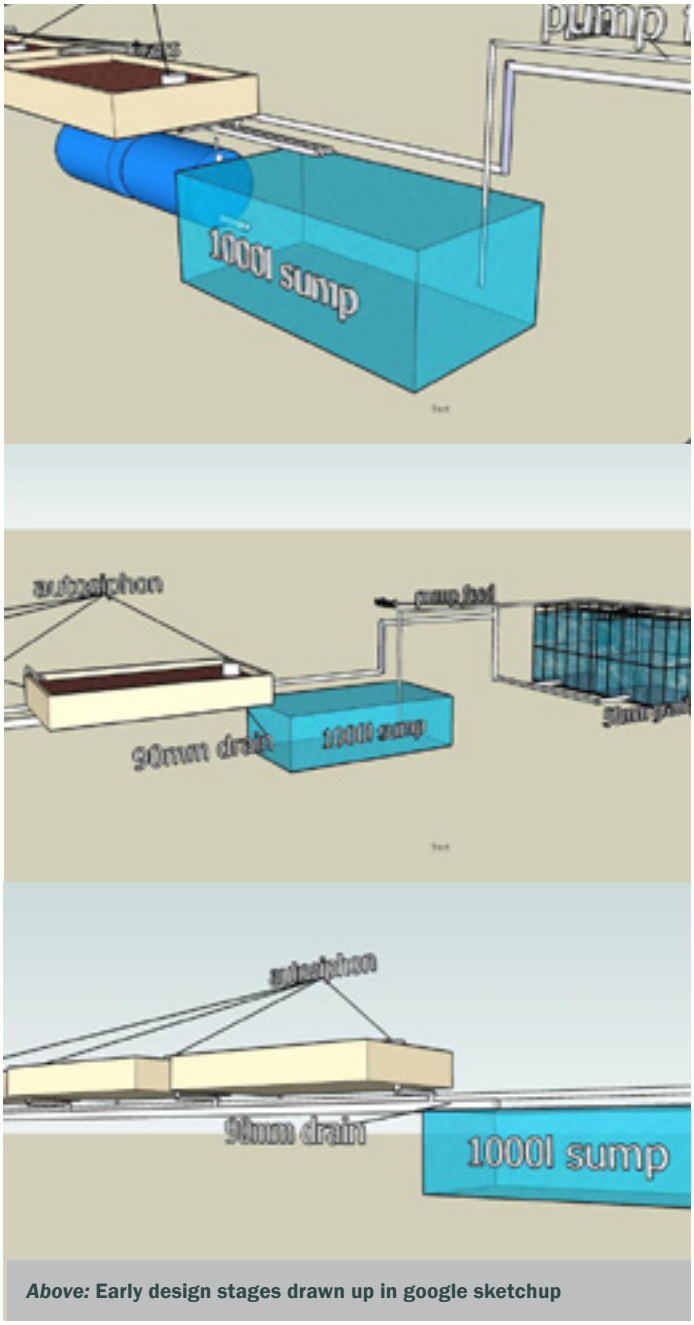
Water was pumped from the main sump to the two IBC's in the shed where the fish were. From here the water flows out the base of the IBC's through a flexible hose into a manifold. The pipe work then comes outside through the shed and along the back of the growbeds where individual taps are set at each bed to control the flow into the beds. The drains of the beds have auto-siphons installed in them to flood and drain the beds, the water then drops into the sump and ultimately moves through the underground piping before being pumped back into the IBC fish tanks in the shed.

The growbeds got quite hot during the day over the summer so Lungy set up a simple shade cloth cover to keep things a little cooler.

The system was set up and running beautifully but Lungy wanted to add another aspect to his aquaponic system. Although he had power in the shed for running the system, why not put some solar panels on the shed roof and run the system off the grid. With a couple of solar panels on the roof, batteries and inverters inside the shed with the fish, everything was looking good, the system was booming and it was running on solar power as a bonus.

Here begins the warming. When setting up solar systems yourself you must be very careful. Lungy left for work one day but shortly after received a call from his wife, "The shed was on fire!" By the time he got back home and started to hose the shed, there wasn't much left. It seems that an electrical fault had started the fire, quite a strong fire too, even the IBC's melting and tipping their 2000L of water out into the shed hadn't put it out.

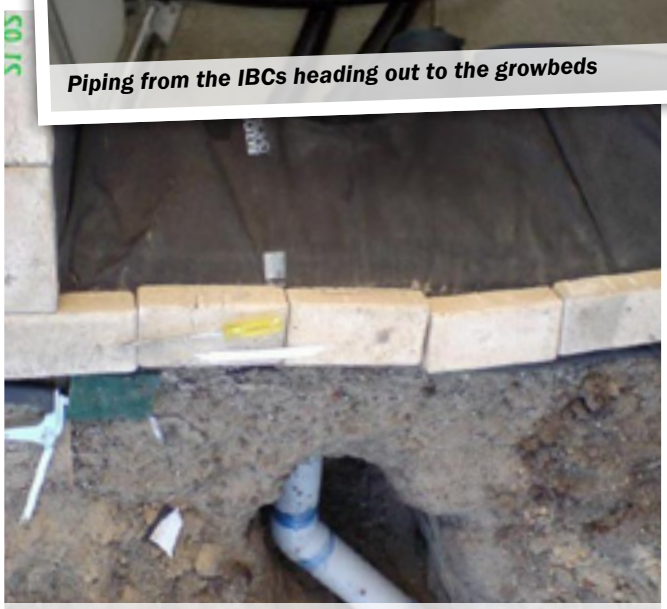
Apart from this unfortunate accident the aquaponic system was a great success, and the destroyed shed was soon replaced so that things could get back on track.



Above: **Early design stages drawn up in google sketchup**

Beds all set up with a layer of gravel around the area

Piping from the IBCs heading out to the growbeds

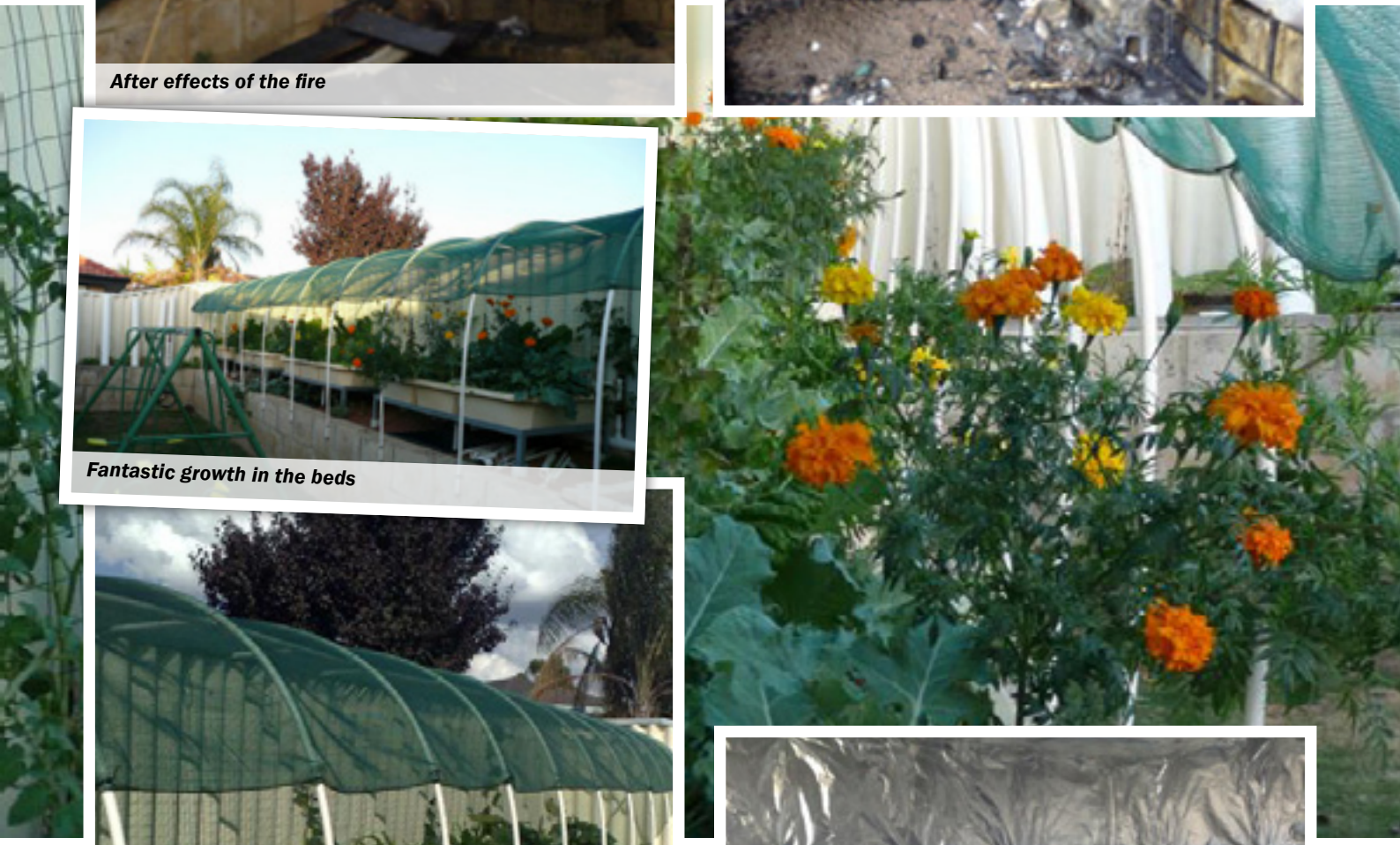


This was a tricky bit of plumbing as the main sump was just a rubber liner

The main sump tank what contains the pump; Sumps all set up, stands partially buried to a better height

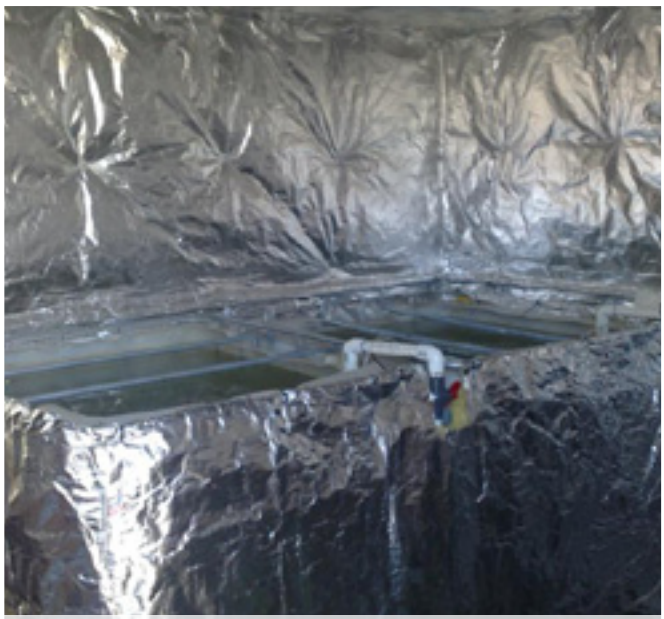
The individual sumptanks for under each bed, buried and plumbed together

After effects of the fire

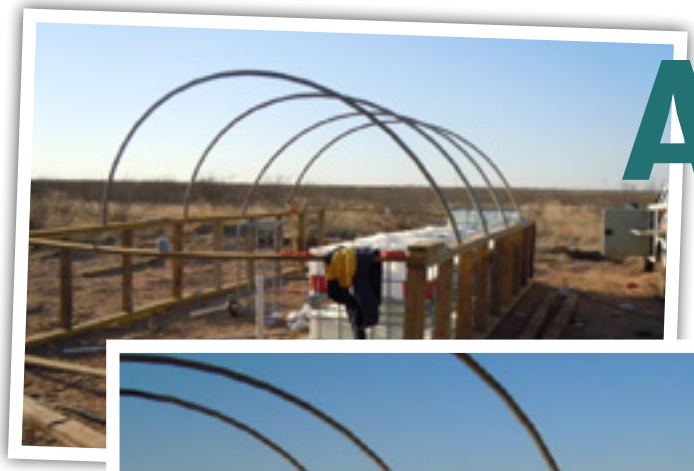


Fantastic growth in the beds

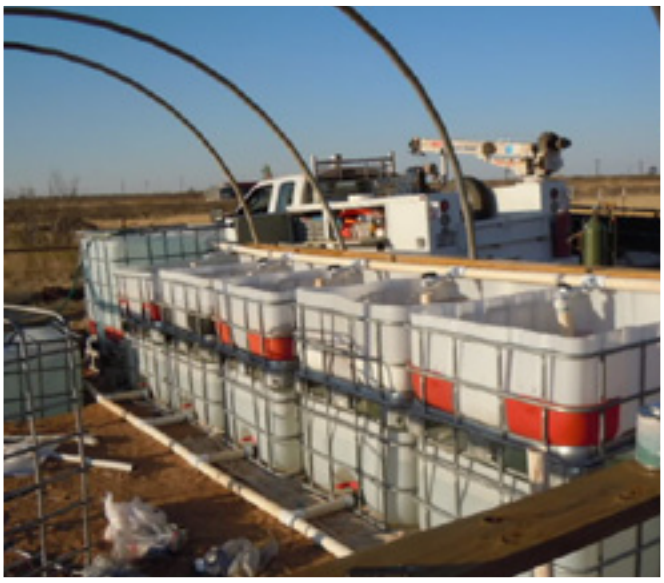
Some shadecloth was set up to provide shelter for the plants during the hot summer



The shed and fish tanks were lined to provide insulation



Arkantex's IBC system

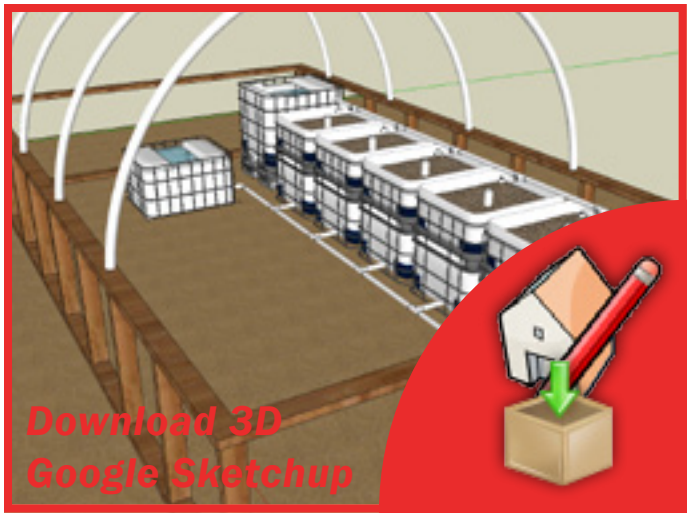


Arkantex has set up a beautiful IBC system that's a really good size as well. This is a perfect example of how you can have a great aquaponic system for very little money if you can find a cheap source of IBC's.

The system consists of an IBC fish tank, 5 IBCs set up as growbeds. These beds have been set up beautifully, they have been cut in half, however the top section of the frame has been set on the ground, with the bottom section of the inner plastic liner placed in here on the ground. Then the frame base mounts perfectly on top of this. This is a great way of setting up a system because normally if you take the top of an IBC and try to turn it upside down there's only two small bars supporting the growbed. But by placing the top section of frame on the ground and slipping the bottom half of the IBC liner in this, the liner is sitting on the ground so it's well supported. Then the normally poorly supported top liner section goes upside down into the frame base which contains a solid support.

The system is set up as CHIFT PIST, with a full IBC, half buried in the ground acting as the sump. Water is pumped from the sump up into the fish tank IBC, from here if flows into the 5 half IBC growbeds. There are taps at each growbed to control the water distribution on all the beds. The water then drains into the half IBC sump tanks beneath the growbeds. These are plumbed together externally and flow into the drain tank. It's surprising the system you can come up with when you have a few fittings, a pump and some pipe, with of course IBC's.

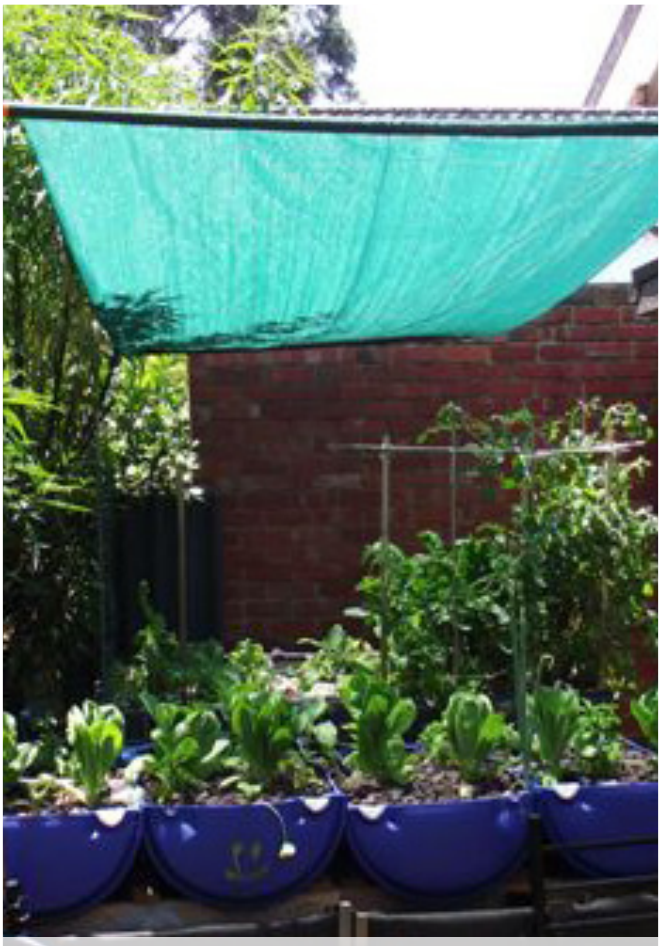
You might have noticed that Arkantex is also building a greenhouse around the system to help keep the temperatures more stable.



Bonsaibelly's IBC system

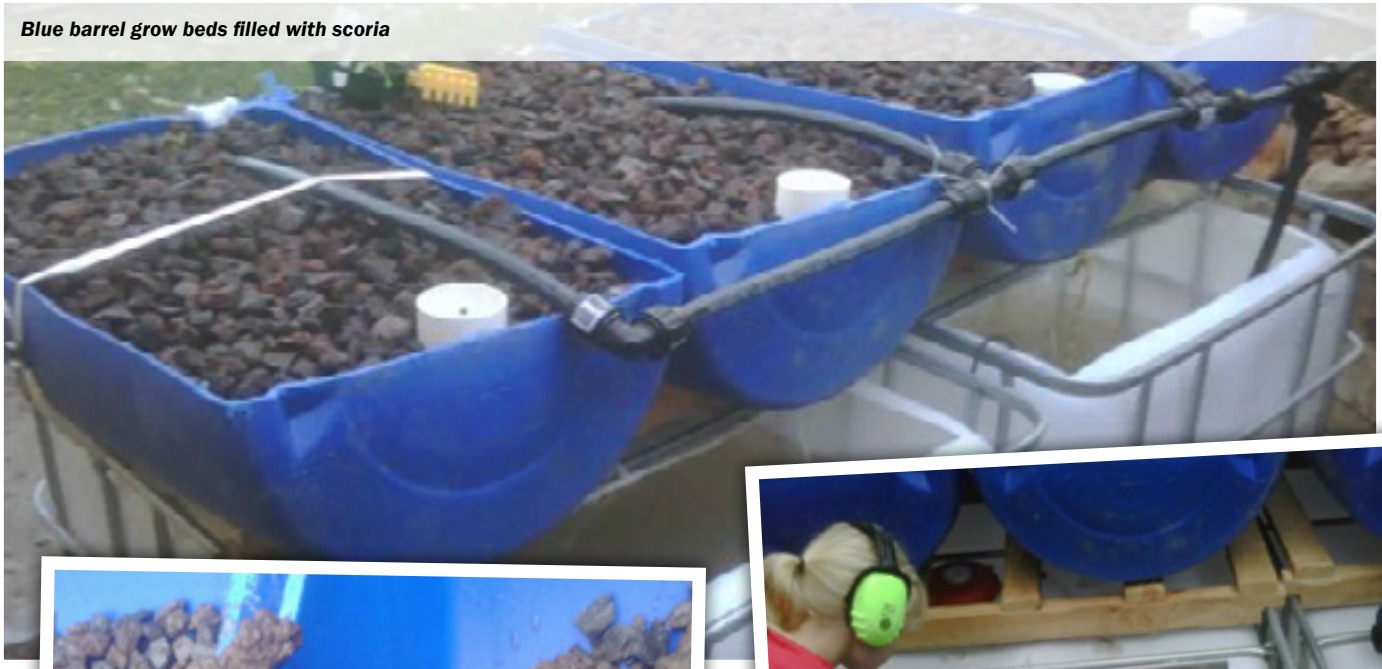
Bonsaibelly wanted an expandable system that he could add to later, so he decided 2 IBC's would be better than 1, as well as 2 blue barrels cut in half lengthways. It didn't take much effort to wash out the barrels which had been used for storing glucose. The available space is 4 metres x 3 metres wide narrowing down to about 1 metre. He ended up using poly irrigation piping which is more expensive than pvc, but easy to use. It screws together and you can snip the pipe easily with secateurs. Another brainwave he says "I thought that if I bury the IBCs, I wouldn't have to build racks for the 1/2 barrels, as they could be supported across the top." He now has 4 barrels on top of 2 IBC tanks which means there is lot of water capacity, though not many grow beds. After getting about half a metre down, the dirt turned to rocks and then to super thick clay which was impossible to dig . He says "Oh well I figured that it is easier to build a step, than to dig deeper. At present the scoria filled growbeds, are at a height of 1.2m."

Second Grow bed



Shade cloth protects from heat and stress

Blue barrel grow beds filled with scoria



He has connected the tanks 50cm above the base with a pipe and tap. The pipe sucks from the bottom of the back of the non pump tank and runs via connection to the pump tank. As the water drains from the pump tank it gravity feeds from the other. The idea is the water is gravity forced from the bottom of the non-pump tank helping cycle the water from the bottom up. It is actually a pretty slow feed but seems to keep up. He added a tap just in case there was the need to isolate the tank later. The pump tank will drain around 300 litres per cycle. If the system is to be expanded later he can see there may be the need to add a sump tank to maintain a more steady flow in the 2 tanks but it will be fine initially. At 50cm if there is a pump blow out when he is not around, it can only drain the non-pump tank to that height. The pump in the fish tank comes with a float switch which has been secured at a height maintaining a minimum water level of 50cm, another form of backup in the event that something does go wrong. Bonsaibelly like many others does not want to come home to a dry tank and dead fish . The 400 watt submersible pump has more than enough power to get 3 more barrels going in the future. He says "I am happier with the pump and timer system- it just seemed a little less complicated and I was a little scared of auto siphons. I saw pictures of drain and overflow by Food&fish and 'referenced' that pretty heavily. Anyway the water is pumping through, now with beds filling in 3 minutes and draining in about 35. The pump runs once per hour, 15 minutes on, 45 minutes off, which has been pretty good. It is great going out and hearing the timer kick on, on queue."

Seedlings were planted in the media filled growbeds and a little seasol was added to give them a boost. Trout were then introduced and grown to plate size before they were harvested and served to some special guests. Bonsaibelly says "We had sushi with trout from the barbie. Yummo! That led to a small success - my 12 year old niece was over, and is usually pretty fussy with food –won't try new things but also suspicious on mass produced cow and chicken etc. I got her to try some trout - promised it was super fresh and pretty much organic. Great to see kids try new food." A variety of produce can be grown easily including fruiting crops such as tomatoes, broccoli and peas. Leafy greens also do very well including English spinach, silverbeet and lettuces.

Chainsaw's IBC system

Hay surrounding fish tank keeps out the sunlight and acts as insulation

Chainsaw system started out as 3 IBCs and 24 half blue barrels, which has been running for around 2 years now. The barrels were cut in half lengthways and set up in a neat looking greenhouse. He really likes the idea of using top hat grommets as they are very cheap and ideal for use in the barrels, they provide a seal around take-off adaptors and poly fitting when connecting in to PVC.

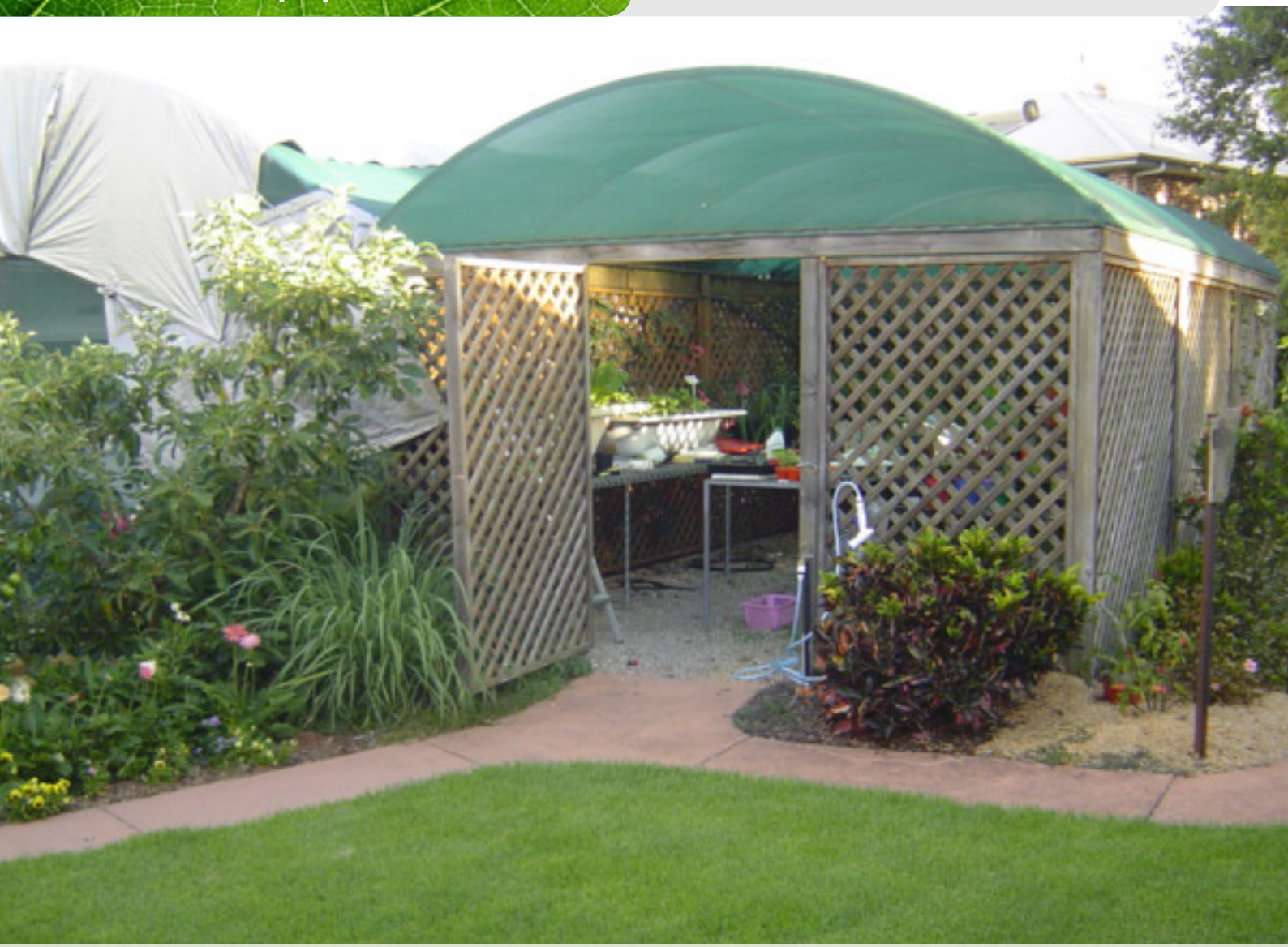
The three IBC s are all connected with a SLO. The sump tank is one of the three IBC's and it holds the sump pump with float switch. This pump is on a timer which allows it to pump water every second hour for 15 minutes. The water is pumped up to the growbeds which then drain back to the first fish tank, SLO to the second fish tank and SLO to the sump tank, which is the third full sized IBC.

Chainsaw occasionally adds seasol, a seaweed concentrate, to the system as it is safe for the fish and gives the plants a range of nutrients and trace elements. It is always a good idea to ensure that anything being added to an aquaponic system is safe for fish. Chainsaw started a thread on the Backyard Aquaponics forum titled "Beware the Pest Control Man" after an annual routine spray turned in to any Aquaponics enthusiasts worst nightmare. After losing all his silver perch, Chainsaw has some Jade perch coming along nicely. We look forward to seeing them reach harvest size.

IBC fish tank with pump and float switch. Jade perch growing well

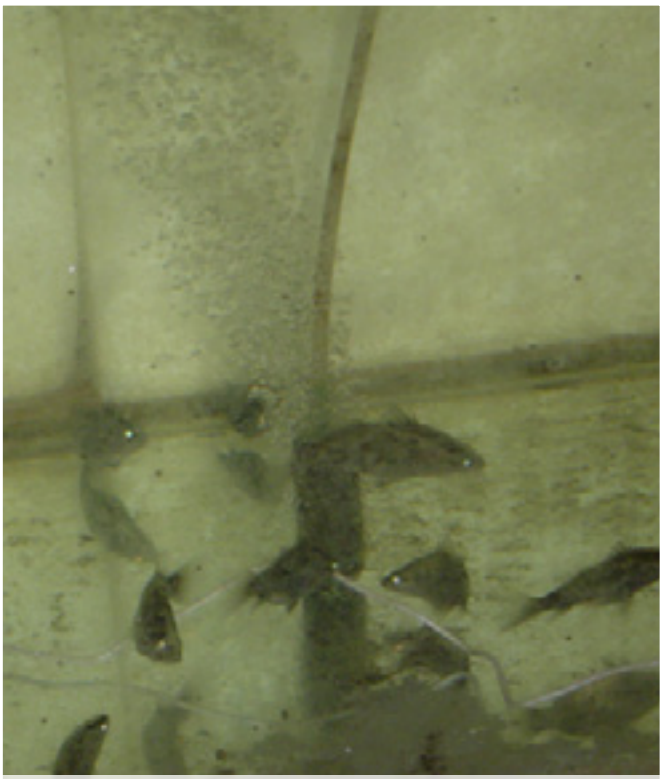
Bell Syphons

Fish tanks



Greenhouses offer protections from unwanted guests

Growbeds full of plants



Barra fingerlings

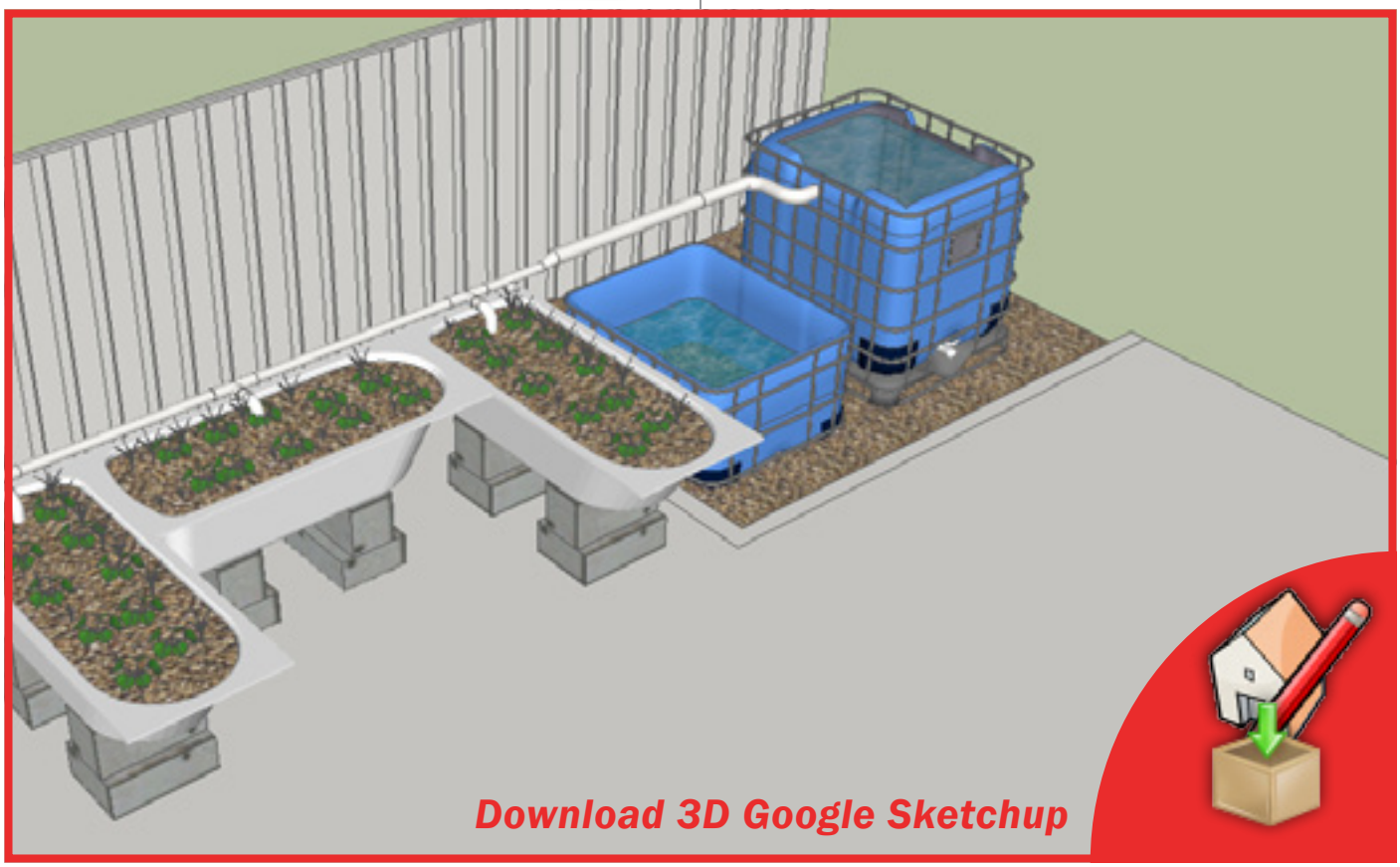
Extra external filters have been added to the system over time

Hillsy's IBC system

Hillsy's system comprises of two IBCs and three fibreglass bathtubs acting as growbeds. He has created a very neat looking system at an affordable price. The style of the system is based on a CHIFT PIST method, a term coined in the early days of aquaponics, standing for constant height in fish tank pump in sump tank. The main fish tank is a complete IBC , this will hold around 1000 litres of water which will be maintained at this height. He has cut out the top of the IBC, allowing easy access to the fish, the sump tank is a second IBC positioned next to the main fish tank in which another species of fish could be kept, or ideal for use as a fingerling tank. The submersible 6000lph pump sits in the sump tank and pumps constantly to the main fish tank, then overflows to the three growbeds which are operated by auto siphons. The standpipes are made using a 25-20mm reducing coupling which sits snugly in the existing drain of the bath tubs. Hillsy used the standard bath tub fitting before connecting in to a threaded adaptor and 40mm plumbing pipe commonly known as DWV. A swirl filter has also been added to the system as an additional solids filter.

The bathtubs have been installed on limestone blocks which make for an ideal height for planting and harvesting the vegetables. Gravel media has been used to grow the plants

System all laid out and ready for plumbing



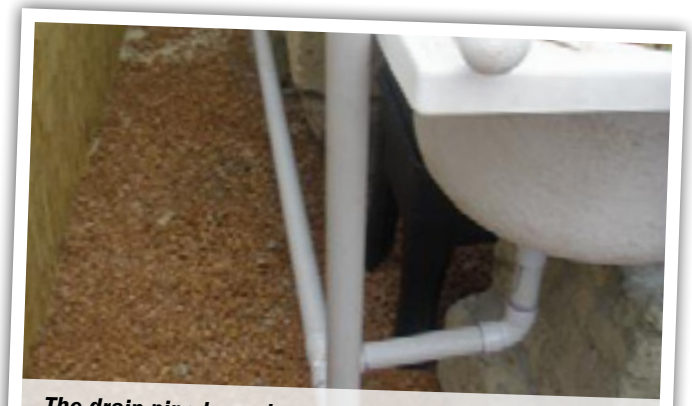
The rewards of Hillsy's system

and Hillsy advises others to make sure that they wash the pea gravel very well, as he found that weeks later the fine clay was still coming out of the growbeds. He planted up the beds and planted some tomatoes, garlic chives, capsicum and tomatoes which before long began to show some good results.

Here we can see the bubbles from the venturi sucking air into the water stream. Also the 90mm Solids lift overflow in the background

These are the bell siphons in the growbeds

Swirl filter addition to the system



The drain pipe has a breather; Gravel growbeds are very neatly laid out

Fish tank and sump tank installed in place

Gravel growbeds are very neatly laid out

Plants are just starting to take off

Freeboy's IBC system

Freeboys IBC system began as one of the simplest systems you can make with an IBC- cut the top off and turn it upside down, fill it with media and there you go.

This might be how it started, but it hasn't been left there, Freeboy has souped up the simple system with quite a few "extras". He's added a 35L filter made from large diameter pipe, the pipe is filled with expanded clay and water is pumped through the filter continuously. This aids the filtration of the system greatly. However it quickly became evident that the 200L growbed and filter was not adequate for the amount of fish Freeboy wanted to grow.

Freeboy has since removed the 35L filter, and added an additional 400L fiberglass pond as a growbed. Then an old 150L fiberglass live bait tank was added as a sump tank, and later filled with hydroton to act as a constant flood growbed for water loving plants (mint, watercress, celery etc.). There have been a few more filter arrangements added to the system signs of an active student mind.

The system now consists of an 800L IBC fish tank, 200L IBC lid growbed, 400L pond growbed, 150L growbed/sump, and 3 airlift bio-filters, to provide extra aeration and filtration if the water pumps fail or there is a power loss. Freeboy now manages to raise 30 fish at a time, plus plenty of fresh vegetables for him and his family.

IBC covered with bamboo

Outbackozzie's IBC system

Lots of digging

Outbackozzie has been a member of the Backyard Aquaponics Forum for many years and he's created a few classic aquaponic systems utilizing IBC's. In fact, I think that of the many systems he's built only his very first system didn't have any IBC's in them. Since that first bath tub system, all of his systems have incorporated IBCs to some extent, and more recently with his large commercial systems he has included many IBC's into the design of the system.

Firstly we'll take a look at his IBC and Blue barrel system in his backyard. This started as an IBC system, however the IBC's had to be removed and replaced after a while. Four IBC's were buried in the ground and a number of Blue 200L barrels were cut in half across their middle to be used as growbeds.

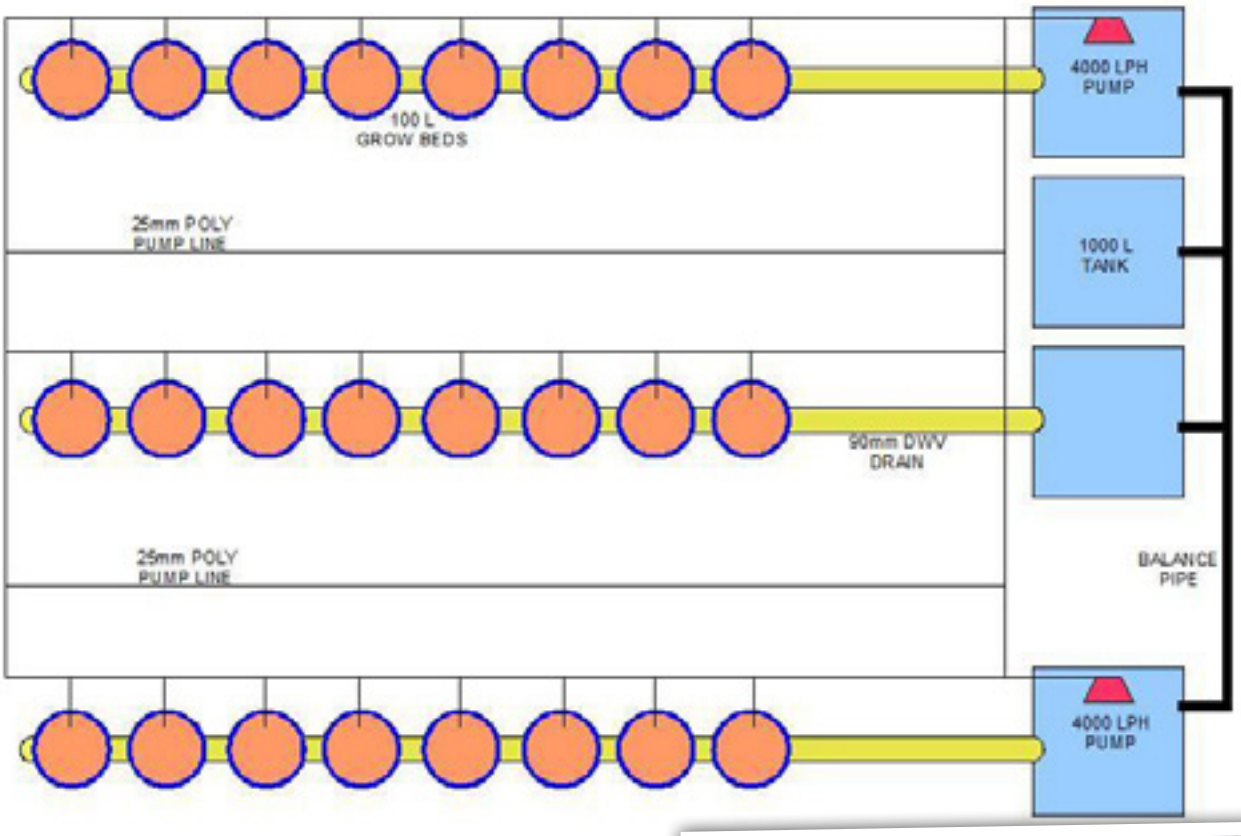
The plan for this initial system was well thought out. 4 IBC's were buried in the ground as fish tank, these were all plumbed together underground so that the tanks could equalize water heights between them. The IBC tanks on either

The growbed in full glory

end had 4500L/h pumps in them, these pumps pumped up out of the IBC fish tanks and down the side of the row of growbeds. The growbeds are 200L blue barrels cut in half around their middle. At each growbed there's a T in the main line with a riser coming up to the bed with a small valve to control the flow going to each bed.

The growbeds are sitting on bricks, with a main 90mm drain line running down the centre that each growbed drains into. Each growbed has a standpipe and a outer standpipe surround to keep the media away from the standpipe, the system works with the beds being constantly flooded with water to the height of the standpipe.

All the main 25mm irrigation pipelines in the system are joined together, and both pumps are actually hooked into the same system, This means that should there ever be a pump failure then the system will keep going, just at lower flow levels to each bed.



To neaten the whole system up and hide the pipe work OBO brought in a lot of dirt, piling it over all the pipe work around the base of all the barrel growbeds. Not only was this dirt going to act as a cover for the pipe work, but also it would act as an insulator from the harsh extremes of heat often experienced in Kalgoorlie.

After some time, a problem with the system became quite apparent, the IBC buried fish tanks were starting to collapse. They had been buried without their steel cages, and without any additional support and the external pressure from the ground especially after rains, was too much and they all began collapsing.

Time for another plan. The IBC's were removed, the hole dug out a little more and used steel drill rods, a waste product from the mining industry, were used to line the hole. These were welded into place before a rubber pond liner was installed. Now the system had just the one very substantial fish pond, but no IBC's in the system.

A second expansion of growbeds was under way. These were being installed around the corner behind the shed, 4 complete IBC's with the tops cut out, installed as growbeds. This adds a huge amount of biofiltration to the system and another 4sqm of growing area. These beds remain constantly flooded just below the surface of the media, they are filled with blue metal with a layer of expanded clay on top to make it easier to work.

As you can see from all the photos of plant growth and fish harvests, this system has been very productive over the past couple of years in its various forms.

Mounding soil around the barrels

Common 90mm drainpipe runs under the growbeds

Harvesting some trout

A nice cabbage

Soil level raised around the growbeds by using old drill rods

String supports for climbing plants

Struisje's IBC system

Two weeks growth

Struisje has built a simple yet interesting robust system here. Using 2 IBCs, a couple of heavy duty beams, a pallet and some large bricks or cinder blocks.

The fish tank IBC has just had the very top cut off the thin inner plastic container, leaving maximum depth for lots of water, and the cage surrounding it was left intact. The growbeds were another IBC that was cut in half and then trimmed down to be about 35cm each in height for the two growbeds.

Struisje was hoping to bury the fish tank at least half way into the ground but when digging the hole he ran into some buried foundations, so it's only about 1/3 buried.

A small cinderblock wall was then created just over 1 metre away from the fish tank, this was to act as growbed support, while at the other end, the fish tank frame would act as the support.

Two heavy planks have been placed across the fish tank and onto the cinder blocks at the other end, a pallet has then been placed on the planks, this pallet ensures that there's greater support covering the whole base of the growbed.

A three thousand litre pump has been placed into the fish tank, from here water is pumped up to both growbeds, the growbeds are filled with expanded clay and autosiphons have been installed to flood and drain the individual beds with a continuously running 3000L/h pump.

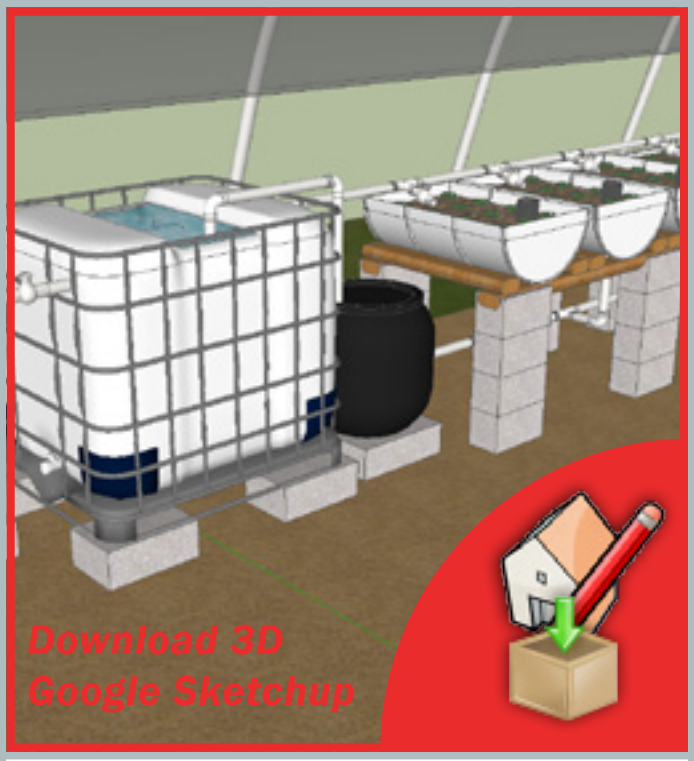
Struisje has built a nice little greenhouse to cover both of the growbeds, very handy thing to have in the cold weather as it helps to extent the growing season of many plants.

Drainpipe and flexible irrigation pipe in background

A sturdy simple IBC system

A nice little greenhouse

Markcaso's IBC system



Markcaso has built a nice simple CHIFT PIST system here from a couple of different types of barrels and an IBC. The IBC acts as a fish tank with only a very small hole cut in the top of it for access to the fish. Out from the side of the fish tank a 50mm main pipe line runs off to the growbeds, Mark has combined a couple of different aquaponic methods here, firstly he has 4 half barrels filled with media, then a floating raft tank amongst the barrels. The main 50mm irrigation line coming from the fish tank runs at the back of the growbeds, each growbed has an outlet with a tap from the main line to provide water.

The media filled barrels have autosiphons in them for flooding and draining, and the drains all run back to a 1/3rd buried black plastic drum. This black plastic drum acts as the sump and as such houses the 4000L/h pump for the system. There is also an overflow from the fish tank back into the sump barrel in case of any problems with the water levels in the tank.

Biofilter added to the system once it was up and running

Two different siphons were tried, one bell siphon with a breather hose

The second type of siphon used in this system, an Affnan siphon

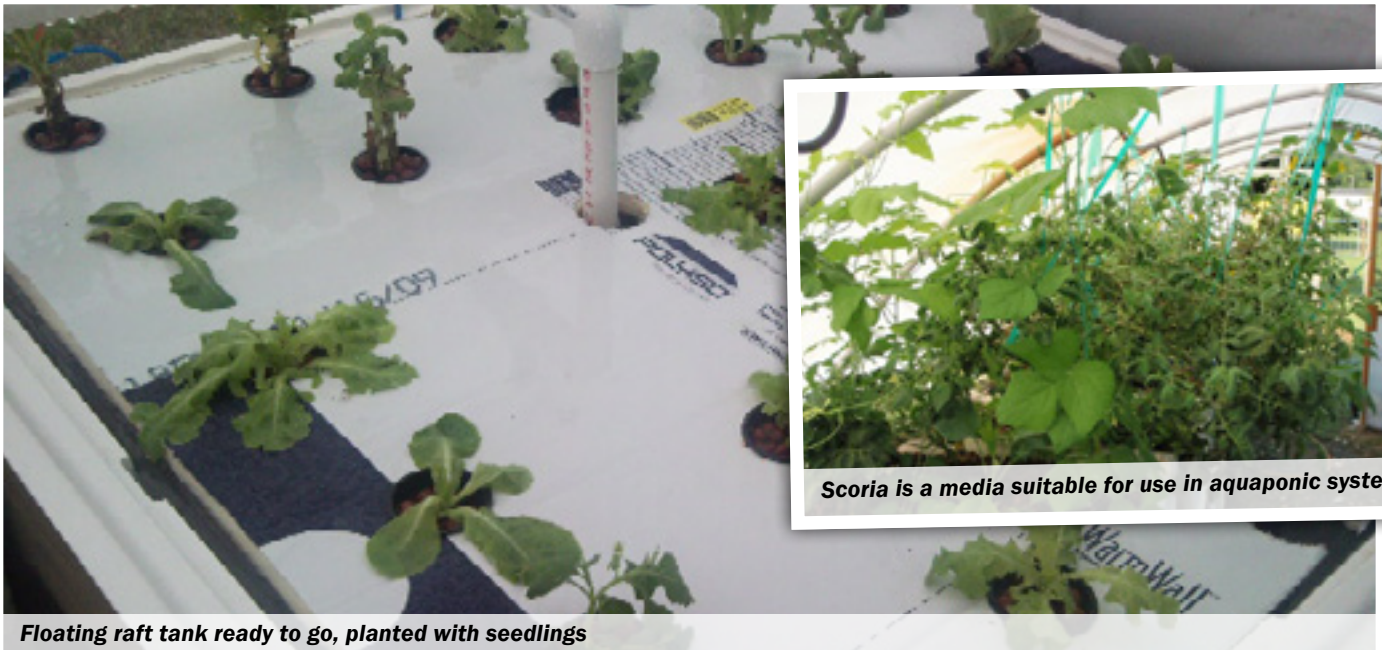
Early testing of the system before filling the beds with media

As a later addition to the system Markcaso added a separate biofilter off the side of his fish tank, once again this is a black plastic barrel, the type with a removable lid as he has used for the sump tank of the system. These black barrels aren't much good for cutting in half as a growbed, but having a large removable lid makes them ideal for use as biofilters, and sumps. One interesting feature that Markcaso has obviously thought about with this system is a pump out point. In the main pump line from the sump tank up into the fish tank he's included a T with a valve off to the side. This means that he can attach a hose and open the valve, pumping water out of the system into the garden if required.

The system was stocked with Tilapia and has been very productive with both fish production and vegetables as you'll see from the pictures.

Early on plant growth is rather impressive

Tilapia are nearly always hungry, especially when the water is nice and warm



Floating raft tank ready to go, planted with seedlings

Scoria is a media suitable for use in aquaponic systems

Boris's IBC system

IBC growbed

Boris started with a 1250 litre IBC and plans to expand, which is most often the case when ones starts down the aquaponics path. After designing a custom fish tank that he built himself from bricks and mortar, he used cut down IBCs as growbeds to provide a shelter over the rectangle shaped brick fish tank. The growbeds provide some protection for the fish as well as proving shelter for rabbit pens he planned on adding later.

The system utilises the back wall of a courtyard and Boris aims to clad the IBC's with wood to give the system artistic appeal.

Gravel was used as Boris's grow media of choice in the growbeds and he used square patio tube cut to length to support the front of the growbeds as the weight of the media is quite substantial, the back of the beds are supported by bricks, built in to the fish tank structure. Water is pumped from the 2000 litre brick fish tank up to the three growbeds, water returning from each of these provides aeration to the fish tank below.

Initially a wine barrel was designed to hold water or for a future deep gravel growbed, however this failed to hold water and was later replaced by a 200 litre blue barrel. There is

Gravel media waiting to be placed in to first growbed

The metal base for the IBC is just deep enough that it can fit a 90 degree outflow pipe

IBC growbeds supported over custom designed fish tank

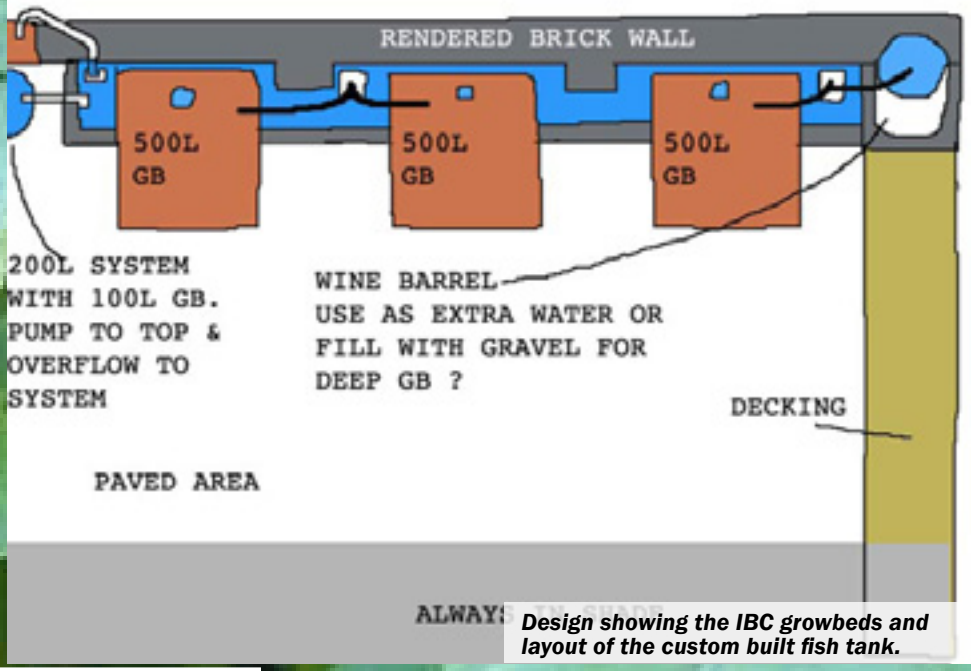
IBC growbed supported at the back with bricks and at the front steel legs were bolted on to provide the support

another blue barrel at the other end of the system which feeds a 100 litre raised growbed, which drains back to the blue barrel and overflows to the main fish tank.

The design is styled on the flood and drain media based system which operates using a stand pipe. Operating on a timed cycle, water is pumped up to the growbeds allowing the water level to rise to about two cms below the surface of the media, flooding for a short while, before draining back to the fish tank below. Boris has been an active contributor to the Backyard Aquaponics forum and hosted a get together to showcase his system with other likeminded individuals.

Custom designed fish tank in progress

The plates on the IBC cage are the perfect size to use as lids for the two ends of the pond



Design showing the IBC growbeds and layout of the custom built fish tank.

Square patio tubing supports the front of the growbeds

Water is pumped up the black growbed positioned above, returns to the blue barrel as shown here and overflows to the main fish tank.

Timber cladding brings style to the humble IBC

Originally a wine barrel was used here to hold water but leaked and had to be replaced

Rainbow trout on the barbecue. A very satisfying harvest

Rabbit hutches are shown here in the shade of the growbed and are a great way to utilise the space underneath

100 litre growbed filled with expanded clay fills from pump in a blue barrel

Snake's IBC system

Rockmelon

Two stainless steel milk tanks had been given to Snakes, which had been lying around doing nothing for a couple of years, right up until the time she found out about aquaponics. It wasn't long before she decided that these could come in very handy for keeping fish. So she began collecting IBCs as well as blue barrels and she began designing two systems, one at her dads place and one at her own house. Snakes got the blue barrels from her work and found the IBCs available for free, they had been previously been used for fertiliser and just needed a good clean.

The first growbeds were made from a blue barrel cut in half lengthways as well as the top of an IBC which was cut and supported with extra bracing underneath. It wasn't strong enough and the bed began to sag under the weight of the gravel, so Snakes decided that next time she would be using lighter expanded clay media.

Snakes used the remainder of the base of the first IBC to set up a sump tank. She estimates this will hold around 400 litres of water. The system is set up on a flood and drain cycle using standpipes.

Framework for the barrels under construction

Tomatoes are fruiting a bit early!

Blue drums have been in for 5 weeks, and big white one for 4 weeks

Tomatoes fruiting well

Water is pumped to the growbeds using a 3600 litre per hour pump through black poly pipe, with a tap at each of the beds to regulate the flow The timer is set to pump fifteen minutes on and thirty minutes off. Water drains through the growbeds and PVC pipe back to the sump tank. When the water level raises to a predetermined height the float switch kicks in and returns water from the sump tank, back to the main fish tank using a 6000lph pump. The system has since had additional growbeds added, including a blue barrel cut crossways another IBC made into a growbed with the frame from the bottom acting as a stand, as well as more half blue barrels.

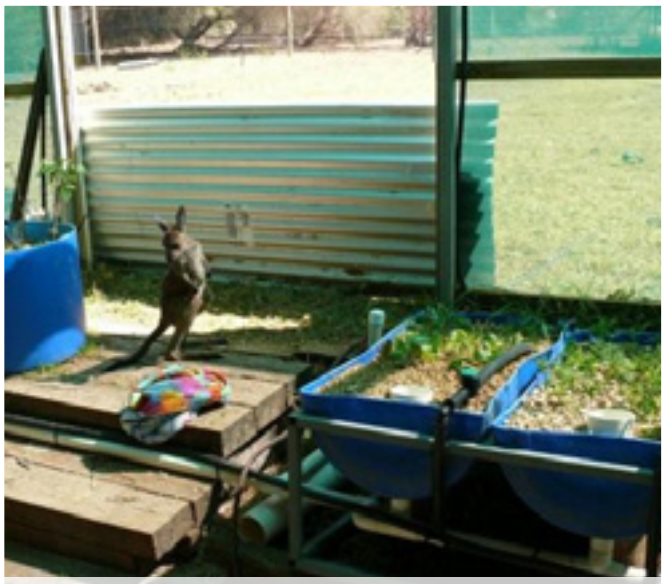
The system was stocked with Barramundi and a couple of water heaters were added to keep the water temperature up. Snakes reports that their growth so far has been fantastic.

Johnny looks on with interest at the stainless steel fish tank

Stainless steel milk tank

Sump tank with 6000lph pump and float switch

And so it begins



Planted 3 beds today with tomatoes, spring onion, garlic, raspberries, strawberries, parsley, lettuce, bok choy, rhubarb, asparagus, snow peas

The IBC collective!

The Barramundi have definitely grown, and look very healthy indeed

The tomatoes are still going nuts, and I've been eating tomatoes, lettuce, bok choy, and strawberries for a few weeks now. Picked my first beetroot yesterday

My dad- in awe!

Learnt a few lessons so far - gravel is really, really heavy, and the beds need a LOT of support!

Not enough support for this bed when the gravel went in

And some new beds

Mattyry's IBC system

WATCH the Video

4 IBCs en route to their new destination

Matt's aquaponics adventures continued with the development of his second system. He returned home one afternoon with 4 IBCs loaded up and well strapped to the trailer. This system was designed to go in to a hot house so that he could gain some better growth during the cooler months of the year. The original plan was to include a 1000 litre sump tank, dug in to the ground. However those plans changed when it was discovered that there was an easement in that location, and digging would be almost impossible.

Matt liked the idea of a CHIFT PIST system, so planned that a 1100 litre fish tank made from a single IBC would house the fish and this could overflow to three growbeds, before draining to the sump tank. The water level of the fish tank sits around 200-300mm above the top of the growbeds. An opening was cut in to the top of the fish tank for feeding as well as allowing access when it comes to harvest time. The IBCs that he had purchased were originally clear/white ones but he wanted to block out the sunlight so they were spray painted black. Three of them were then cut into 350 mm deep growbeds and the bottom of the IBC became the stand/sump. He wanted the growbeds to all be the same height and he used two cypress posts to support them on the bases. The bottom sections were then linked together increasing the sump size to around 1500 litres of water volume.

Broccoli

Bases were spray painted to reduce light and stop algae growing

Lettuces growing well in gravel media

Newly planted first growbed

Beetroot

Water is pumped from the interconnected sump tanks to the main fish tank from here it overflows through a SLO to the growbeds .

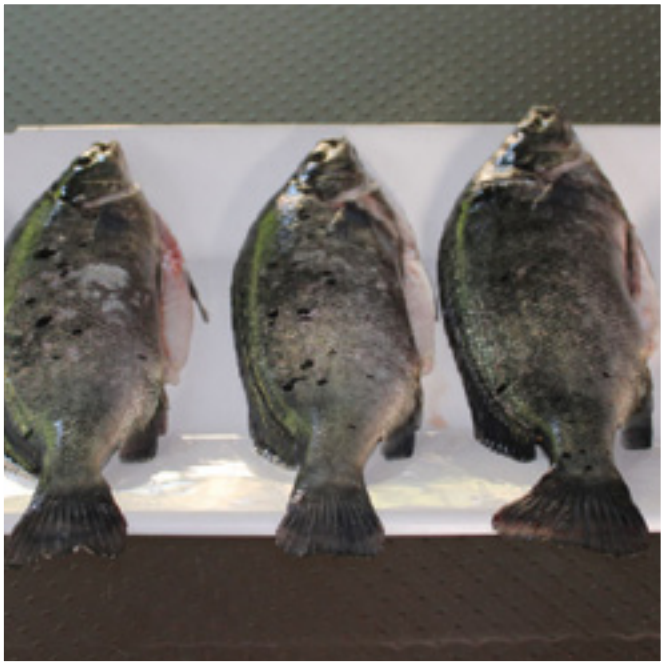
Each of the growbeds has a ball valve inline which can be adjusted or even turned off if required. Matt is very happy with his system, it has produced an abundant variety of vegetables including beetroot, broccoli, cucumbers and lettuces. Matt has also grown silver perch as well as some trout in the system.

Preparations begin by separating the IBC forming a sump tank and growbed

Silverbeet, cucumbers, broccoli and lettuce

Lord Viykor's IBC system

IBC cut in two the growbed is rotated 90 degrees to sit on the base



Lord Viykor found an IBC on Ebay for his first attempt at an aquaponic system. He cut away the top part of the cage and created a standard 300 mm deep growbed, to which he added some strapping underneath for extra support. This section was rotated 90 degrees and sits above the base which is the fish tank, trimmed to hold around 600 litres and allowing access from the front through an opening in the framework. The cage bars pointing upwards were edged with timber to stop any injuries from the sharp metal.

A 4800 litre per hour pump was placed at the back of the fish tank, and water is pumped up to the growbeds for 15 minutes each hour. Some slight modifications were made to the system, the pump was moved to the front area of the fish tank. It will be much easier to access if there are any problems.

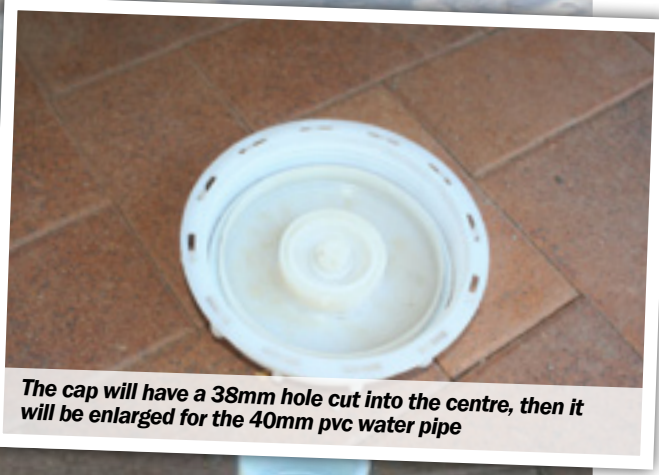
20mm gravel was chosen and works very well as a variety of different plants have grown easily in this system. Jade perch as well as goldfish live in the fish tank providing nutrients for plants growing in the growbed above. Shadecloth was wrapped around the fish tank to minimise sunlight causing algal growth. Vegetables grown in the growbed have included tomatoes, habanero chillies, coriander, lettuce, strawberries and basil.

Also put an edge around the grow bed on the IBC frame

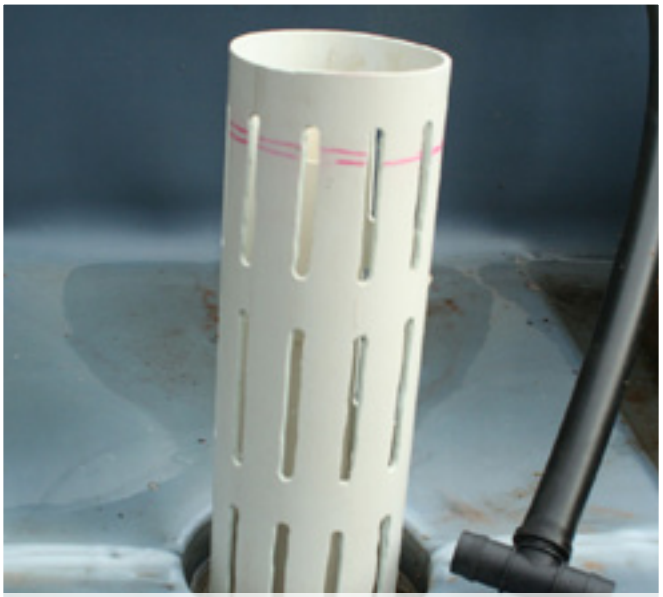
20mm washed river gravel for the grow bed

An inline tap allows for flow adjustment as water is pumped to growbed as well as to the surface of the fish tank providing additional aeration.

Filling the growbed with water as a test run



The cap will have a 38mm hole cut into the centre, then it will be enlarged for the 40mm pvc water pipe

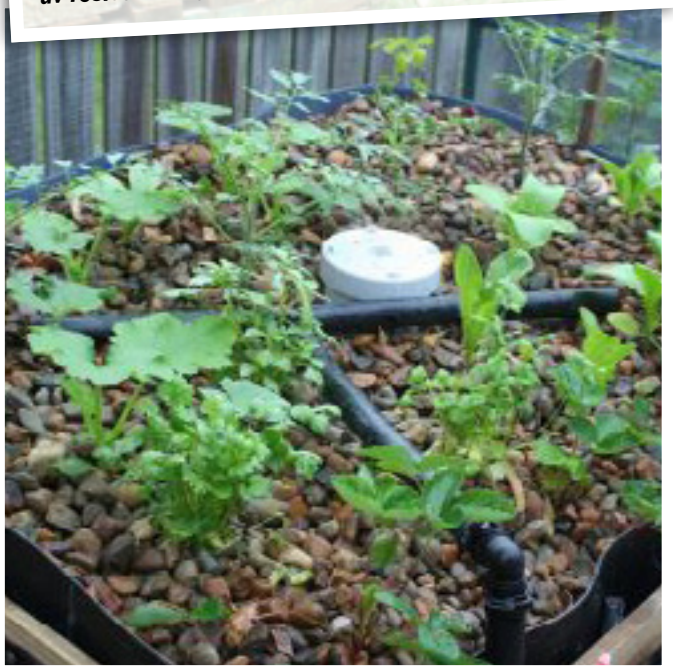


Standpipe surround ready to hold back media. Holes are cut to allow water to flow through

Fittings installed in the lid of the IBC

Habanero chili

The IBC was purchased from Ebay and supposed to be uv resistant hdpe



Strapping has been added for extra strength

Zman's IBC system

Shadecloth was wrapped around the fish tank to reduce the light in the fish tank

Growbeds must be well supported to save pain and heartache later

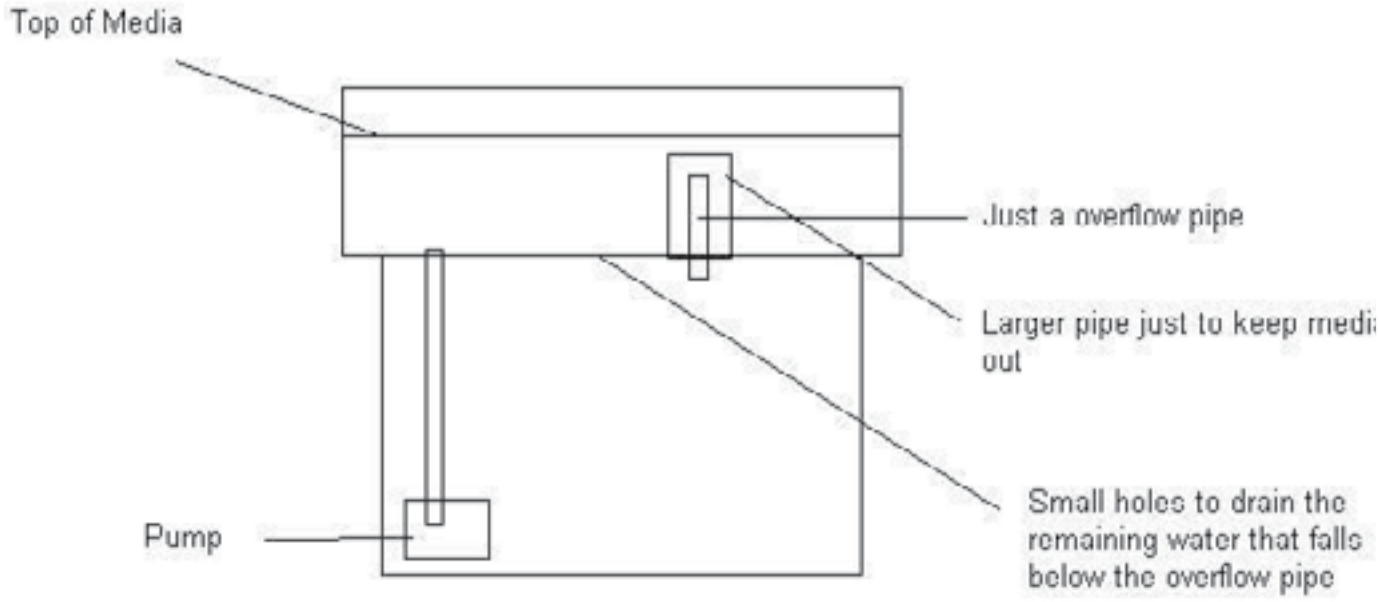
Zman found an IBC that had previously been used for storing window cleaner. He firstly cut it in to two sections, one that would hold around 600 litres of water and the remaining section would form the growbed of around 400 litres. He began by cleaning the IBC with warm soapy water before letting it dry out in the sun. He tested the tank to see if it was fish safe by adding a couple of goldfish that were easily available. Later silver perch and yabbies were added to the system.

The water in the fish tank is pumped up to the growbed using a 4000 litre per hour pump and was initially running full time, maintaining a water level height just 2cm below the surface of the media. The fish tank water runs through 25mm pipe and elbows channel the flow directly over the surface of the Hydroton. A ball valve and tee under the growbed divert some of the water flow back to the main fish tank providing aeration. Additional aeration is supplied by an airpump with 4 clear airlines attached to stones, these sit on the floor of the fish tank and bubble up through the water.

The spinach was not growing well as the roots seemed to be getting water logged so the standpipe was trimmed by a further 1cm and this worked well, later some seeds were added and began to germinate within a few days.

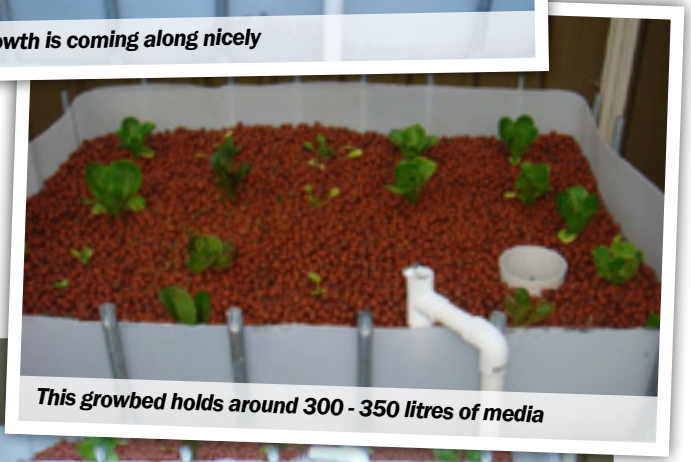
IBC and olive barrels

Piping and fittings under the bed



Seedlings are easy to plant in expanded clay

Plant growth is coming along nicely



This growbed holds around 300 - 350 litres of media

Seeds and seedlings doing well

I now regret setting up the GB on top of the FT. So hard to look at the fish and yabbies!!!

Blissy's IBC system

3000lph submersible pump

Blissy's system consists of eight grow beds which are made from 200 litre blue drums cut in half. Two bath tubs were used as sumps and a 1000 litre IBC as a fish tank. The system is CHIFT PIST, with water flowing through 25mm poly pipe to the growbeds. The beds then drain through 19mm poly into the bathtub sumps which have been stocked with a few yabbies. Shade cloth has been used to cover the entire system, to minimise evaporation as well as to keep sunlight off the IBC and reduce the amount of algal growth. The IBC originally had citrus based environmentally friendly degreaser in it, but was thoroughly cleaned out for use. There was a little algae growing in the fish tank which is a good sign that it can harbour beneficial organisms. PVC pipes were cut to lengths and placed in the sump bathtubs for yabbies to hide in. Blissy later managed to get hold of an old rainwater tank which held more than 3000 litres of water and this was eventually added to the system. The materials were locally sourced and show how resourceful and cheap a backyard aquaponic system can be. Fresh fish and vegetables can be easy to grow in your own backyard saving you the trouble of getting to the shops and then storing the produce for later use.

Poly pipe is directed to each of the blue barrels to irrigate the plants

3000 litre rain water tank added to the system

The system is now 1 year old.

Trout harvest

Rainbow trout growing well in system

Shadecloth covering reduces evaporation

Shadecloth covering was added as summer temperatures reach 42 degrees

Jaymie and Axl's IBC system

Bathtub growbeds filled with gravel

When Jaymie and Axl scored another free IBC they decided that it was time to set up a system that would house redclaw. They managed to get a couple of bathtubs and set about building a rack on top of the IBC to support them. The fish tank IBC has also been set up with plastic bread crates stacked on top of each other to make homes for the redclaw. Bricks have been placed above the bread crates to weigh them down and stop them from floating. A pond pump in the IBC pumps water straight up to the two bath tubs, where it is diverted at a tee piece and dumped directly on the surface of the gravel. Simple standpipes are used in each bed and the water is run on a timed cycle of 15 minutes every hour. Water then drains back via gravity from the beds to the redclaw tank below.

The beds are in the blazing sun with limited shade and are producing sage, thyme, rosemary, welsh onions, fennel, tomatoes and Ceylon spinach which are all doing very well. The redclaw manage to keep out of sight and the tank is now home to 8 large rainbow fish and 2 juvenile tandanus catfish as well.

Bread crates must be weighted down as they will float

Bread crates provide multi level living spaces for redclaw

Jaymie planting out the bed with little helper

The rack on the sump will support the bathtub growbeds

Water returning from bath adding aerations as it breaks the surface

Redclaw haven

Redclaw

20 redclaw added to their new home

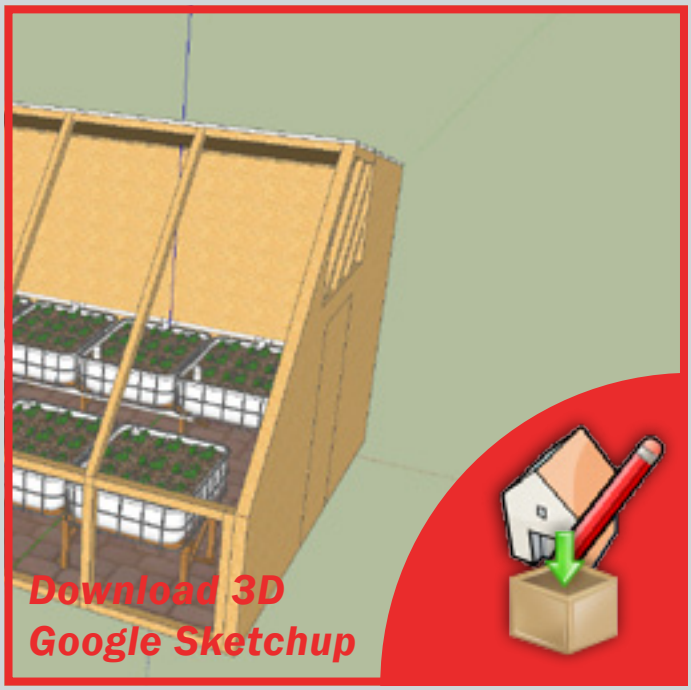
Redclaw hides can be made from simple PVC pipes

Vines planted to shade the chookpen

Welsh onions, thyme, rosemary, sage, basil, fennel and some feral cherry tomatoes

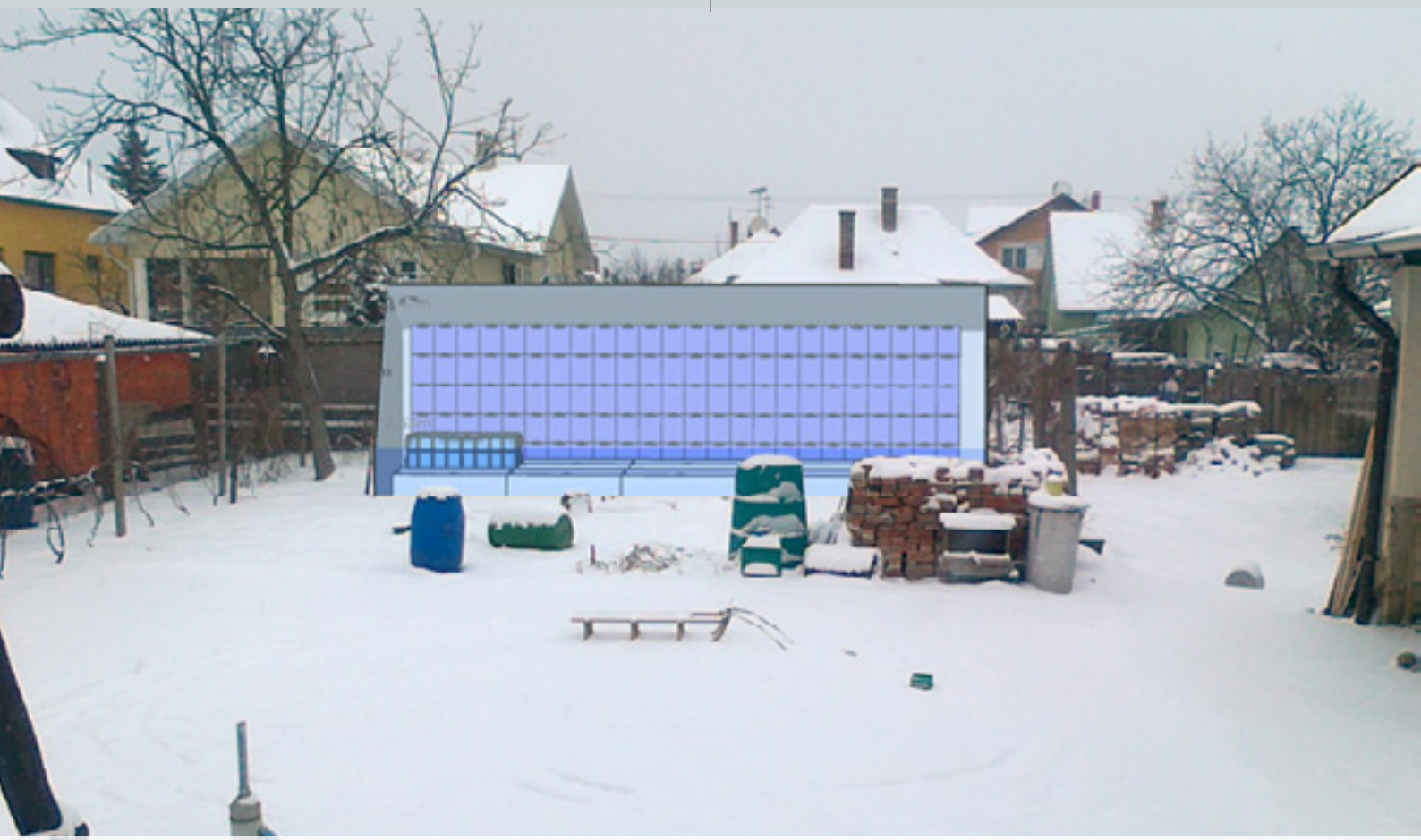
Zsazsa's IBC system

WATCH the Video



Zsazsa is from Hungary, and Hungary has a continental climate, where winter temperatures can get down to minus 17C, however summer can also be fairly warm reaching 35C. Because of these contrasting conditions a great deal of thought would have to go into not only the system design but also how the system is housed. When temperatures are down to -15C, if your aquaponic system is this cold then you're not going to get any plant growth let alone fish growth.

So an intrinsic part of Zsazsa's aquaponic system was going to be the design and construction of his passive solar greenhouse where the system would be located. As you will see from the following photos showing the construction of the system the solar passive greenhouse is quite a beautiful construction. Luckily for Zsazsa he was a member of a Hungarian folk dancing group and he invited friends from the group around to help with the foundation works. The greenhouse is partially sunk into the ground; this aspect of the design will help retain heat throughout the winter. The foundation wall has been constructed from recycled bricks



3D model transposed over a winter picture

A busy worksite, it pays to have friends when there's lots of digging to do

A team of happy workers laying the foundations

Foundations of the greenhouse finished

Brick foundations starting to take shape

to a height of 60cm, while the whole greenhouse structure is 3.6m x 6m x 3.6m high. The south facing window is a 10mm double layer polycarbonate and the rest of the structure is well insulated. The back wall will eventually be a solid mass of recycled 20litre plastic drums, this will add fantastic thermal mass within the greenhouse that will be heated by the sun during the day, then release heat into the greenhouse during the cold evenings.

The actual aquaponics system will run as a CHIFT PIST system, consisting of a 1000L IBC fish tank 9 x 300litre IBC growbeds and 3 x 400L interconnected IBC sumps. The fish tank will be stocked with Wells catfish, which should suit the conditions in the greenhouse quite well.

The growbed supports are made from very large heavy duty wooden beams with regular vertical supports, this heavy duty support is going to be required with the total weight of rock and water being supported. Zsazsa wanted the benefits of planting in and working with expanded clay, but didn't want the costs associated with such a large volume of clay, so the beds are filled with rock media in the bottom 2/3rds, then topped up with expanded clay.

At the time of writing this manual Zsazsa was just finishing his system and starting to cycle so unfortunately we can't show you any pictures of his actual fish or plant growth in the system. By the time you are reading this, the system will probably have been running for a while, so click the button at the start of the article and check out his discussion on the forum, there will be loads more pictures, videos and further information about his system and how it's been performing.

With the structure well on it's way to completion, time to check how the system is going to fit

Greenhouse walls being constructed

Growbed frames and one sump frame

IBC's a plenty

Wels catfish should be ideal for this system

Heavy duty beams to support the growbed

Checking how everything is fitting

Polycarbonate window fitted and IBC bits ready to go in

Heavy rock media

A proud Zsazsa in his greenhouse

Outbackozzie's second IBC system

It's hard to know where to begin with Obo's second system, it's just going to be so huge. The plan is that this will be a commercial system producing seasonal fish and vegetables for the market in the Kalgoorlie region of Western Australia. For those that don't know the area well, Kalgoorlie is a mining town that's situated a long way from the coast. Most of their fruit and vegetables are trucked in from hundreds of miles away and the town's water is pumped from over 500km away near Perth in a large pipeline. What better idea than to set up an aquaponic oasis in this mining town that only receives about 250mm of rain each year.

Obo managed to source some 12,500L fish tanks and a large number of IBC's, now all that was required was a good plan for a system that wasn't going to cost too much to set up, yet one day in the future could provide a return on the investment.

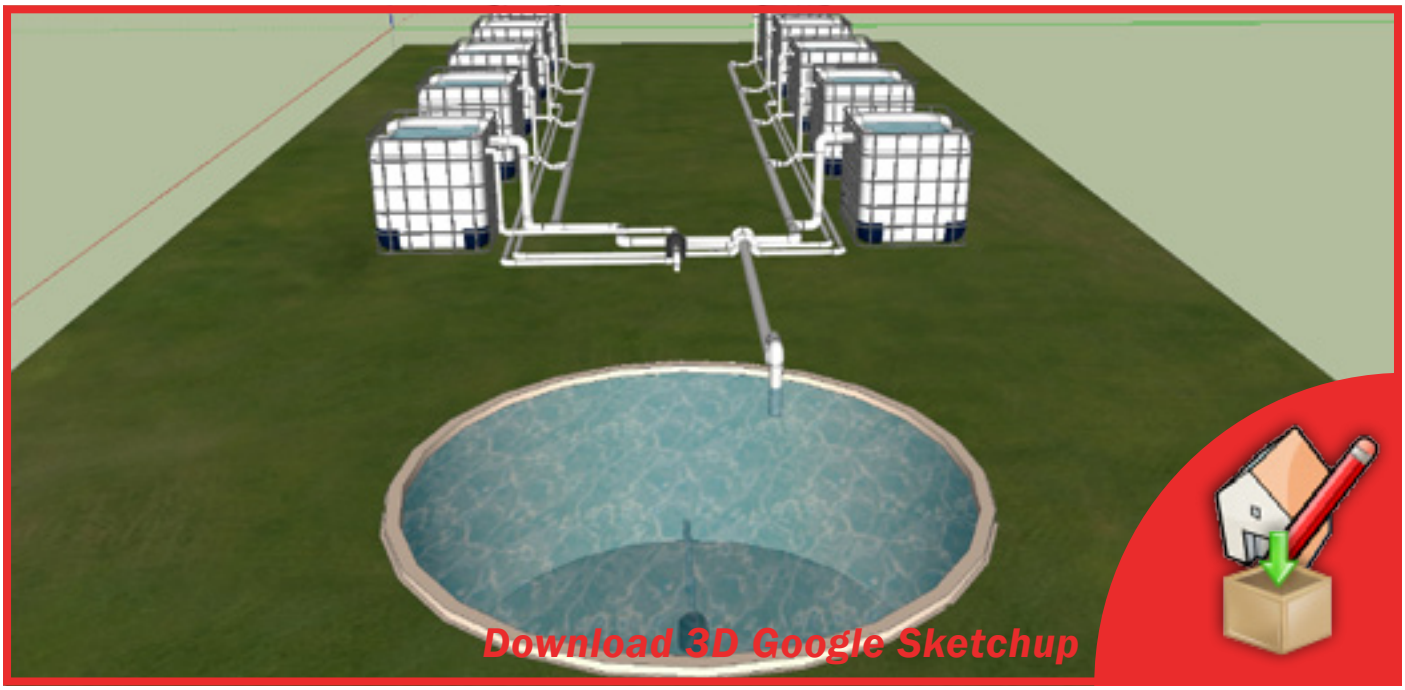
He managed to find some land for lease in Kalgoorlie which was going to suit the purpose of the large aquaponics system well, while also leaving some space for his other diesel fitting business on the side. Mixing the work that has to be done to pay the bills, with the setting up of the aquaponic dream systems.

Ultimately the system is planned to have 45 IBC growbeds off each large fish tank. Obo decided to leave these growbeds whole, so they are 1m deep, he had experimented with this deep style of beds in his previous system and like the way they worked and their simplicity, plus if you can fill the IBC's with media mechanically with some sort of digger or loader then "why not"? The rock media is very cheap to buy.

The first task was to dig the fish tank into the ground. This system was going to be running by simply pumping up to the beds and having the water flow back down into the fish tank. The hole for the fish tank was dug with a ride on mechanical digger, then a crane was used to lower and position the fish tank into the large hole.

Once the tank was buried it was time to lay out the IBC growbeds heading in duel lines out away from the fish tank. The first two IBC's closest to the fish tank were going to be used as additional 1000L fish tanks. This would allow fish of different sizes or different species to be separated from the main tank where required.

Pumping to so many growbeds was going to create some issues with the water levels in the fish tank if all the beds were filled at once so a sequencing valve would be included, this would allow water to be pumped to sets of growbeds one after the other, along with the extra IBC fish tanks. The steel bases were removed from all of the IBC's as they are not required when the growbeds are going to be sitting on the ground. Substantial fittings and piping were required for this project, each IBC has a large tank fitting installed near the base for the drain these 50mm and then plumbed into a main 100mm drain.



Plants all growing well

Growbeds filled with plants

Mesh next to the IBC's provides a trellis for the plants

The supply irrigation lines are set up to pump from the sequencing valve into 2 beds at a time. Each time the pump is switched off, it swaps from one set of beds to the next, then the next and so on. The two IBC's that are acting as extra fish tanks are also set up to with their own outlet of the sequencing valve.

This is just the piping and set up for what will ultimately only be half of the growbed on the fish tank. Phase 2 of the system is to expand by repeating the same setup of growbeds on the other side of the fish tank.

To date both 12,500L fish tanks have been buried into the ground and the first phase of growbeds and plumbing have been installed and completed and have been running for some time now. The second pumps for the second phase of the system, doubling the number of growbeds on each tank are already plumbed into the tank and ready to go, it's just going to require a whole lot more work to double the growing area.

Tank fittings are one of the safest ways to plumb an IBC

Positioning the enormous fish tanks

IBC's being filled with media while plumbing is being organized

Fish tank IBC's are part of the system

A freshly planted grow bed

Freshly planted new system

Filling the whole IBC's with media is easy when you have the right tools

Standpipe surround to keep media away from the standpipe

Covering the tanks for safety

Sequencing valve

Plants grow extremely well in the system

Mantis's IBC system

Details of the standpipe and media guard in the growbed, with the drain pipe coming out of the bottom into the sump

Great flow rate coming from the pump

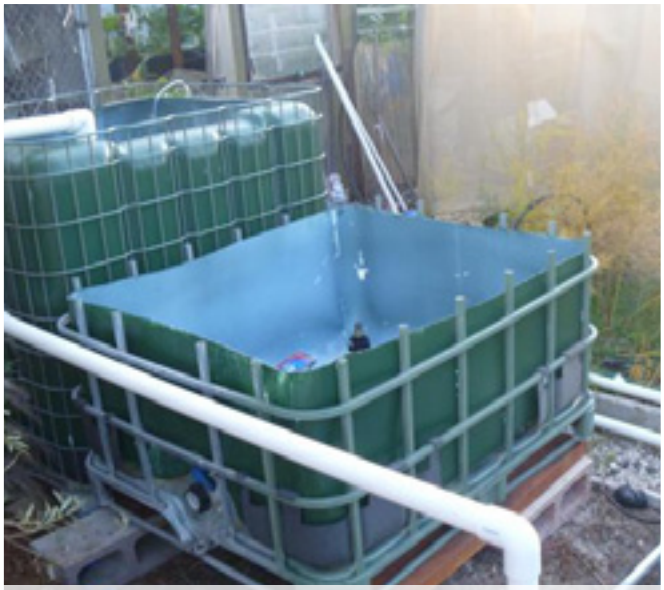
Mantis has set up a fairly straight forward CHIFT PIST system here using 3 IBC's. One IBC has had its top section cut out of it for the fishtank, another has also had its top cut out and it forms the sump of the system. This second IBC had to be dug into the ground, not such an easy task when your ground is very hard, but eventually a deep enough hole was dug to get almost the complete IBC into the ground low enough that the growbeds would be able to drain into it under gravity.

There are two growbeds on the system, these are made from half IBCs so they are a good deep growbed. Mantis has used two bottom halves of the metal outer part of the IBC. This is a great idea for growbeds because you have the additional support for the media filled growbeds. The second metal base came from the sump tank, the buried sump needs it's outer frame support but it doesn't need the steel base, it only needs a flat earth base to sit the inner plastic container of the IBC.

There's a 9000L/h pump in the sump that pumps water up to the fish tank IBC through the main 40mm pipe, the water then flows out of the fish tank into the two beds before flowing from the beds into the sump again. All of the IBC components above ground have been painted green for the dual purpose of looking a little nicer as well as making the plastic more resistant to UV degradation. Mantis is adding to his system and modifying quite a bit, when we first started this manual he only had the one bed, now he has 3 growbeds. By the time you read this, who knows how many beds he will have.

Second growbed being set up

Sump tank finally in it's hole



IBC's are painted not only to look nice but also to stop UV degradation of the plastic

The steel base of the IBC cage is not required when burying

Pump set up ready to go

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And so it begins

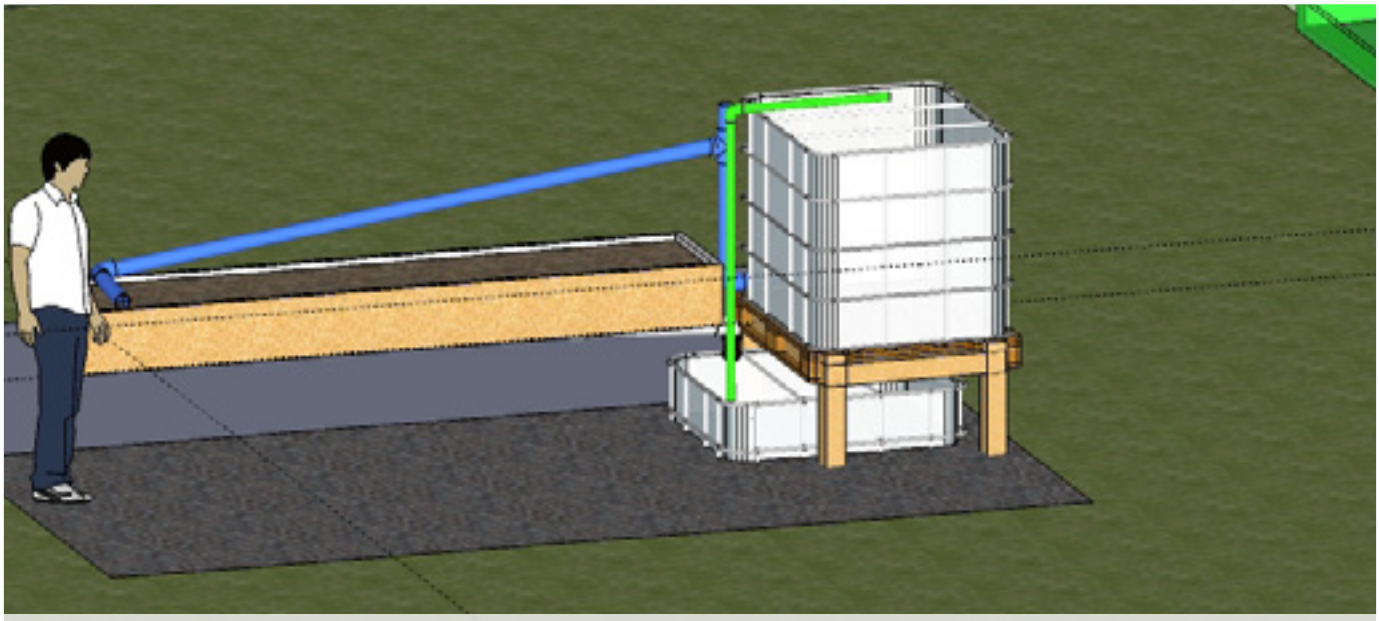
Joey's IBC system

Joey's IBC system has a 1000 litre IBC partially buried under the fish tank and offset so that he can put a step on top of it to gain easy access to the fish tank.

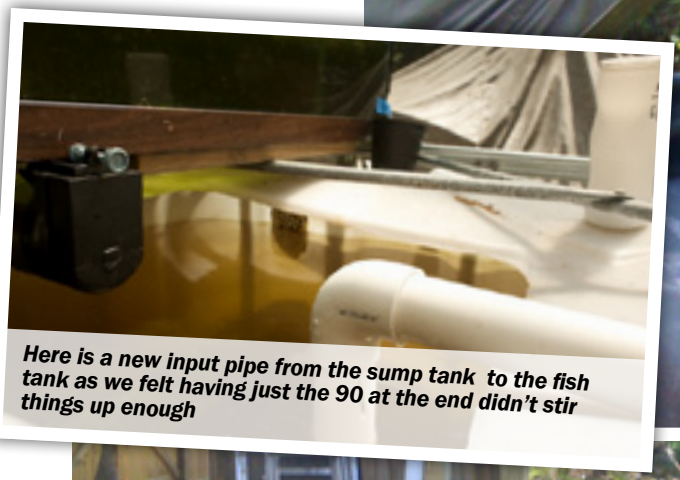
The growbed is 2.5' x 11' which is just over 200 gallons and made from ¾" ply and lined with black plastic liner. 2 x 4 timbers are used around the whole frame and then screwed together with 4 1/2" strong tie tags, about 60 of them in total.

A 1hp pump was used initially to deliver water from the bottom IBC to the top IBC which in turn overflows through a 4" pipe to the growbed. The bed fills in around 10 minutes and the water then drains out of the growbed in around 10 minutes, through small holes and back to the sump tank. A ball valve in the bottom of the growbed allows for adjustment in the system. The system then had a greenhouse frame constructed with clear plastic to protect against pests and extreme weather conditions. Though Joey found that when a storm blew the roof off and the plants became exposed they started to grow much better. Some of the growth had been quite leggy indicating they were not getting the sunlight they needed for optimum growth. Additions are planned for the system in the form of NFT channels as well as another growbed. Aquaponic systems are often expanded or second systems begin evolving, sometimes even before the first ones are complete.

Simple standpipe with surround acting as a media guard



Design Layout



Here is a new input pipe from the sump tank to the fish tank as we felt having just the 90 at the end didn't stir things up enough

Pumping from the sump tank into the bed with the giant pump

When I was standing waist deep in the hole I was beginning to wonder if I'd lost my mind. The wife questioned my sanity when I was inside the IBC in my swimming trunks with assorted scrub brushes and soaps

Testing the waters

Carrots transplanted in to the growbeds

The biggest tomato plant, looking very viney with no blossoms or fruit

Looking down the growbed the basil has perked up a bit

Some rather spindly looking squash and zucchini

Quachy's IBC system

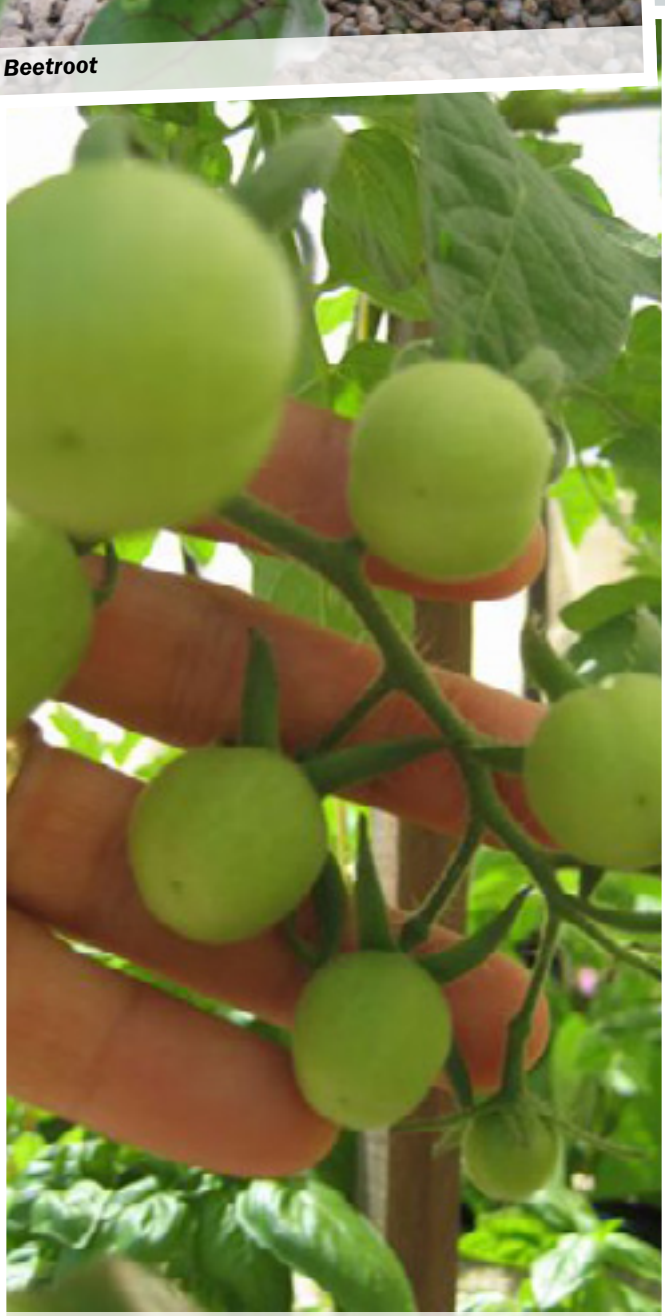
Beetroot

After the success of Quachys first concept system he decided that it was time to get serious with his second system, now that he had seen for himself that aquaponics really works. He set out with 4 IBCs and decided on the popular CHIFT PIST method. This allows the water to remain at a constant height in the 3 IBC's that would serve as fish tanks and the fourth IBC acts as a sump tank. The sump tank is dug in to the ground and a hatched deck has been created over the top and hinged for easy access to the tank below. Drain pipes are covered making it a very neat system. The fish tanks have been screened with bamboo fencing to keep out the sunlight and stop algae growing.

The benefit of having separate tanks include having different species of fish as well as being able to grade fish by size, essential with some species. The original system can be used as a nursery for fingerlings or as a hospital tank.

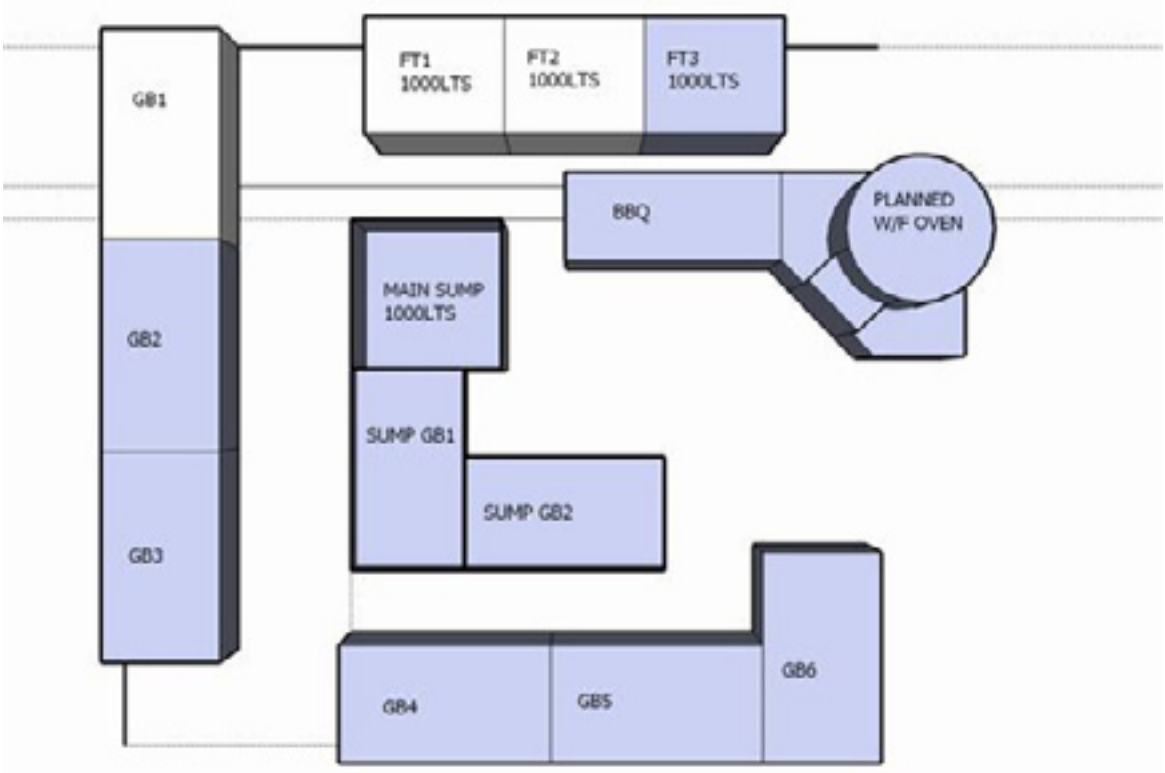
The growbeds were made from 500 litre stock troughs and filled with gravel, donated by a friend. Quachy's aim was to have a ratio of one to one, so for every litre of water he would have a litre of growbed medium as his biofilter. 3000 litres of fish tank water and 3000 litres of growbed medium.

For Quachy the progression to Aquaponics from a traditional dirt garden was very easy as both he and his wife are keen organic gardeners. He joined the Backyard Aquaponics forum after doing a quick search on the web and spent hours upon hours of reading and designing before posting pictures and sharing the progress of his successes with other forum members. He says "being able to provide fish for the family were added bonuses to the masses of fruit and vegies aquaponics can and does produce."



Healthy crop of tomatoes

Garnished and ready for steaming



It is only the beginning

Decking is hinged and can be accessed when required

Pipework is hidden discretely under the decking and out of sight

More IBCs and the in ground sump tank with child proof cover

Fish tank IBCs shown at rear

Shadecloth provides shelter from the hot sun

IBC screened with bamboo fencing

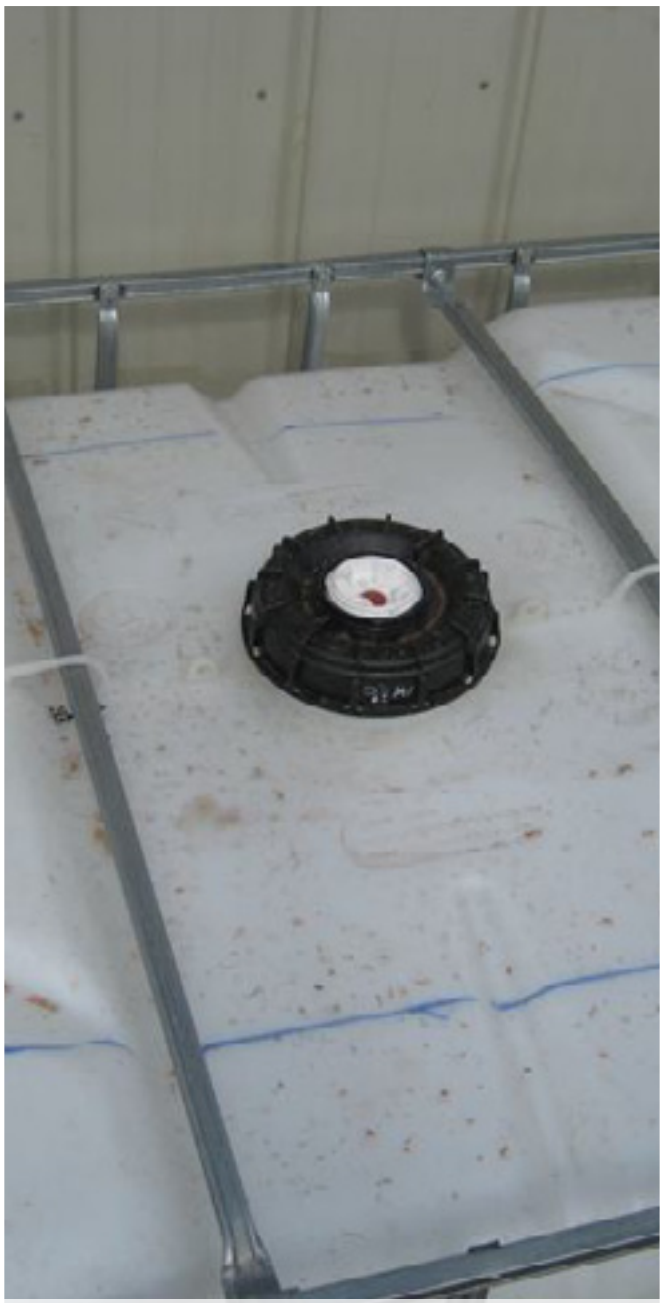
System overview

Plant growth coming along nicely

Carrots and corn going crazy

Tilkey tubs and olives barrels awaiting their new position

System laid out and ready to go



IBC marked out for cutting

More tomatoes

Cucumber just developing

Strawberries

Gone Fishin's IBC system

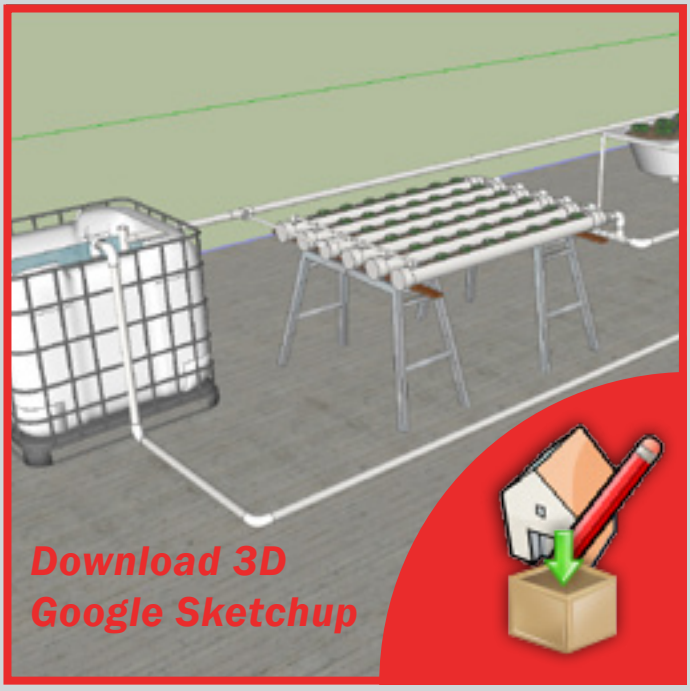
Gone Fishin has managed to get a system up and running using two standard 1000 litre IBC's, three bathtubs and an NFT style addition. The system is run as CHIFT PIST but without having to bury any of the components as the setup will be installed on an existing concrete slab, making it an easy site to work with.

The second IBC was cut down to about half way, this forms a sump tank of around 500 litre capacity. Water is pumped from the sump tank to the main 1000 litre IBC using a 2400 litre per hour pump. When the fish tank water level rises, the tank will overflow through a 50mm pvc pipe on to the growbed via gravity feed and then from growbed to sump tank.

The bath tubs are metal and have been thoroughly checked over for any signs of damage due to leaching and the risk to fish. The volume that each bathtub can hold is around 600 litres of media, which in this case will be a course gravel. The water level in the bed has been managed with a simple standpipe and surround acting as a media guard. Water flow is adjusted at each of the beds using ball valves.

The channels were originally plumbed with 19mm and 13mm poly pipe, but water flow was not sufficient as the pipe would not lay flat and was eventually upgraded to 25mm pvc to allow the water to flow more easily. The system has performed well and barramundi were harvested and enjoyed as well as a range of vegetables which included radish, carrots, asparagus which was suggested by his wife and appeared to b growing very well.

All in all a great little combination of aquaponic styles in a neat system, thats performing well.



Garlic and brassicas

Celery stalks covered and growing well

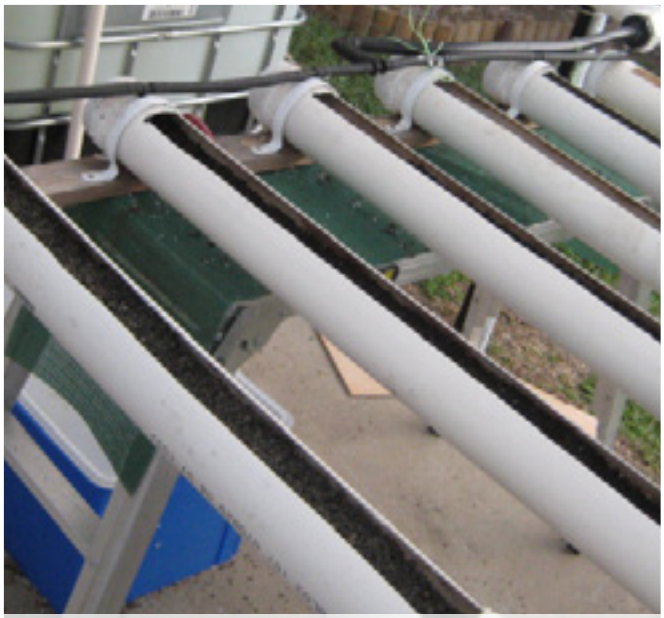
IBCs, bathtubs and NFT style channels

Plate size barramundi

Overview bed 3 beans radishes and garlic

Media guard surrounded by onions

Pipework plumbed and ready to check for leaks



Original polypipe since upgraded to PVC

Asparagus spears

Radishes are quick and easy to grow

Ivansng's IBC system

1st 2 IBC's in place with tank fittings installed and trenches dug ready for pipe work

This is Ivan's third system. Originally he bought an off the shelf BYAP system, however this only encouraged Ivan's curiosity about aquaponics and started him down a path of experimenting with ideas of his own, where a second smaller prototype system was put together using components obtained from local hardware stores. Eventually he had sufficient confidence to embark on a major aquaponics design using a combination of second hand IBCs, blue barrels, an off the shelf tank and other components that would certainly transform his boring backyard into a functional food-producing one.

His third system is vast and fairly complex to get a grip on at first, but it's well designed and very carefully thought out, in fact he went to great lengths in designing his system in 3D using Google Sketchup before building it.

Decided that the bamboo thing covering the IBCs was too crappy looking and seems to have weathered to a bad state. So I got a handyman to clad up the IBCs with the corrugated sheets of the same colour to the wicking garden bed

At the heart of the system is a 2000L off the shelf tank. Water is pumped from here to a few different areas through a sequencing valve. If you're not sure what a sequencing valve is, try looking online for further information. It's basically a distribution valve that has one inlet port (from your pump) and then a different number of outlet ports depending on the one you buy. Say you have a 4 port valve, one inlet, and four outlets. When you turn the pump on, water will flow out of port 1, then when you turn the pump off then on again it will stop coming out of port 1 and come out of port 2, then when you turn it off and on again water will flow out of port 3. Then port 4 and then back to port 1. This sort of device allows you to have many growbeds and by switching the pump off and on you can water different growbeds sequentially rather than all at once. Of course, a timer or similar is used to continuously cycle the pump off and on. But back to Ivan's system.

In the first zone (port 1) water is pumped into two complete IBC's that act as very deep growbeds, filled with blue metal rock media. These growbeds drain straight back into the 2000L fish tank. In the second zone (port 2), water is pumped to 4 blue barrels filled with media (with fruit trees planted in them) and a 500L BYAP growbed. These also drain back into the fish tank. Another IBC acts as an additional raised fish tank that is turned over with tank water every time the pump is turned on. Water from this raised fish tank overflows back into the 2000L fish tank.

As you can see from the plans, this system is still going to be added to over time. At the moment, a third zone is planned with 1 additional complete IBC and 4 blue barrels filled with blue metal rock media. To get the latest updates, get online and check out the latest posts on Ivan's third system.

The whole IBC growbed is filled with crushed granite media

Peaches starting to ripen on the dwarf peach tree in half barrel

Super long standpipe and standpipe surround

Tank cover over the 2000L fish tank

Dwarf peach tree producing a strong crop

PVC greenhouse frame in place

Dwarf lime tree planted in half barrel

Skygazer's IBC system

Week two growth

IBC fish tank

Skygazer has created a classic recycled system here using lots of different recycled materials. The IBC is the fish tank, then there's two bath tubs for growbeds, and finally a recycled wheelie bin for a drain tank. Because of the slope in the land and the way the system was laid out against the house , there is one pump in the fish tank with a timer on it pumping into the bathtub growbeds. The growbeds then drain into a partially buried wheelie bin, under the house just behind the steps. This wheelie bin sump has a sump pump in it with a float switch, this allows the water to be pumped back to the IBC automatically.

The pump in the fish tank is only 1000L/hour, while the sump pump in the sump tank is about 7000L/hour. The pump in the fish tank only runs for 30 minutes, then it's off for 30 minutes giving time for the beds to drain. Then of course the pump in the sump only turns on with its float switch, being 7000L/hour it doesn't stay on for long when it pumps back to the fish tank. Originally the system was only stocked with half a dozen goldfish to cycle the system, once things were running well, 20 Silver Perch were stocked into the IBC fish tank.

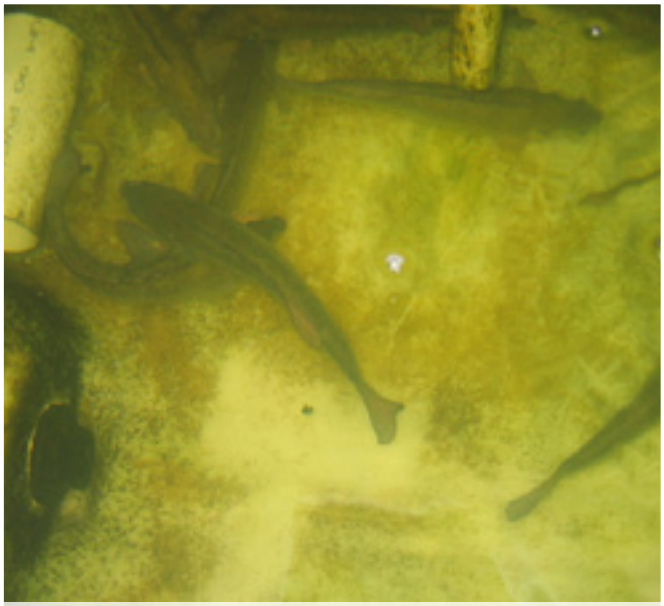
Use of bathtubs for growbeds was quite handy because they have built in drain fittings. To make it a little more aesthetically pleasing one of the growbeds has been surrounded with timber. Ultimately the plan is to cover the other growbed with timber as well so that it blends in with the house. This system was a proof of concept for Skygazer to try out aquaponics on a small cheap scale before advancing to a much larger system.

Timber surround on the fish tank

Second bathtub grow bed has been added to the system

Timber slats around the bathtub to help it blend in

Netting placed around plants to protect them



Silver perch were added to the system once it was cycled with goldfish

Great crop in second tub

Alosthippy's IBC system

Fish tank

IBC cut to make a growbed

The lost hippy just goes to show how cheaply and easily you can start an aquaponics system using readily available items that others are throwing away. In his own words "I went for a gleaning day through the local industrial area and got more 44 gallon drums that I needed, some wheel rims, 2 beds, pallets etc! The only thing getting in the way now is work."

To be able to work with the 24 degree slope of his land the drums were dug in before being filled with water to keep them in place. Pallets were placed above them to create a base for the top third of an IBC that he was going to use as a growbed. Other growbeds included 160 litre black plastic tubs from Bunnings, the national hardware chain store, and preloved bath tubs. Many of the plumbing components came from demolition yards and the local hardware store. He confesses that he has spent countless hours reading the Backyard Aquaponics forum and asking numerous questions.

The growbeds are filled with a course gravel medium which is irrigated from the fish tank along pvc pipes which then change to a black poly pipe. An inline tap is fitted and water is then diverted to each of the growbeds, where it drains with the help of a siphon. A siphon system relies on a certain level of water being in the system. Water levels must be kept up to allow the siphons to run, if the level drops the siphons are unable to operate. Fortunately he installed a diversion pipe back to the sump which means if the siphons failed to trigger the pump would still be moving water and wouldn't pump dry. One bucket of water can make all the difference and when added to the system is all that was required to trigger the siphons and away it goes again. This can become a problem in areas that are both hot and dry and prone to high evaporation rates.

View along the outflow

Crustaceans make great inhabitants of sump tanks as they help keep the bottom clean

PVC offcuts form hidey holes for yabbies and redclaw.

One month after planting

Jim still standing guard

The growbed

Go little fellas....

Purple king climbing bean and they were yummy...

Pesky empties are still breeding

So...this is where all the beans went....and only one is mine!!

Seemore's IBC system

Seemores system was started in a greenhouse using an IBC and two bathtubs, materials that were easy to obtain and locally available. The greenhouse made of plastic offers some protection during the cool winter months and provides a cosy growing environment. Initially the pump was set to run continuously, though the idea was to set it up as flood and drain design and a timer was later installed after reading many threads about the timing of flood and drain systems . Once the timer was added the beds would actually get a chance to drain, allowing more oxygen around the root zone and allowing the plants a period of dry time.

Polystyrene was used to cover the outside of the fish tank and stop the sunlight hitting the water. As the sun hits the water it contributes to growing algae, although the goldfish would be happy to nibble away, making them almost self sufficient.

Frames were welded together using recycled steel and keeps them raised above ground level, pipe work is free to drain to a sump tank which is located at the junction of the two bathub growbeds. Raised beds have the added advantage of keeping the plants away from the ground dwelling pests.

A larger pump was installed which helped with getting the solid waste out of the fish tank and in to the growbeds, where it was better able to provide nutrients to the plants growing in the bathtubs. This was an obvious advantage as the plants were reported to have started booming once the larger pump was added.

A good idea to block sunlight from the IBC and reduce the green water stage

Greenhouse offers protections from the elements

Zucchini and cucumber, tasty and abundant

Gravel is locally available in many areas and makes a cheap growbed media

Goldfish are easily obtained and a great way to start out in aquaponics

Inline taps are used to regulate the water distribution to the bathtubs

Plants growing well in bathtub

Bathtub supported by metal frame

Edroe's IBC system

Ed started out with a couple of IBCs and a few blue barrels. One IBC will be home to the fish and the other IBC will serve as a sump tank which is partly buried. Eight barrels have been cut in half to make a total of eight growbeds. After displacing a mountain of sand to bury the second IBC the layout began to take shape, before it was on to shovelling and washing a ton of pea gravel. A back breaking job for sure, but part of the induction to Aquaponics as any experienced aquaponics person will tell you.

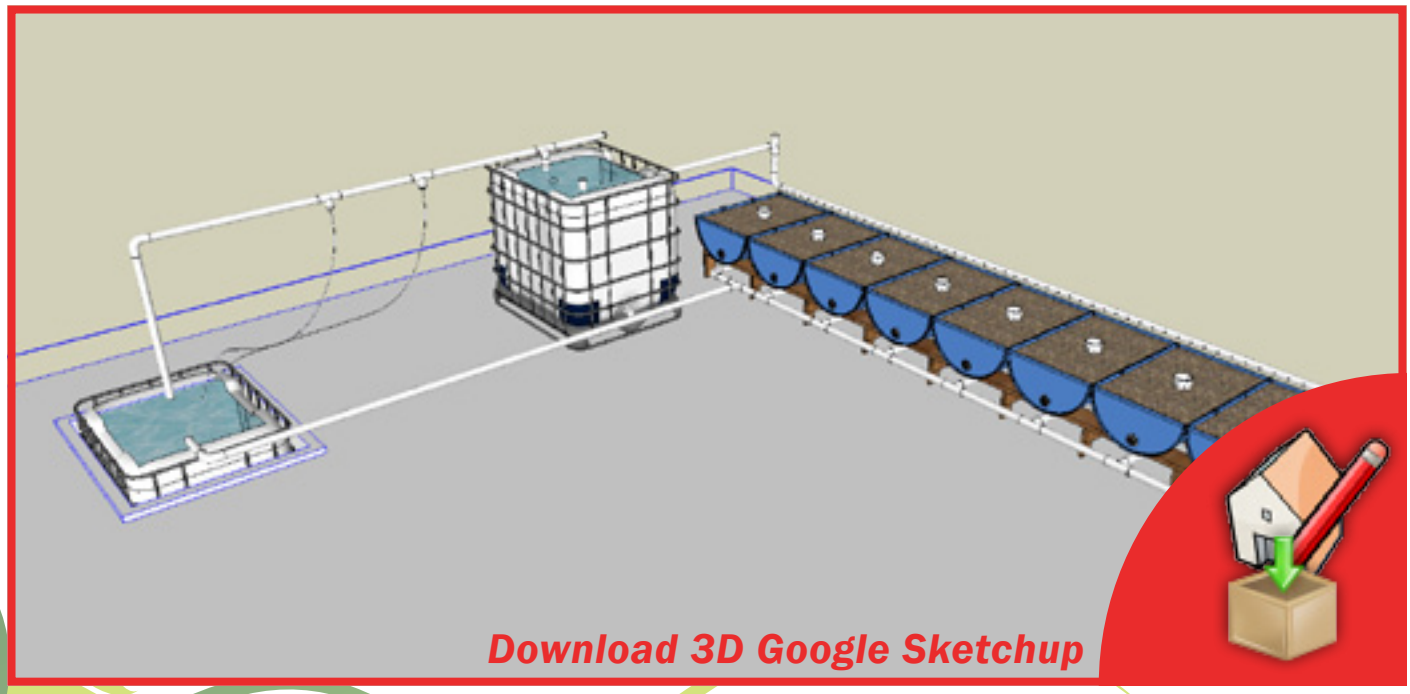
A Pondmax 8000lph pump was used as a trial run. Water is pumped from the sump tank to the fish tank through 25mm pvc pipe, the water level then overflows to the growbeds and fills them in around 20 – 30 minutes. Each bed has a stand pipe with a 4.5mm hole allowing them to drain in around 35 minutes. The same 25mm pvc pipe returns water back to the sump tank through two lengths of 13mm polypipe, this allows for stage 2 of the overall plan.

Unfortunately the 25mm pipe caused the fish tank to overflow so fittings were added to reduce the outlet to 20mm. A short piece of pipe was then put in the overflow to prevent water from running over the T piece.

Ed's plan is to expand the system by slicing about 350mm off each side of an IBC, though it will initially cost more than the equivalent of 4 blue barrels, it will be a lot cheaper on the plumbing.

Blue barrels filled with pea gravel

Progress photos showing barrels and IBC fish and sump tank

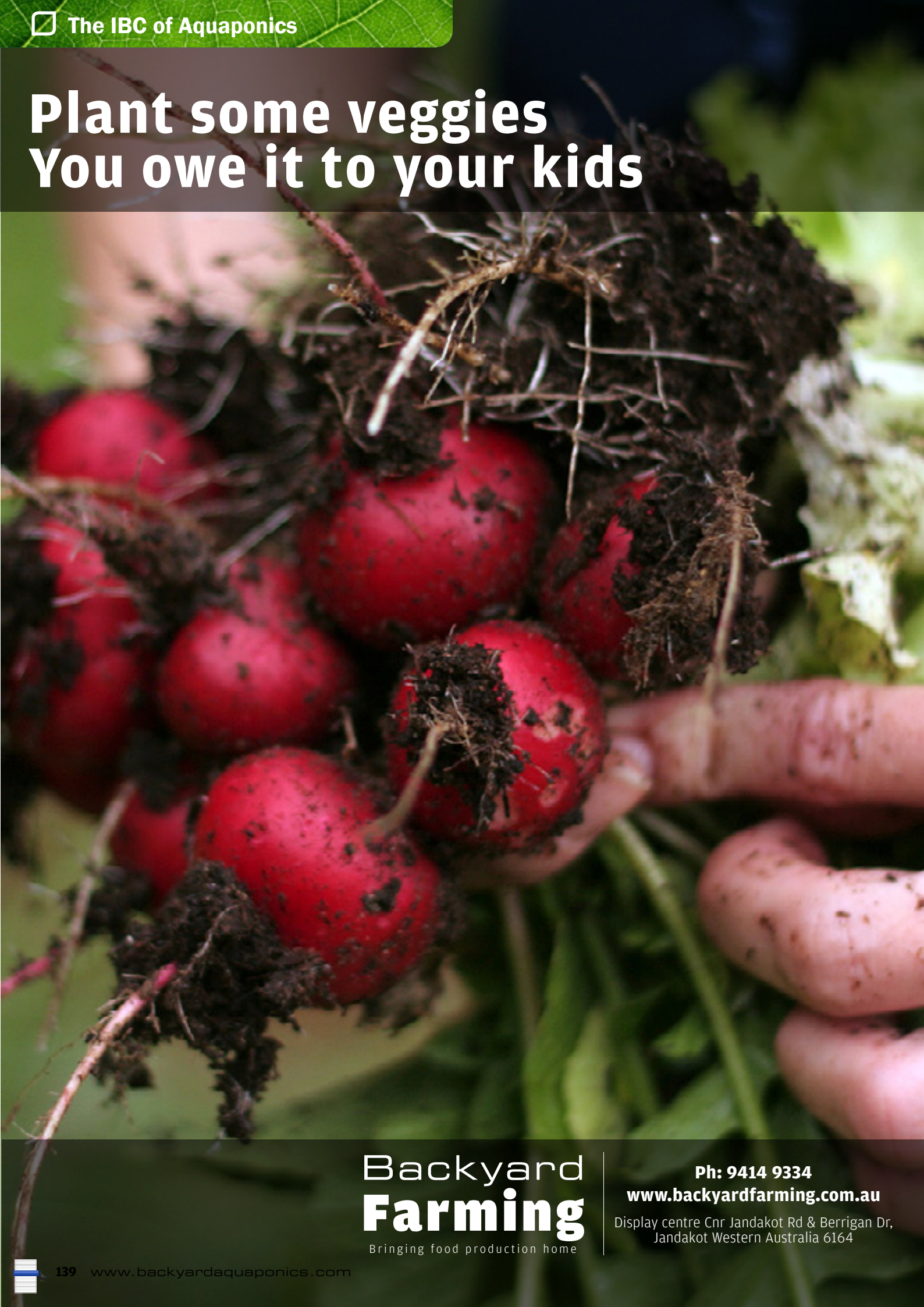


Fish tank showing water return elbowed to create current

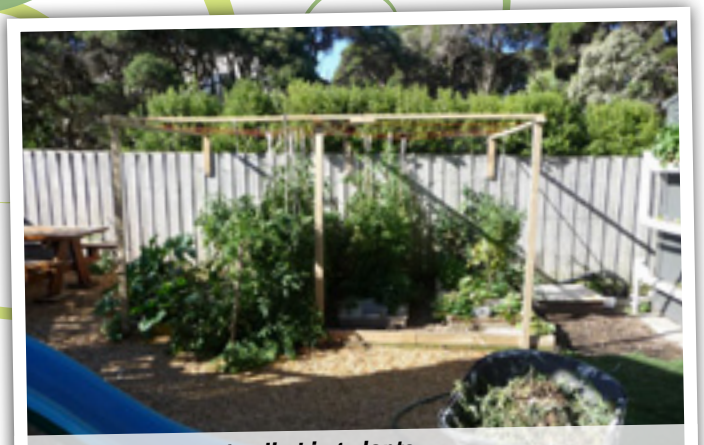
Tank and polypipe returns

Sump tank buried and supported in ground

Plant some veggies
You owe it to your kids



Edwood's IBC system



Structure supports climbing plants

Growbeds installed at ground level and all drain pipes buried. Irrigation line runs along the fence behind

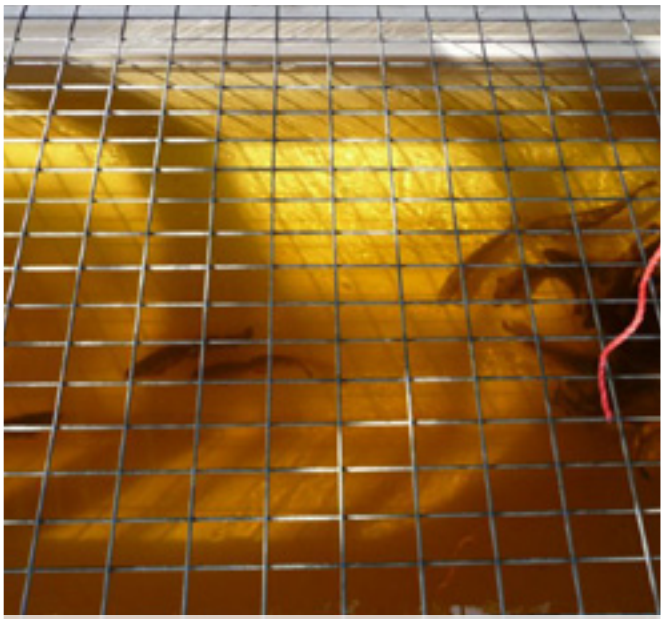
Edwood lives on the Mornington Peninsula, not far from the coast and believes this is one of the reasons that he has been able to keep trout in his system over the summer months. Another factor that he attributes to keeping the water cool is the fact that his fish tank is insulated and the growbeds are buried in the ground. He has an IBC as a sump tank and this is also buried, it provides a home to around 40 yabbies and a few mosquito fish. The fish tank is rectangle in shape made from fiberglass, measuring 3 metres in length, 800mm wide and 800 mm deep. It has a V shape in the bottom with flow holes for added water flow. When the tank was set up it was surrounded with insulwool to help maintain the temperature. The system is very neat with the majority of the pipe work being out of sight, the irrigation pipes from the fish tank run along the fence behind the growbeds and screened behind a wall of foliage.

This fish tank and sump tank supports 4 growbeds which have been dug in to the ground, four of these measuring 2.1 metres 700mm wide and around 300mm deep. These beds drain in to the sump tank which is where the submersible pump is located. Rock like white marble fills the beds and provide a stable source to anchor the roots of the plants as well as acting as the biofilter in the system. Two of the beds are operated by auto siphons, while the other two are constantly filled with water. A structure was erected to train plants like tomatoes allowing for vertical growth. The tomato plants are doing very well being constantly flooded, however the capsicum plants seem to prefer better drainage.

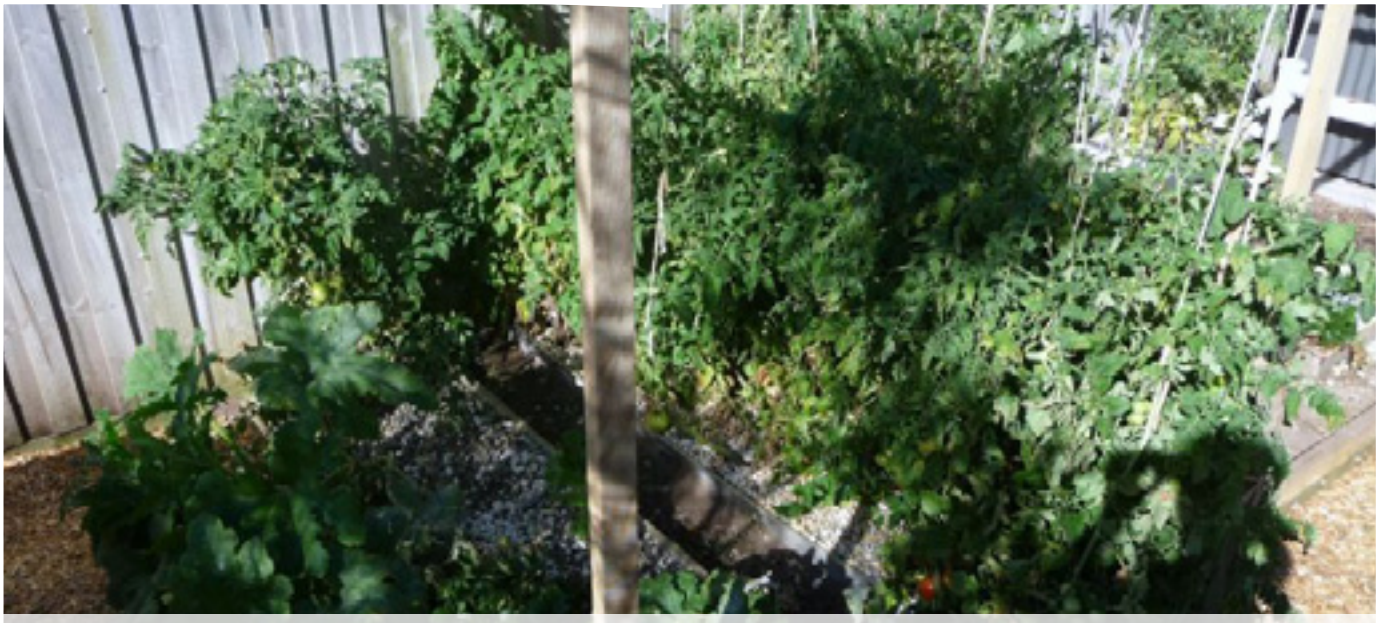
Hinged fish tank cover keeps out sun and protects fish from predators

Buried IBC with childproof cover

Vertical gardens hide an old shed



Rainbow trout fingerlings



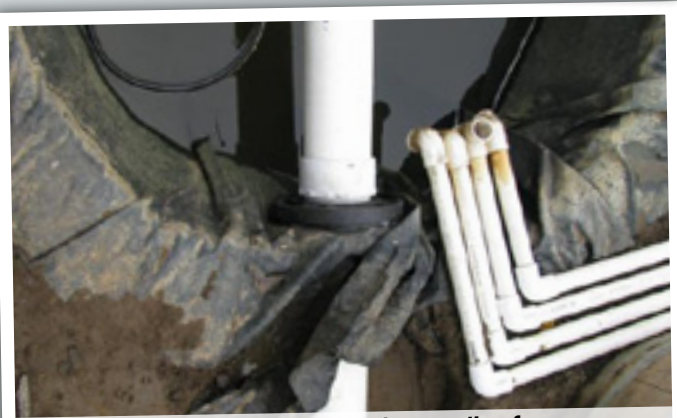
Summer fruits such as tomatoes make use of vertical spaces

View of growbeds and IBC sump tank

Rainbow trout

The Native's IBC system

Renovation in progress



SLO to interconnected ponds and return line from growbeds

Solid timber stands are required to support the weight of growbeds

The Native has created lined ponds in the ground to hold a large volume of water for keeping his fish. There are three in total, two hold 400 gallons each and the third is around 350 gallons. Originally he had created a ledge and one pond was higher, overflowing to the next. He realised that he could almost double the size by removing the steps in the pond and they could overflow between them if the ponds were at the same height.

IBC s created ideal growbeds when they were cut in half, each having a depth of around 500mm. He started off with gravel but in time made some renovations, which included changing over to ¾" black lava rock or scoria. The Native says that it is has more benefits than the gravel as it is cheaper, lightweight - therefore easier to shovel, it hasn't affected the pH and it has a high porosity making an idea surface for beneficial bacteria.

An Affnan bell siphon controls the flood and drain in each of the growbeds, the bell is 4" and the standpipe is 2.5" which reduces to 1.25" as it exits the grow beds. All the growbeds drain in to 4" drainage pipe which then returns water to the pond. The standpipe is housed in a media guard made of pvc pipe which is 6" in diameter allowing access in the event that the siphon requires any attention. The other end of the bed also has a 6" pipe that is a worm feeding station.

The pump used was a 800 GPH (3000lph) probably requiring an upgrade at some point said the Native. A (SLO) solids lifting overflow was installed using 4" pipe to help with the build up of solids in the second fish pond. Water is pumped to fill the growbeds which takes around 22 minutes and then drains in around 3 minutes. The system has produced great harvests of vegetables such as carrots, celery, onions and trout. Just take a look at the pictures of the healthy plant growth.

Drain from growbed to 4' drainage pipe back to pond

You can grow carrots in an aquaponic system

Admiring the crops

Cabbage

Growbeds fill in around 22 minutes. Worm feeding station at one end and siphon at the other

Carrots planted in to net pots of vermiculite

Decking recently installed makes great access to fish ponds and growbeds

Growbeds being added with black lava rock

Aquaponic fresh harvest

Homegrown rainbow trout

Scottie & Shelley's IBC system

Scottie & Shelley started out with 2 standard IBC containers and a few 44 gallon drums. They cut them in to two parts, the top portion became growbeds and the bases became fish and sump tanks which were connected through the side of the IBC, and the water flows freely between them.

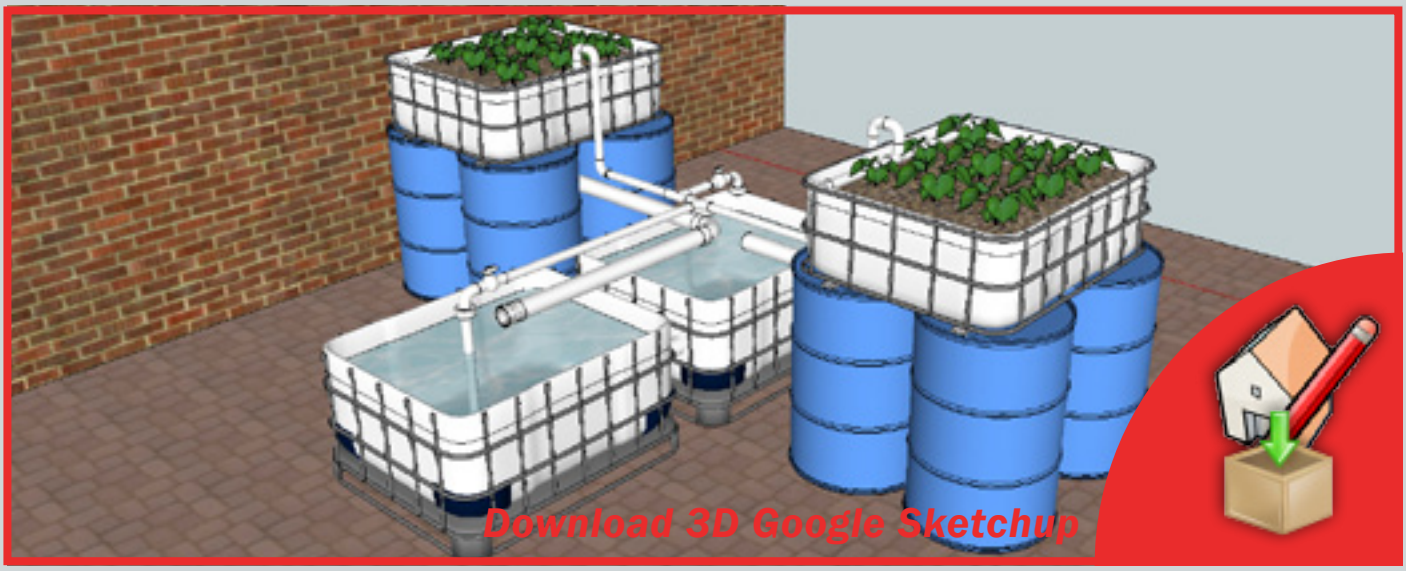
They set about purchasing the plumbing components and used the 44 gallon drums to make the bases for the growbeds, as they are sturdy and as long as you are not too short they will serve the purpose well without breaking the bank. The media chosen for this system is gravel which is locally available and cheap on the pocket.

The system was set up and, irrigations lines were added using 25mm PVC pipe. A barrel union was added to the pipe above the submersible pump, this is a really good idea because it makes the pump easy to access in the event that something needs to be cleaned, or the pump has to be removed for any reason. Ball valves were placed inline to adjust the flow to each of the growbeds as well as returning water to the sump tank. A spray bar was also designed to reduce flow from the pump and provide additional aeration to the fish tank .

The pump was turned on and lines were tested, checked for leaks and made sure that the drains were able to keep up with the water flow. Water is pumped from the fish tank to the growbeds and takes around 12 minutes to fill the beds. The pump is operated on a timer, on for 15 minutes then off for 45 minutes. The cycle is repeated 24 hours per day as fish have a high requirement for dissolved oxygen overnight.

Stand pipes were fine tuned and the system was then ready for operation.

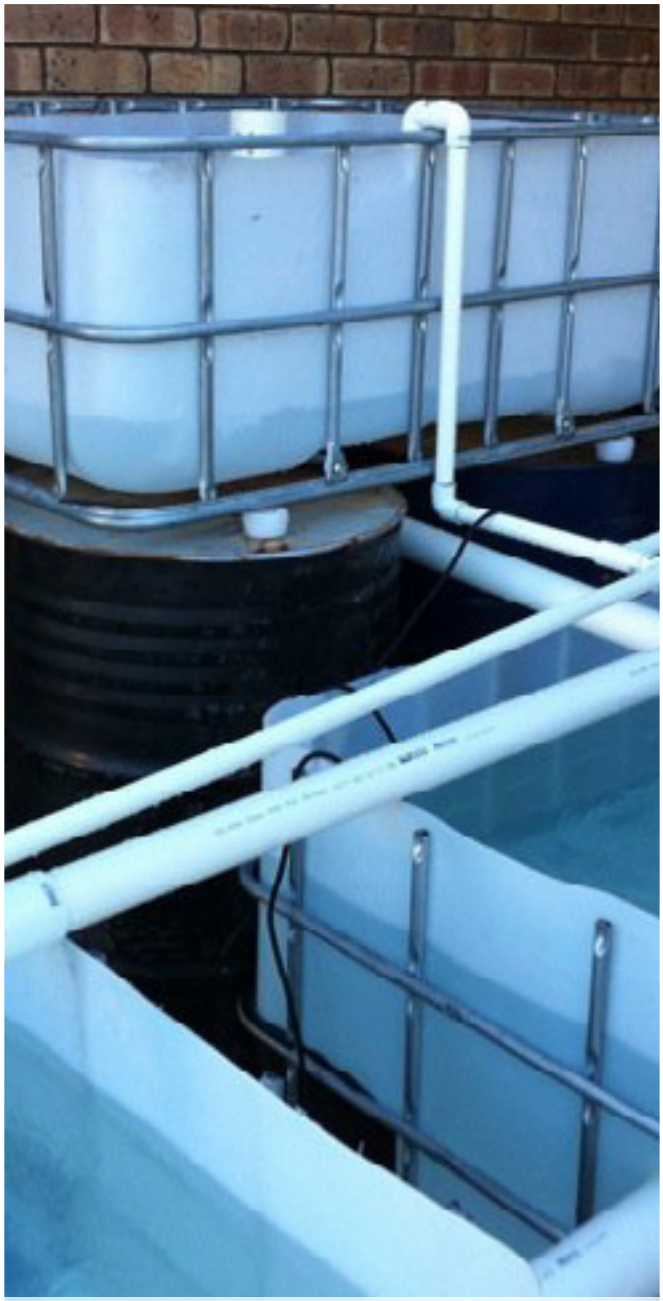
Scottie also made a shadecloth cover to reduce the direct overhead sun as well as covers for the fish tanks which are easy to remove when it comes to fish feeding. Fish were added and it wasn't long before the system started to show some good results.



IBCs cut in to growbeds and fish tanks

Pump with float switch

Pump going, stand pipe in, just waiting for media



Pipes are checked for leaks

Biofilm establishes naturally on the inside surface of a fish tank

Gravel is added to growbeds

Shadecloth cover protects fish tanks and shades from direct sun

Aquaponic system is neatly screened from the patio

Screens protect the tank from sunlight helping it last longer

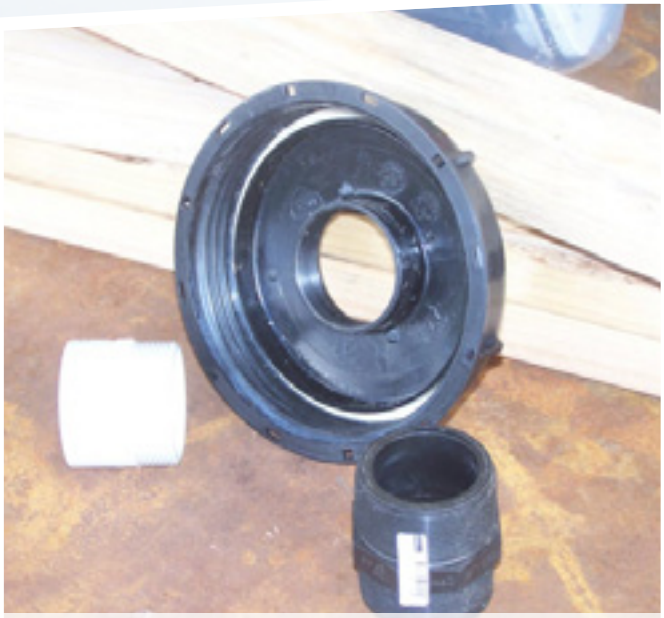
Irrigation line using 25mm pipe and ball valves

Trellis made from bamboo helps support plant growth

Retractable shadecloth can be pulled across in the hottest part of the day

Threaded adaptor fits snugly in to position

Curnow's IBC system



2 inch thread on lid makes for easy adaption

Framework ads style to a humble IBC

Curnow set up his first system with one IBC, though it is like most other IBC systems, he has come up with another innovative way of recycling using an old pump. Curnow decided to try something a little different, when he salvaged a couple of pumps from some old dishwashers. The pumps have two outlets on them and he decided to use one outlet for the growbed and the other to the tank to stir up the sediment and move it towards the pump. The black pipe delivers around 45 litres per minutes and the grey pipe delivers 30 litres per minute, the small clear pipe delivers only 3 litres per minute. (As it is of little to no use, it was blanked off.) He was very pleased with this trial and believes it has the potential to pump to two growbeds simultaneously. The pump sits outside of the fishtank at the bottom of the IBC and was relatively easy to plumb. Because it sits out in the open a weather proof cover was made to protect it from the elements.

The pump operates on a timer and water is pumped up to the beds which are filled with expanded clay. Curnow discovered the 2" thread came in very handy and fits easily to a threaded PVC adaptor, making it easy to install a stand pipe and media surround.

The system was stocked with yabbies from a mates dam and Curnow found that they rather enjoyed the cherry tomatoes that he had in abundance. They also regularly get fed lupins and carrot. The system has come along in leaps and bounds in a short space of time and Curnow is also growing plants in hanging basket that filter the water back to the fish tank, although the coir media has turned the water brown. The fish tank was later wrapped in underfelt and a tank cover was also made to reduce the amount of sunlight and algal growth.

Dishwasher pump

Slope is handy for gravity flow systems

Water return lines to fish tank

Finished

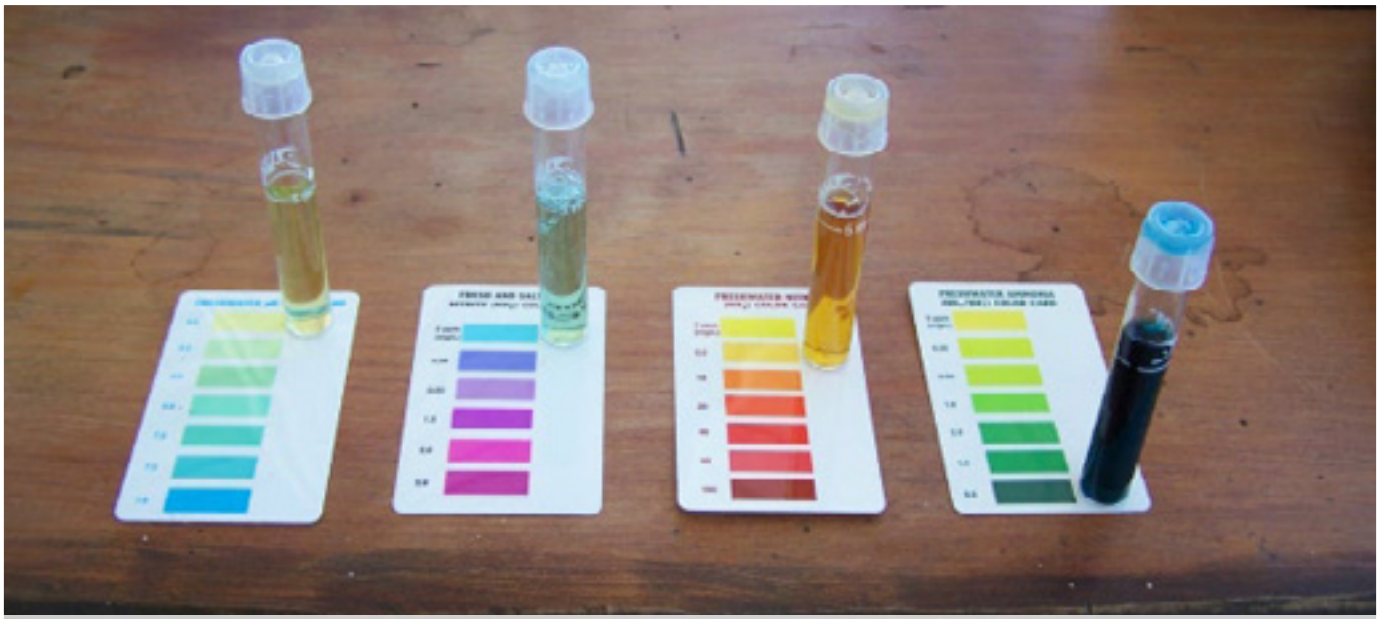
Corn is doing well and the bed is filling out very quickly

Coarse filter for inlet made from gutter guard

Seeds beginning to germinate in expanded clay

Dishwasher pump trial works well

Root growth from sweet corn



Test kits are handy to check water quality results

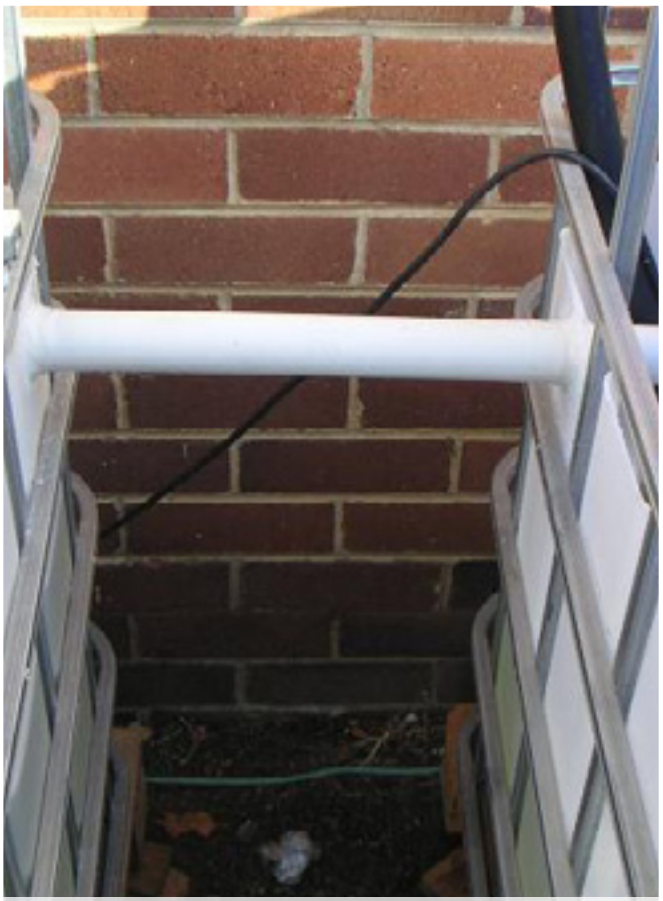
The plants are growing at an astonishing rate

Cucumber trellis added

Water flows through the conconut fibre and coir turning the water brown

Siphonphobia's IBC system

A couple of different supports were used to determine what would work best



Overflow from tank to tank

Siphonphobia has created a neat looking system using 3 interlinked IBCs, as he saw it as a cheap way to get a 2000 litre fish tank. The IBCs were cut with the top portion becoming the growbed and supported on the base below. He used a couple of different ideas as supports such as pine logs and metal rods, but quickly realised just how much weight you have to support. He purchased the pipe and fittings which were needed to link the tanks. Water was able to move between the base of the fish tanks though it is a good idea to protect the opening with filter mesh to stop fish being caught in the tap area. The fish tanks were stocked with sivler perch and some mussels were also added to the system. Unfortunately the mussels found their way in to the pump and stopped it from working. An 8000 lph submersible pump with float switch was installed which is a little larger than was required, but easily fixed by placing a tee in the line and returning water to the fish tank, providing extra aeration at the same time. The advantage of a float switch is that when the water level drops to a certain point the pump will stop pumping water rather than completely draining the fish tank.

The growbeds are filled with expanded clay which is lightweight in comparison to other gravel media, though the supports underneath need to be fairly sturdy as the IBC plastic is not terribly strong in itself and will bow easily. As anybody will tell you having an aquaponics system will take you on a wonderful journey of discovery and there are many people from all over the world who willingly share their experience on the Backyard Aquaponics Forum.

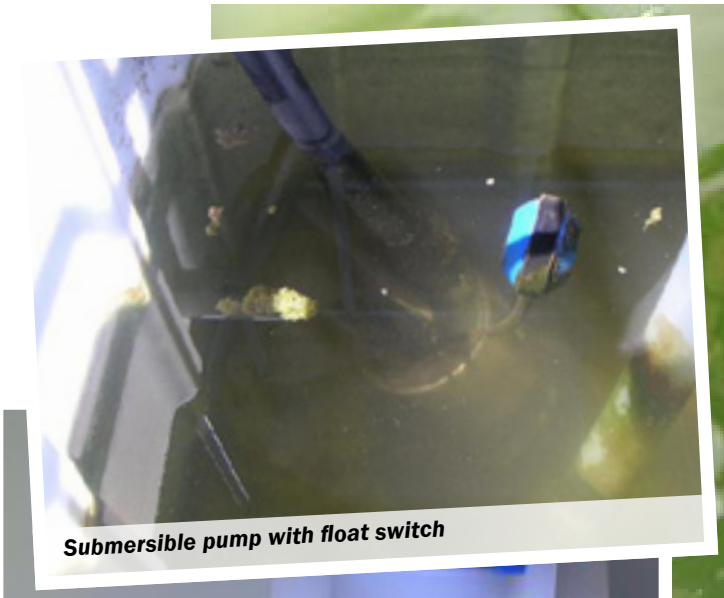
Growbeds supported above fish tank

What not to do

Shadecloth to reduce sunlight

Water returning to the tank

The water level should be below the surface of the media. This was too high



Submersible pump with float switch

Fish caught in tank outlet

Silver perch fingerlings

IBCs connected

First plant

Azolla

Wal's IBC system

Wal lives in the remote north west town of Tom Price where conditions can be harsh. Extreme heat and cool nights are one of the challenges that he faced when venturing in to aquaponics. His two fish tanks are made from the bases of the IBCs which he insulated with pink batts and set up in a shed. The fish tanks are connected with a balance pipe, which allows water to flow between the two tanks and provides a total fish tank volume of around 1200 litres. The tops are used to provide a total growbed volume of around 650 litres.

The system is fitted with two 3500 litre per hour submersible pumps as well as two air pumps which maintain oxygen levels during the warmer weather. A backup system has also been included in the event of a power failure.

Old packing boxes have been used as stands as they are sturdy and support the weight of the expanded clay media. The growbeds are situated on the outside of the shed allowing them plenty of sunlight while the fish tanks are on the inside where day time temperatures are 3-5 degrees cooler.

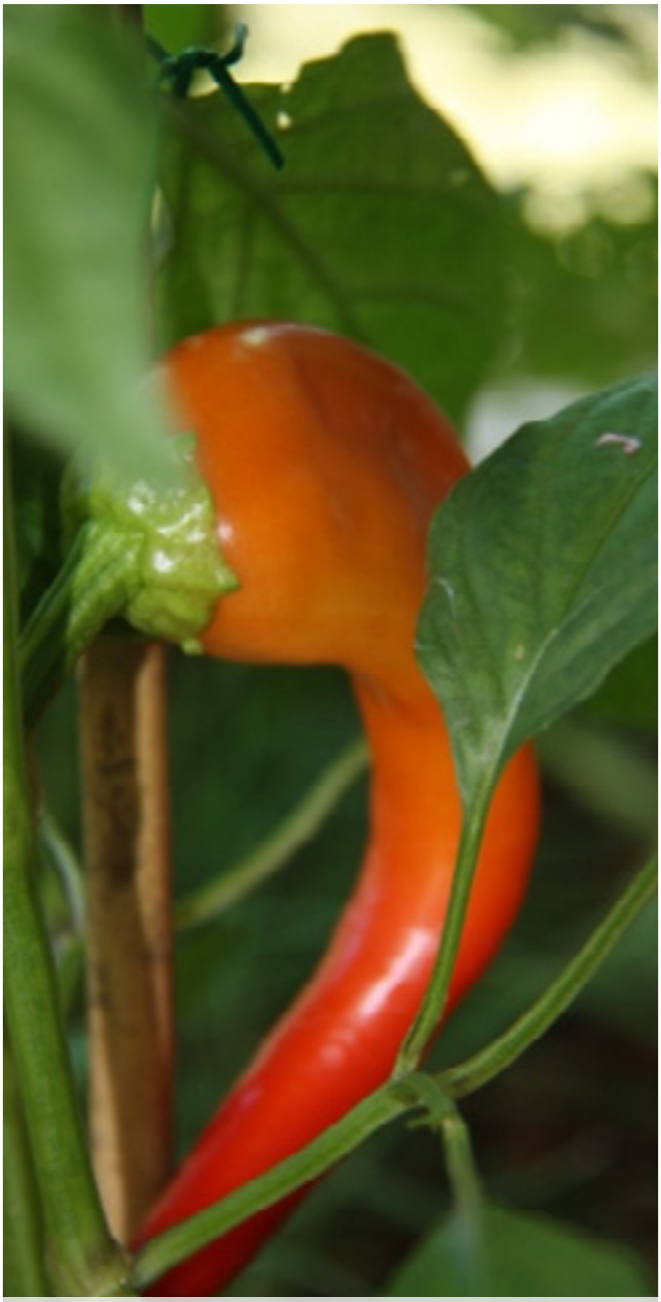
The expanded clay was washed in the cool of the evening and early morning to avoid the heat which climbed to 38 degrees. The beds were set up, filled with media, washed and planted. A simple shade house was constructed to protect the plants from the hot sun.

Barramundi fingerlings were flown in which went off without a hitch and the system has been powering away as you can see from the photographs. An NFT style system was added and the results are fantastic, producing lush healthy lettuce plants.

Contemplating the design

Growbeds filled with media ready for planting

Water entering growbed through filter pad



Fresh colourful fruits are a delight

As with most aquaponic systems, it's hard not to keep from expanding

Acclimatising the new fingerlings

Venturi adding air to the fish tank

Wal took a quick pic of the basic ingredients

Fishtanks setup inside shed

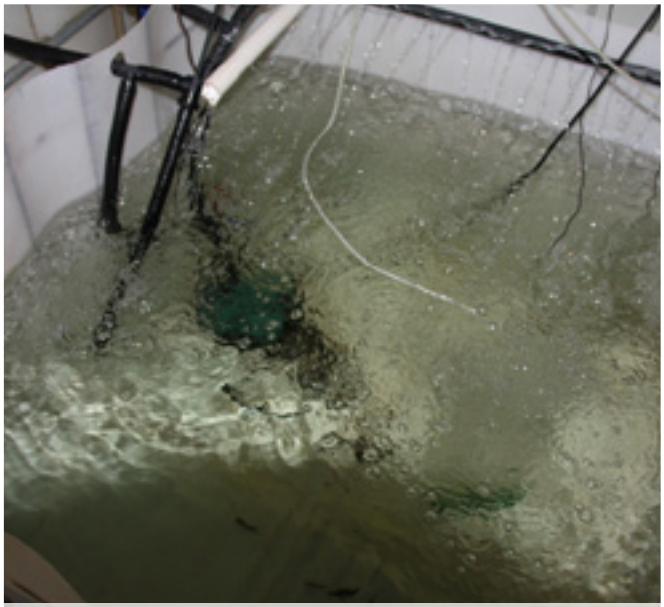


Image shows spray bar directing jets of water back to the fish tank

Venturi, all made from reticulation parts

New expansion is progressing nicely

Looks like Xmas

Wals harvest from the NFT

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Charlie's IBC system

Charlie had already started experimenting with Aquaponics when he decided to build a second system using an IBC. He has had some good results with his first system and has come up with a very neat and workable second system. The IBCs were available free from his work place, and all he had to do was spend a bit of time and energy sourcing some equipment to put it all together.

The pipes and fittings were all easily available at Bunnings, the local hardware store. He also got pipe glue and ball vales as well as a 2400lph fountain pump which cost all up $190-00. He purchased an airpump off eBay which set him back another $120.00 and then spent $20.00 on airline and stones at the local pet store. He visited a local soil yard and found some 20mm blue metal/gravel which would do the job for another $60.00. For under $400.00 he had everything he needed.

Charlie removed the IBC base, by simply removing the screws. This is the part that allows the IBC to be moved with a forklift, which left the thin metal base plate and no supporting beams, but that was okay as it will sit flat on the ground.

There is a section of the bottom plate that is moulded to cater for the drain tap and spout, he used a grinder with a cutting disc to chop it out so that he had flat bottoms on both to aid with sitting the whole set up flat.

Plants growing in 20mm gravel

Cage trimmed to sit flat

Auto syphon

The fish tanks was cut off at the 900 litre mark, washed out with chlorine, placed in its desired location, filled with water and then aerated for a few days to disperse the chlorine. He then cut a piece of the remaining framework to make a stand at the back of the growbed, this allowed a greater opening over the fish tank allowing him to access the fish.

The growbed was cut off at the 400 litre mark, this was stamped on the side of the IBC. He marked the spot for the drain hole (double nut fitting as he calls it), making sure the space was flat and without seams. Once the magic spot was marked, it was cut out with a hole saw, followed by an opening in the base plate. Three timber supports were used to sit the growbed on, although Charlie would recommend steel box tube as the timber is already starting to bow and needs replacing, not a job he is looking forward to as the gravel probably weighs around 500 kilos. Charlie decided on an auto syphon, which he says took a fair bit of mucking around and after 6 prototypes he has one that works a treat.

The pump is connected with 25mm pipe and two ball valves allow for flow adjustments. One goes to the growbed and the other returns water back to the fish tank.

Charlie admits that although he is relatively new to Aquaponics he is absolutely addicted. Everyone that visits his house is very intrigued and wants to get their own thing going, because everyone loves fish and everyone loves food. It is a winning combo! His only wish is that he had started years ago.

Timber supports must be heavy duty to support the weight of heavy media beds

Underside of growbed showing frame

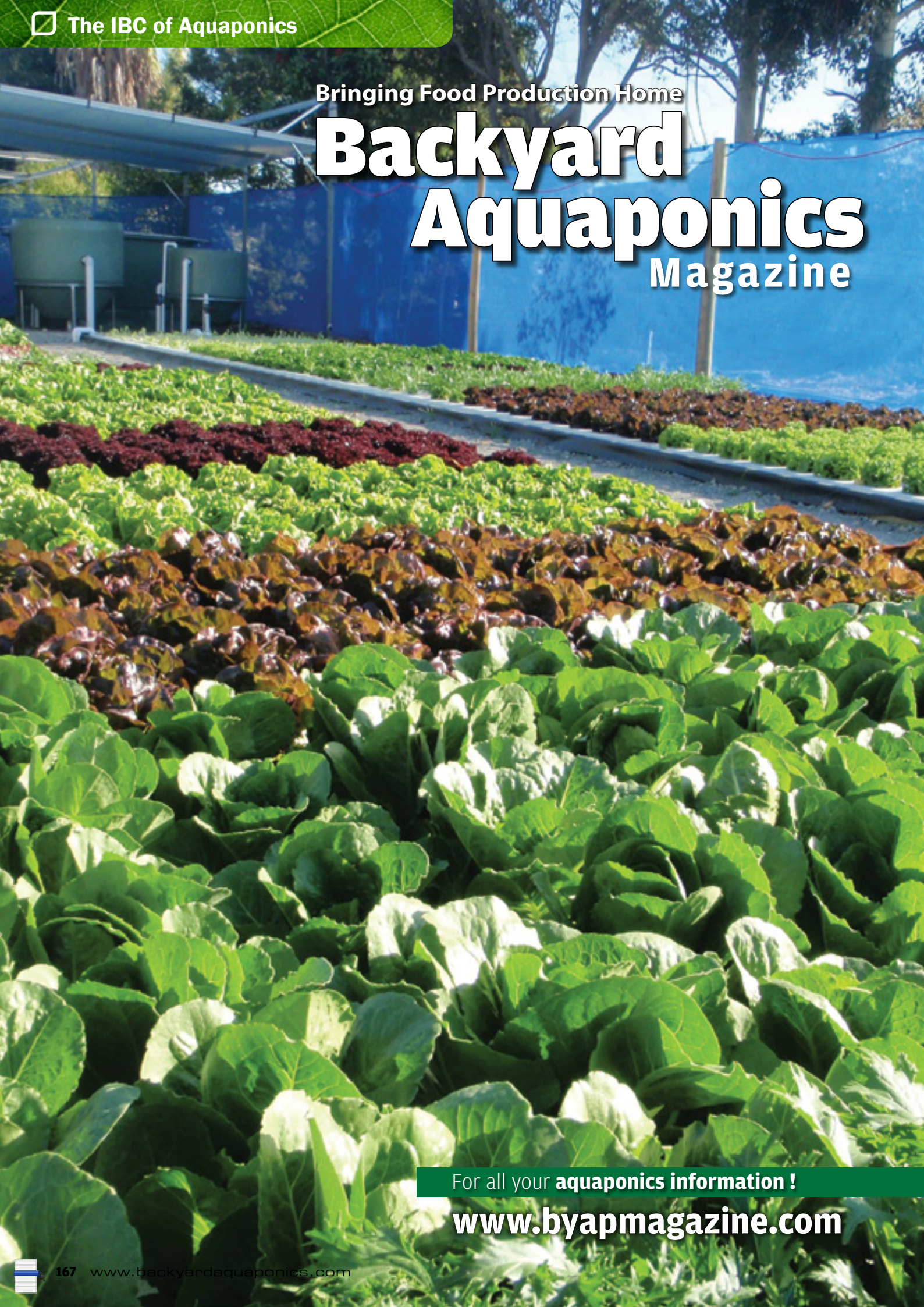
Water flows to the growbed and tee returns water to the fish tank

Floating basket provides a safe haven for new fingerlings

Compact system fits neatly in to a small space

25mm pipe and ball valves

Electrical rack made from IBC frame



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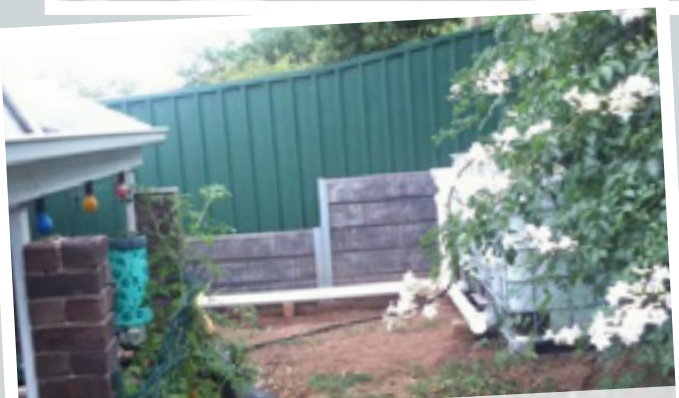
Bigdaddy's IBC system

Drain from the barra grow bed ready to be hooked into the new IBC drain



IBC's on the right showing the drain to the filtration on the left

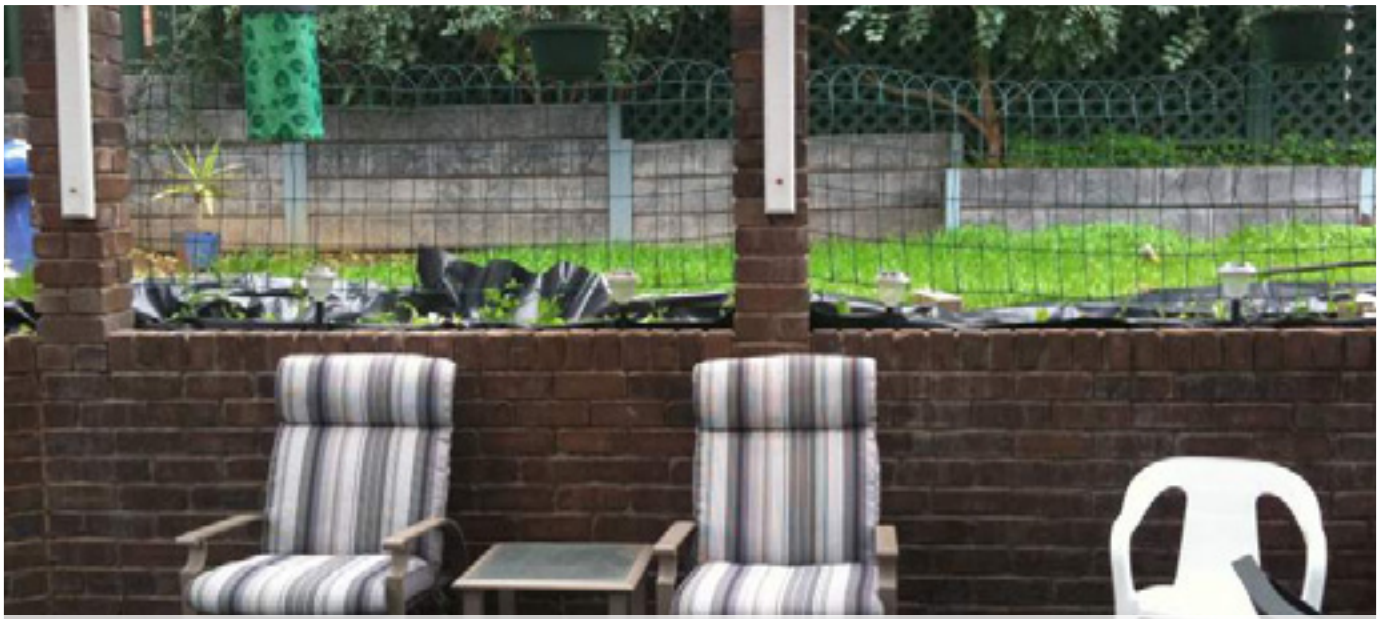
Looking from the filter and sump module

Biddaddy has a challenge working with a tiered backyard and it means that every time he brings materials in, there are steps to climb. He has used two IBC's for his fish tanks which are set on a higher level. The ground level drops away about a metre to the growbeds, which are built in behind the brick wall, retaining the patio area. The bed is lined with plastic and then filled with riverstones.

The fish tanks are connected with a 50mm PVC pipe at the 1000 litre mark. Rubber couplings with jubilee clips supplied from Bunnings were fitted to the ball valves at the base of the IBC and then attached to a 50-90mm reducer to the coupling. Tees in to the 90mm drain allow for what Bigdaddy describes as the emergency dump valves. There is a 200 litre sump tank, a 9000lph pump with float switch and a washing basket full of clay balls providing extra filtration. Ball valves have been installed to the 25mm irrigation line so that when the pump pumps, all the fish tanks and growbeds are balanced out and you can allow as much water as you want to flow through them.

The system works in a very simple fashion with just one pump. Water is delivered to the fish tank and then flows to the growbeds, the flows are adjusted by the ball valves, they all drain back to the solids filter and then to the sump tank, when the float switch rises the pump is activated and pumps to all the growbeds and fish tanks.

Older grow bed in distance

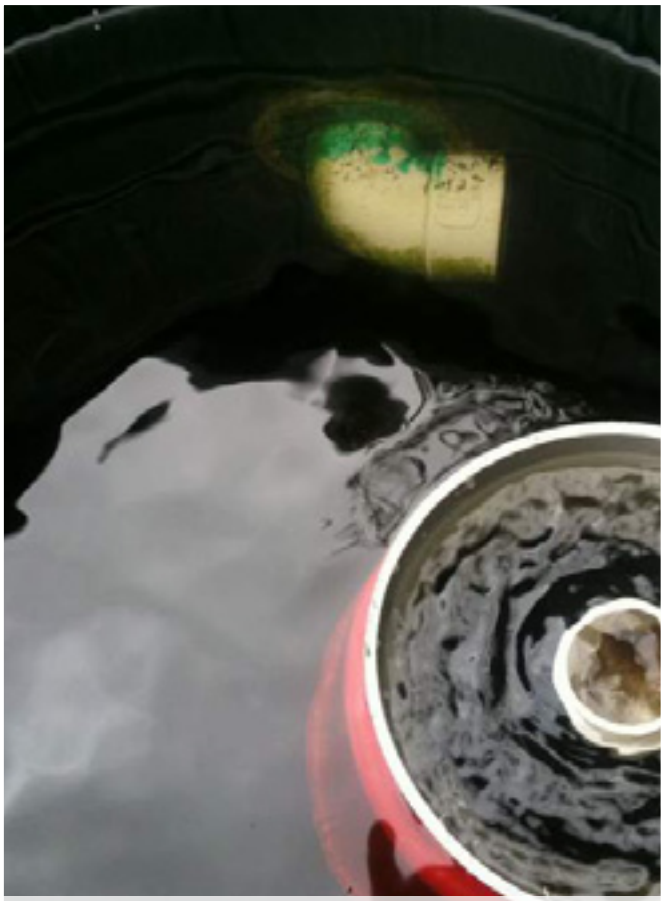


Other side of barbie, second bay of grow bed

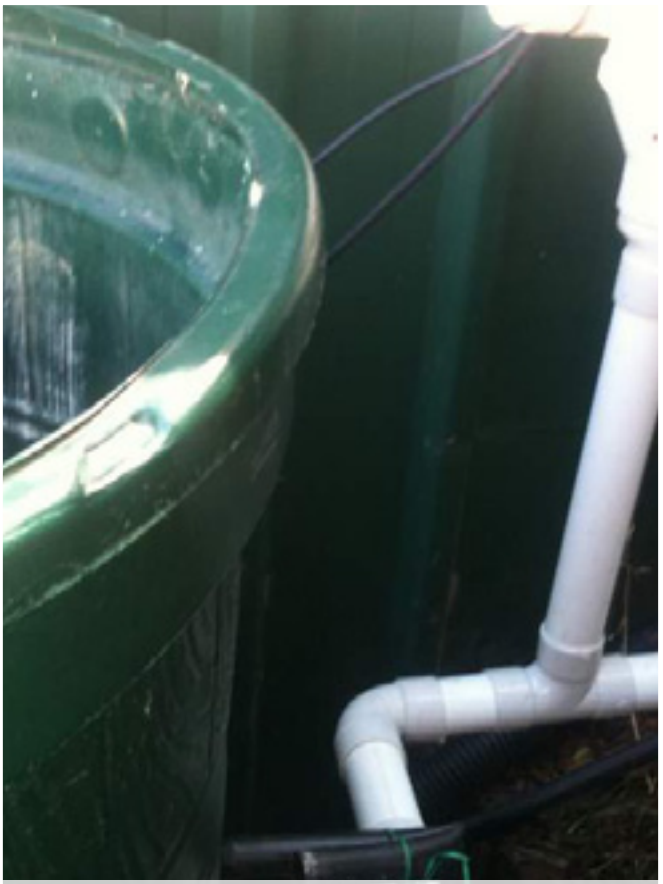
Shows top view of IBC and skimmer box

The peas and the other plants have taken off just three weeks old

Side view showing where they are situated in the backyard. Home made level control skimmer boxes. 90 mm storm water PVC with removable ends for cleaning



Solids filter

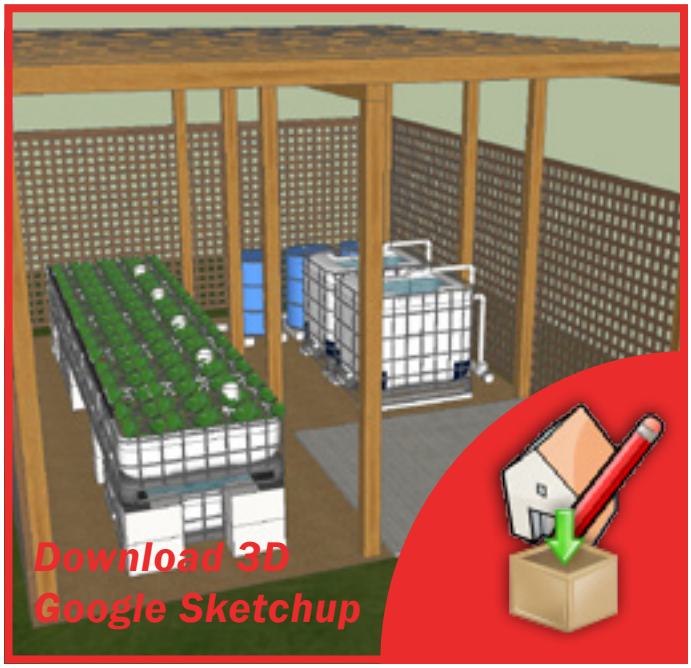


The fish tanks and barra bed drains tee into the trout bed drain and go into the filter

Jet's IBC system

Dual IBC fish tanks

Pipework from the fish tank



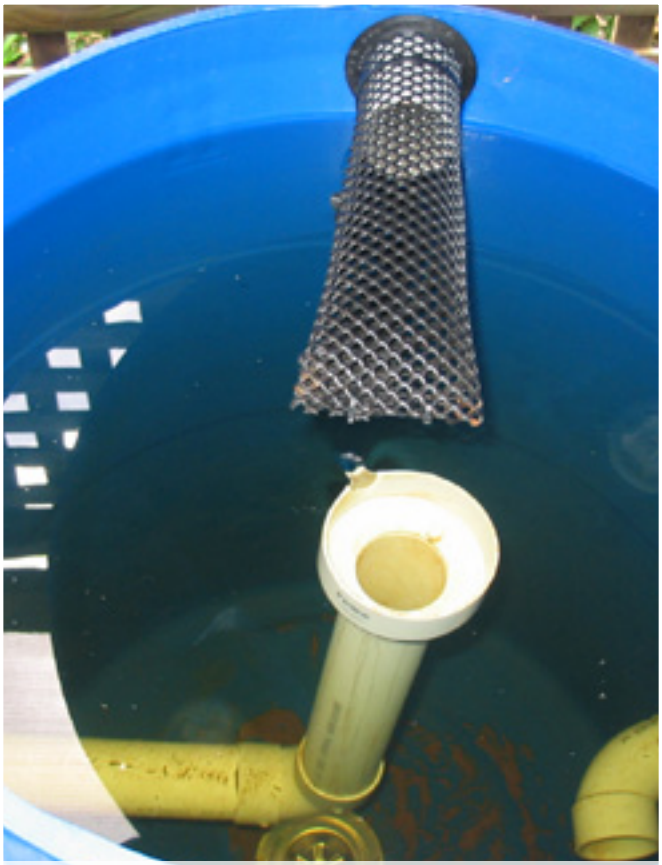
Jet has created a very neat system from IBC's with three blue barrels incorporated into the system. This neat system is based on the CHIFT PIST principle with two 1000L IBC's acting as fish tanks. The water leaves the IBC's via a fairly modified solids lift overflow, from here the water flows into a swirl separator made from a blue barrel. In the separator the heavy solid particles of fish waste and uneaten food drop to the base where they can be removed when required via a drain with a tap in the base. The cleaner water leaves this drum via a pipe near the surface in the middle of the barrel, then flows through two different types of biofilters. The first biofilter is a fixed media filter, while the second is a moving bed biofilter, both of these have about 50L of Kaldnes K1 media in them. Once the water has passed through the biofilters, it then continues to flow through to the growbeds where there is a tap on each bed to control how much water enters individual beds.

The growbeds are filled with a course rock media , each growbed is the base section of an IBC, there are five growbeds in total, that sit on some large timber beams supported off the ground by cinder blocks or large cement building blocks. Under the growbeds are three IBC tops which have been inverted and plumbed together to act as the sump for the system. The growbeds have been fitted with autosiphons to control their flooding and draining cycles. From the sumps, the water is pumped back to the fish tank where the process starts all over again.

A few things that Jet has changed, modified or added since building his system are a battery backup pump in case of power outages. The return to the fish tank is now inside the tank, he has added a second pump in the bottom of the moving bed biofilter which means he can bypass the growbeds at night when it's cold, helping to keep up the heat in the fish tank. There are also a few more changes or planned changes, hopefully we might be able to cover these in the next edition.

One of the biofilters in action

The complete system in operation



Swirl separator

The swirl separator and two biofilter barrels

Plants starting to take off in the growbeds

Plants growing well

Netab's IBC system

Tiered yabby tanks

The beginning of the project.

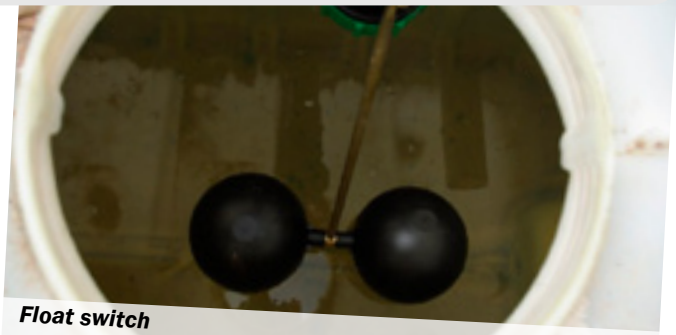
2 rows of growbeds in centre and tiered yabby tanks behind

Netabs system is one of the biggest systems we have seen to date. An enormous amount of effort has been put into this system, both in the planning and construction. In total there are 21 IBC halves used as growbeds and filled with river stone, as well as 16 IBC yabby/duckweed 2 tier tanks. These top tiers will eventually be converted to gravel growbeds. Two 2000 litre and five 500 litre fish tanks are housed in an adjoining shadecloth structure. The growbed layout was designed to best utilise the greenhouse which measures 8 x 13 metres with a solar weave roof and shadecloth sides which can also be covered in solar weave creating a warmer growing environment for the colder winter months. The system began to evolve after some second-hand goods became available and the plan was hatched.

When they started looking in to Aquaponics they had initially planned to use blue barrels as growbeds. After coming across an auction and other sales they were able to collect around 40 IBCs in total, this seemed like a better option as there was no need to create specialised stands. Because they had so many IBCs they had the opportunity to have a play and try a few different ideas. The twenty one growbeds are positioned in three rows of seven. At the end of the middle row another IBC has been buried in to the ground

First Row

Gravel shovelling was just too much



Float switch

to operate as a sump tank.

An 18000lph submersible pump with a float switch pumps water to the fish tanks, while a second pump of the same size operates on a timer and delivers water to the growbeds through a sequencing valve. All the fish tanks have cone shaped bases with centre drainage, and are connected using pvc irrigation pipe and have inline ball valves to either adjust the flow or isolate a tank. A float switch will be eventually fitted to prevent the fishtanks accidentally emptying.

Each growbed also has a ball valve which can be used to adjust the water flow and regulate the amount of water to the individual bed. Drainage pipes have all been hidden underground and return to the sump tank which you would hardly know was there. A trap door with a hinged wooden lid hides the sump from view but allows easy access through the top of the IBC. A barrel union was placed in the pipe near the pump which makes life easy if the pump has to be removed for any reason. All the pipework has been buried and the system is certainly one of the neatest and well thought out and has to be one whose progress is well worth following. The yabby system is quite extensive being sixteen IBCs in total. As IBCs are made to stack easily on top of each other they took advantage of this by cutting at the second square from the bottom, then the bottom became the top level and the top became the base frame as it is reinforced to support the weight.

The water level is maintained in the base around 40cm and water is allowed to flow through a stormwater filter elbow where the 90mm pipe is interconnected joining all the IBCs together. The bottom 16 yabby growing beds have had openings cut out of the front to allow easy access to the water below. The tops are filled with water to grow duckweed and water is maintained at the height determined by a standpipe, made from a tank fitting and 90mm stormwater pipe. This can be easily converted to flood and drain once these tanks are ready to be turned into growbeds. Recently a gas pool and spa heater has been installed which draws and returns water to the sump tank and is working well.

All in all quite an amazing system that Netab and her Husband have built, we look forward to following their progress and updating this manual with further information over time as the system has run for a while.

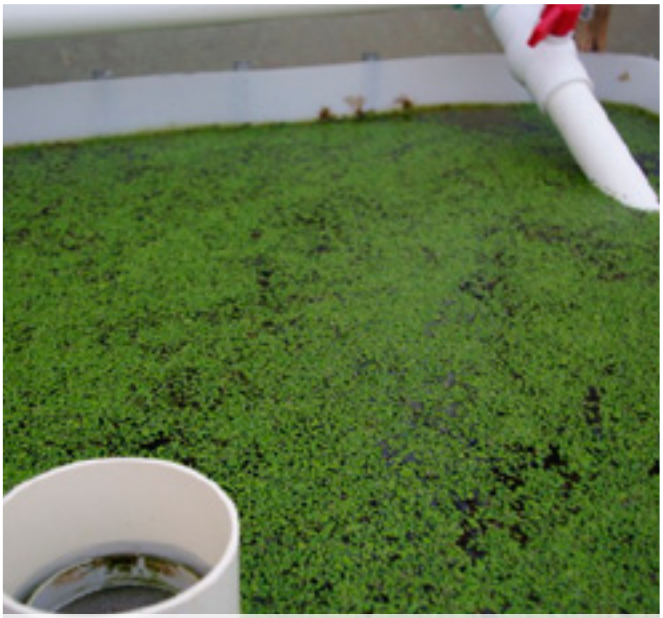
Cucumbers growing

Seedlings planted

Yabbies

Irrigation and drain lines set out

Standpipe using tank fitting, coupling and pvc pipe



Duckweed

The Nitrogen Cycle

One of the most important yet least understood aspects of Aquaponics is the bacteria that we rely on and its function in the nitrogen cycle. I know what you're thinking, bacteria (or "GERMS" if you watch a lot of disinfectant commercials) are meant to be bad, aren't they?

The fact is that there is good and bad in everything, even down to bacteria. Life wouldn't be possible without them.

Fish excrete ammonia. In a lake or ocean it's all good because the vast volume of water dilutes this ammonia. When you're keeping fish at home it needs to be managed as it is very toxic to the fish.

Decomposing food also creates ammonia. Some of the effects of excessive ammonia include:

- Extensive damage to tissues, especially the gills and kidney
- Impaired growth
- Decreased resistance to disease
- Death

Luckily natures got it all sorted! Enter Nitrosomonas sp. This good little bacterium eats ammonia and converts it to nitrite.

Now, nitrite is much less poisonous to the fish than ammonia, but it's by no means a good thing. It stops the fish from taking up oxygen. Natures got it under control again, with Nitrobacter sp. This good bacterium eats nitrite and converts it to nitrate.

Luckily nitrate happens to be the favourite food of plants. Also the fish will tolerate a much higher level of nitrate than they will ammonia or nitrite. What you've just read is pretty much the nitrogen cycle. When an aquaponics system has sufficient numbers of these bacteria to completely process the ammonia and nitrites it is said to have "cycled".

Your goal should be to establish the nitrogen cycle quickly and with minimal stress on any aquatic life you may already have.

Without their respective "foods" these bacteria will not exist in useful numbers.

This is why you will see an ammonia "spike" when setting up a new tank. The bacteria will increase their numbers (reproduce) in response to an increasing ammonia load, so it makes sense that we would see a "spike" before they respond. Shortly after you have ammonia the bacteria will start reproducing and working away for you.

The same goes for Nitrobacter sp., they'll only want to start reproducing and working once Nitrosomonas sp. is comfortable and producing lots of nitrite.

Now, while one point you've just read indicates that Nitrosomonas sp. won't process ammonia at pH 6.0 or below, this was determined in a sterile lab culture. Similar research has shown that species of Nitrosomonas sp. in a natural environment such as soil will still process ammonia even at pH 4.0! This goes

Facts

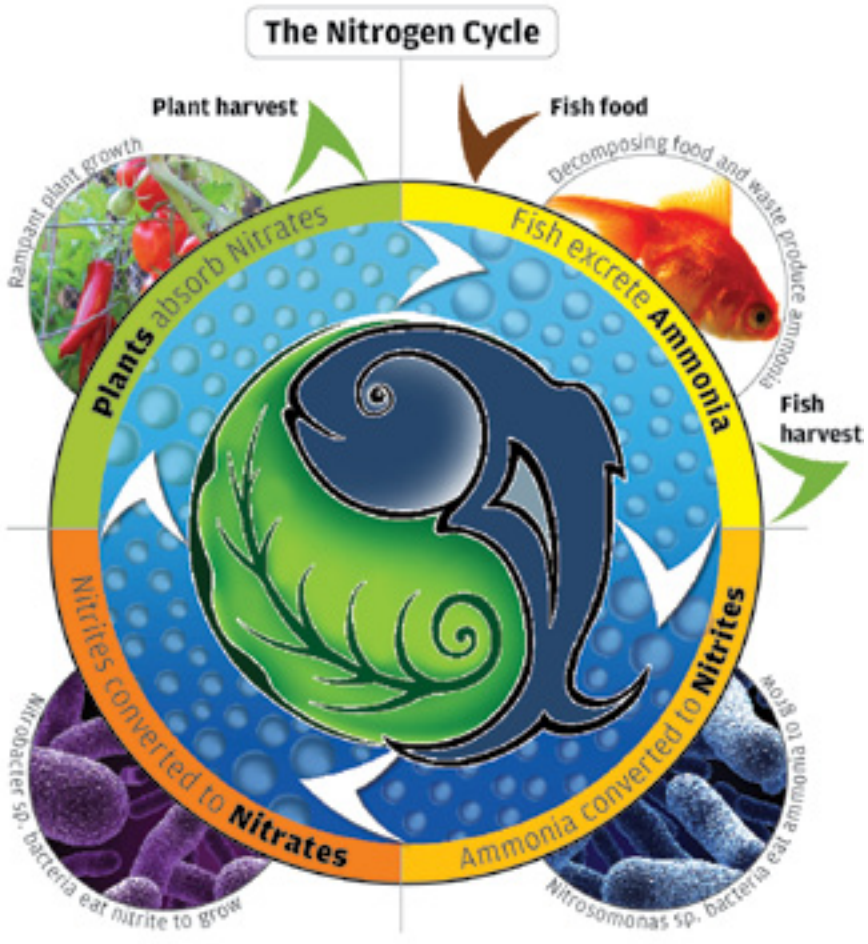
- They must colonize a surface (gravel, sand, synthetic biomedia, etc.) for optimum growth.
- They need oxygen in the water to live and work.
- Nitrifying bacteria have long reproduction times.
- Under optimal conditions, Nitrosomonas sp. may double every 7 hours and Nitrobacter sp. every 13 hours. More realistically, they will double every 15 - 20 hours.
- To put that into perspective. In the time that it takes a single Nitrosomonas sp. cell to double in population, a single E. coli bacterium would have produced a population exceeding 35 trillion cells.
- As a general rule a brand new system will require about 4 weeks to cycle at around 20°C. It will take longer in colder water.
- Nitrifying bacteria cannot survive in dry conditions or at sustained temperatures higher than 49° C .
- There are several species of Nitrosomonas sp. and Nitrobacter sp. bacteria and many strains among those species. Most of this information can be applied to species of Nitrosomonas sp. and Nitrobacter sp. in general, however, each strain may have specific tolerances to environmental factors and nutrient preferences not shared by other very closely related strains. Temperature and pH seem to be common.

pH

- The optimum pH range for Nitrosomonas sp. is 7.8 - 8.0.
- The optimum pH range for Nitrobacter sp. is 7.3 - 7.5
- At pH below 7.0, Nitrosomonas sp. growth will slow and increases in ammonia may become evident. Nitrosomonas sp. growth is inhibited at pH 6.5. All nitrification is inhibited if the pH drops to 6.0 or less.

Temperature

- The temperature for optimum growth of nitrifying bacteria is between 25° – 30° C (77° – 86° F).
- Growth rate is decreased by 50% at 18° C (64° F).
- Growth rate is decreased by 75% at 8° C – 15.5° C (46° – 50° F).
- No activity will occur at 4° C (39° F).
- Nitrifying bacteria will die at 0° C (32° F).
- Nitrifying bacteria will die at 49° C (120° F)
- Nitrobacter sp. is less tolerant of low temperatures than Nitrosomonas sp. In cold water systems, care must be taken to monitor the accumulation of nitrites.



some way to explain why some of us have systems that are YEARS old with a pH of 6.0, no ammonia and happy fish. Once a system has a compliment of micro flora and fauna at work there seems to be an inherent synergy that allows wider environmental ranges to be accommodated.

I would definitely recommend that people strive for the above environmental tolerance ranges on initial system set up and the early life of their systems.

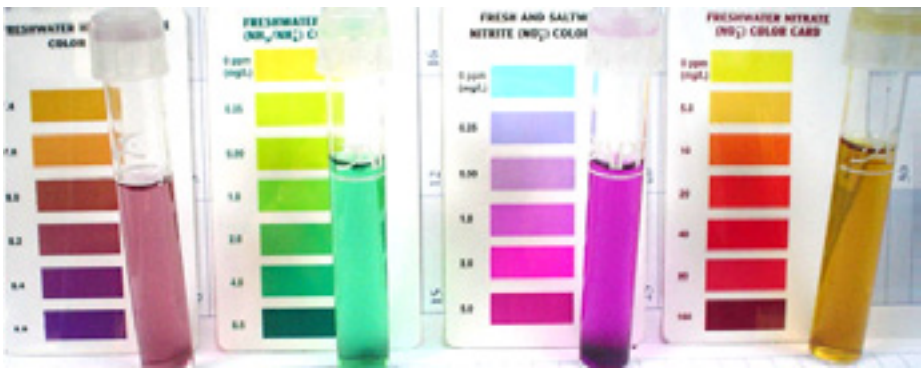
Many people with aquaponics systems try to maintain their pH at around 7.0 to 7.2 because this range satisfies the plants, fish and bacteria. The nitrogen cycle itself has a tendency to reduce pH, however it is pretty easy to keep pH at around 7.4 through the addition of calcium carbonate. Calcium carbonate increases pH, but will stop dissolving at pH around 7.4, meaning pH will stay pretty stable until all of the available calcium carbonate is depleted.

Readily available forms of calcium carbonate include:

- shell grit (available at many produce stores)
- sea shells
- calcium carbonate powder (available at many produce stores)
- limestone
- egg shells

As mentioned there are many strains of nitrifying bacteria, each having their own water parameter preferences, so when cycling a new system its best to keep your water chemistry as stable as possible in relation to factors such as salt concentration. The number of fish used to cycle your system should be much less than your system is intended to hold. If too many fish are used the ammonia and nitrite will reach very high levels, which are likely to kill or cause permanent damage to your fish and will require you to undertake more frequent and larger water changes. Also, be sure not to overfeed the fish as this will also result in the production of more ammonia. Many people choose to use cheap goldfish for the cycling process, due to the minimal cost and their high tolerance to poor water conditions. The best advice you can take when cycling your system is to be patient and let nature take its course. Do frequent tests (at least daily) during this period and perform water changes as required.

Don't forget, fish will still excrete ammonia even when not eating, just not as much!



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frequently asked questions

My fish appear unwell, gasping at the surface or showing labouring breathing, or erratic behaviour, perhaps flashing?

My water has gone green. What should I do?

The sides and bottom of my tank is covered with green slime, should I clean it off?

I have long strands of algae growing in my tank, what should I do?

How long can I leave my fish without feeding them?

My fish are off their feed, what should I do?

How much should I feed my fish?

What sized pump do I need for my system?

What fish can I grow in my system?

My pH is high or low what should I do?

My ammonia/nitrites/nitrate levels are high, what should I do?

My ammonia/nitrites/nitrate levels are low or nonexistent, what should I do?

Do fish need sunlight?

Can I put plants and other features into my fish tank?

Do I need an air pump for my system?

I have algae on my growbed media, what should I do?

My fish appear unwell, gasping at the surface or showing labouring breathing, or erratic behaviour, perhaps flashing?
If your system is pumping on a timed cycle increase the pumping to 100% of the time, if your system has not been salted before, salt your system water. Using pool salt, salt your system to 3ppt, this means in 1000L of water you would add 3kg of salt. Salt aids fish health and at these levels most plants will remain unaffected, however some plants like strawberries may suffer.

My water has gone green. What should I do?
Normally a problem in the first weeks of setting up a new system. This is suspended algae we are talking about, if you were to dip a glass into your fish tank and fill it with water then hold it up, the water looks very green and is hard to see through it. This is a natural phase your system will go through as cycling happens. Pump full time if you aren't already. Stop all feeding, any nutrient going into the system will only feed the algal bloom. If possible cover the top of your fish tank to keep light away from the water.

The sides and bottom of my tank is covered with green slime, should I clean it off?
No, this is biofilm and we don't recommend that you take this off, generally it only grows as a thin layer on the surface of your tank, it causes no harm to the fish or the system in any way and it helps by harbouring the beneficial bacteria. Many species of fish may peck at the biofilm on the sides of the tank, eating it.

I have long strands of algae growing in my tank, what should I do?
Stringy or filamentous algae, not very nice and it can start to take over your fish tank with its long strands of algae. Try to keep the light off the water if you can by covering the tank. Remove what you can from the sides of the tank manually. Perhaps add some known algae eaters to the tank if you can. We added a few yabbies to one of our tanks which had filamentous algae, they have cleaned it up nicely.

How long can I leave my fish without feeding them?
Almost all species of fish will live happily for weeks without feeding. If you are going away on holiday for a week or two, we would recommend that you get a friend family member or neighbour to come around once or twice a week to check your system and feed your fish. If this is not possible, then leaving the fish without feed for a week or two will not cause any major problems. I would rather leave them without feed than have an automated feeding method because if they are off the feed for some reason, the automated feeder will keep dumping it into the system and it may foul the water.

My fish are off their feed, what should I do?
If it's only been a day or two, don't panic. Think about things: what sort of fish do you have? What are their ideal conditions and what are your water temperatures? How long have they been in the system? Fish can often take a few weeks to settle into a new home. Stand back and throw just a few pellets at a time, they might be shy, then come back in a while and check if they have eaten them.

How much should I feed my fish?
As much as they want to eat if your system is cycled and all is well. You will find that different species have different personalities. Some fish, like trout are eating machines, throw a handful of feed into your fish tank and they will go crazy leaping out of the water. They seem to have an almost insatiable appetite. Other species are shyer and will eat more cautiously. Once your system is established, the simple rule of thumb is to feed them as much as they want to eat within a few minutes. Throw a small handful of feed in, if they eat it all, throw some more in, and so on. When they start slowing down and don't appear to be so hungry, stop feeding them. Some fish are happy to eat all day long, others may prefer to eat at certain times of the day. You can tend to train the fish, if you have been feeding them every day when you get home from work, then don't be surprised if they don't eat when you decide to feed them in the morning for a change.

What sized pump do I need for my system?
A question often asked! A general rule of thumb that can be applied is that you want to turn over the fish tank volume once an hour. So, say you have designed a system using a couple of IBC's, you have a 1000L IBC fish tank and two growbeds above the fish tank made from the other IBC. Firstly you need to know roughly what head your pump will be pumping to, this is the height from the surface of the water where the pump is, up to the highest point it will be pushing the water. Say for this example it might be about 70cm from water surface in the fish tank to the top of the growbeds where the water inlet is. So you will want a pump that can pump at least 1000L litres/hour at a head of 70cm. If you check out pump boxes then you will notice that most of them have a graph comparing pumping rates at different heads. Personally I tend to go a little more because this allows for future expansion and changes, or extra plumbing if required at some stage. Remember that if a pump says it's flow rate is say 2000L/h, that is at 0 head, with no restrictions from pipes and fittings.

What fish can I grow in my system?
That's going to depend totally on your location. Major factors are, relevant government agencies or bodies and what they allow in your area, you might have a fishing and gaming or agricultural department you can check with. The next factor is climate, I really recommend growing a fish which will be happy at the natural temperatures of your system without requiring external heating and or cooling. I have seen some elaborate attempts over the years at heating and cooling water to keep a particular species of fish, in reality they don't tend to last long term because of the expense or effort in maintaining optimum temperatures for the particular species. If you live in England, don't try and grow Tilapia, you can grow them, but you need to keep the water temperatures elevated year round. Grow trout, they will grow year round without any heating.

My pH is high or low what should I do?
There are a few things you can do, however always remember little and often rather than large changes. After running aquaponic systems for well over 10 years, I have never adjusted my pH in any of my systems. Here at the display centre we recently tested some of our systems and found that a few of them had a pH down around 5.5 which is considered to be very

low. In fact in a lot of literature may tell you that nitrification will stop at levels below 6, we've found this to not be true. Some fish species don't like low pH, other species are quite happy at a low pH, it might be worth checking your own fish species to find out if they are ok. The plants are certainly happy at a lower pH and more elements are available at low pH. High pH is generally more of a problem than low, high pH means that ammonia is more toxic to fish and that many micronutrients are locked up and not available to plants. pH naturally comes down in an aquaponic system and generally people are trying to find ways of keeping the pH up. If your pH is high you need to look at a few things, check the water you are using to top up your system. If it has a high pH find another water source for a while. If it's not your top up water perhaps it's your media in the growbeds, test your media with the vinegar test. Whatever your pH reading is, remember "don't panic". This is especially true during the early stages of an aquaponic system, during cycling and for a while after, perhaps the first 6 months of operation, you can experience some swings in pH, just let the system settle and mature, if you have checked your media and top up water and they are fine, just leave your system to do its thing.

My ammonia/nitrites/nitrate levels are high, what should I do?
Firstly, if it's your nitrates, don't panic these aren't highly toxic to fish, you need to think about planting some more plants to use up the nitrates. If it's Ammonia or nitrites, there are a few things you should do. Number one thing, STOP FEEDING. Secondly look for uneaten feed on the bottom of your tank and remove any that you find. If you aren't already pumping full time, turn the water pump on 24/7 for at least a few days, salt the system (to 1ppt), this will aid your fish if the nitrite levels are high.

My ammonia/nitrites/nitrate levels are low or nonexistent, what should I do?
Be happy! :o) Many of the systems we run at the display centre here show levels of 0 for all of the above, the systems are producing well, all nutrients are being converted, and also the plants aren't being force fed to any extent by having constant levels of nitrates in the water.

Do fish need sunlight?
No not at all, or at least only in very small amounts, ultimately it's great if you can keep the sun off your fish tank, fish are happy when they feel protected and in the shadows, there aren't many fish that like sitting in the sunshine. This has come about through many generations of breeding, those sitting out in the sun would be picked off quickly by predators from in the water or the sky. Happy fish are fish that aren't stressed so they will be less susceptible to disease and they will eat more and put on weight quicker.

Can I put plants and other features into my fish tank?
It's recommended that you keep your tank as free as possible of objects if you want to keep maximum numbers of fish. The more things in your fish tank, the more places there are for solids to catch and build up. We sometimes put in a couple of short sections of pipe in the bottom of the fish tank for crustaceans to hide in to give them protection from the fish. Pot plants like water lilies, lotus plants, Chinese water chestnuts etc may be attacked by either fish or any crustaceans in your tank. If you have low stocking levels or the right species of fish you may be ok. Floating plants can work very well in a system and they have been talked about previously in the plant section of this manual.

Do I need an air pump for my system?
Probably not, this will depend on a number of aspects of your system. We have found that in all of our systems the water splashing back into the fish tank creates enough dissolved oxygen in the water for the fish of a fully stocked system at the recommended stocking levels. A little extra air certainly doesn't go astray, but there is no reason to get a huge air pump with lots of air stones for your IBC system.

I have algae on my growbed media, what should I do?
You need to look at a couple of things, do you have water going out over the top of your media where the sun can hit it? This will cause algae to grow. Best if you can try and make sure the water goes straight down into the media away from the sunlight. Another way to help this problem is to put some worms into your growbed, composting worms help consume uneaten food, algae and old dead root matter within the growbed.

glossary

Acidic Having a pH of less than 7

Aerobic Requiring, or having abundant air

Aggregate Course material including crushed rock or gravel

Alkaline Having a pH above 7

Ammonia Produced by the fish in their waste and through the gills, can build up becoming toxic if not diluted or converted in the system

Anaerobic Dead zones caused by lack of oxygen, harbour bacteria and release harmful toxins

Aphid Soft bodied sap sucking insects may be white, yellow, black or green

Aquaculture The cultivation of aquatic animals and plants in a controlled environment

Aquaponics Symbiotic relationship of plants and fish growing together in a system

Autosiphon Useful mechanism for controlling flood and drain cycles of a grow bed

Bacillus thuringensis Naturally occurring micro-organism effective as a treatment against caterpillars. Certified organic and not harmful to beneficial organisms

Bacteria Naturally occurring microscopic organisms both good and bad

Biological filter Place that supports the colonisation of nitrifying bacteria eg. growbed

Blue metal Greyish coloured crushed rock or aggregate, usually granite

Broodstock Mature fish used for spawning and the production of young

Buffer Additive which resists changes in pH when small quantities of an acid or alkali are added

BYAP Backyard Aquaponics

Calcium Silver/white soft alkaline earth metal. Necessary for plant growth

Calcium carbonate Found naturally in chalk, limestone and marble, used to buffer pH

Carnivore An organism that feeds mainly or exclusively on animal tissue

CHIFT PIST Constant height in fish tank - pump in sump tank

Chloramine Combination of ammonia and chlorine usually used as a disinfectant and water treatment

Chlorine Powerful bleaching, disinfecting agent. Used for producing safe drinking water

Clay Naturally occurring consisting of fine-grained minerals which hardens when fired or dried

Coir Natural fibre extracted from coconut husks

Cycled When a system has established populations of beneficial bacteria

Cycling The process of establishing bacteria populations in a system

Dechlorinate To remove chlorine

DWC Deep water culture: hydroponic method of growing plants suspended in nutrient rich water

Deficiency A lack or shortage of

Detritus Waste or rotting matter in the bottom of a fish tank

Dissolved oxygen A measure of oxygen dissolved in or carried in a given media

DWV Drain waste vent: type of pipe and fittings used for drain waste and vent plumbing

Ebb and flow The process of flooding and draining a media filled growbed

Expanded Clay Clay pellets fired in a kiln which expands into porous “balls”

FCR Feed conversion ratio: amount of feed fed to an animal, compared to weight it puts on

Fingerling Young fish that have developed to about the size of a finger

Flood and drain Flooding and draining fish water in a media filled grow bed.

Food grade Components made to a standard for coming into contact with food stuff

Fry Young or very small fish

Fungicide Chemical compounds used to kill or inhibit fungal spores or fungi

Gravel Rock particles

Growbed Where the plants grow in an aquaponic system

Growing media Substrate for bacteria habitat and plant root anchoring

Hybrid The offspring of two animals or plants of different breeds, varieties, species, or genera

Hydroponics Growing of plants without soil

Hydroton Type of expanded clay/clay balls with high water storage capacity

IBC Intermediate bulk container to store and transport liquids

Irrigation Artificial application of water to land or soils

LECA Light expanded clay aggregate

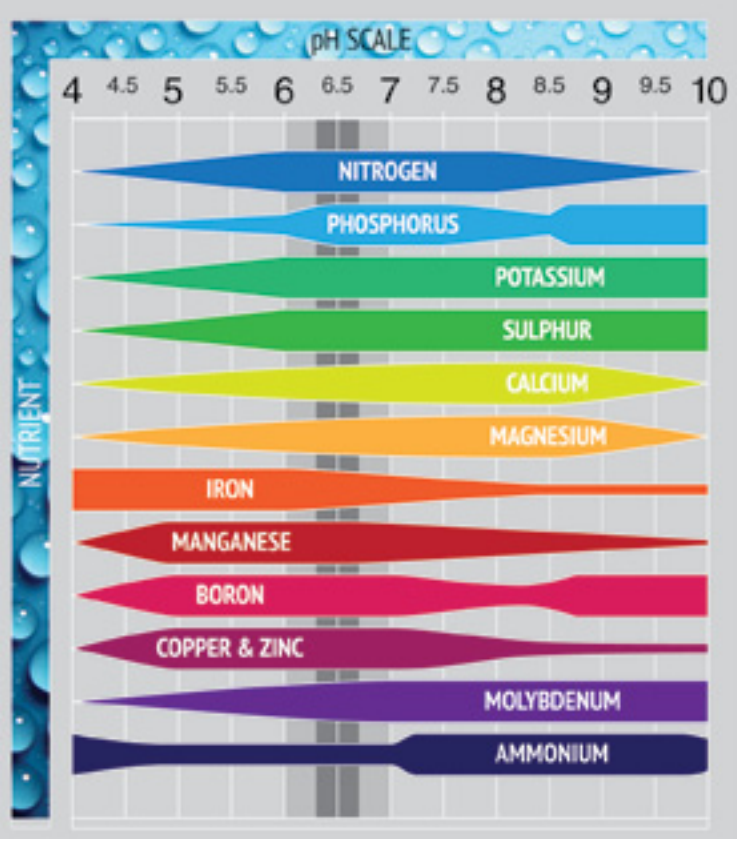
Lime Calcium oxide. Extracted by heating limestone, coral, seashells or chalk. Used for buffering pH

Limestone Sedimentary used for buffering pH

NFT Nutrient film technique where plants are suspended in a small enclosed gutter and thin film of water is passed through the roots to deliver nutrients.

Nitrate	Naturally occurring nitrogen available for plant use
Nitrite	Produced as part of the nitrogen cycle, highly toxic to fish
Nitrogen cycle	Process which nitrogen is converted between various chemical forms
Nitrobacter	Bacteria which oxidises nitrite into nitrate
Nitrosomonas	Bacteria which oxidises ammonia into nitrite
PPM	Parts per million
PPT	Parts per thousand
Purge	Removal of impurities by cleansing
PVC	Polyvinyl chloride- plastic polymer
Salt	Mineral mainly composed of sodium chloride
Species	Biological classification for a group of organisms capable of interbreeding and producing fertile offspring
Stand pipe	Stand pipes set the maximum water level in a grow bed, and excess water that is pumped into the bed goes straight over the top of the stand pipe and down the drain
Stand pipe surround	Casing for the stand pipe which allows water to flow through pre-drilled holes
Stormwater	Water that is derived during rain events
UV stabilised	Substance/object protected from long-term effects of light and ultra violet exposure

ph v. nutrient scale



conversion table

Metric length		imperial
1 millimetre [mm]		0.03937 in
1 centimetre [cm]	10 mm	0.3937 in
1 metre [m]	100 cm	1.0936 yd
1 kilometre [km]	1000 m	0.6214 mile

Imperial length		metric
1 inch [in]		2.54 cm
1 foot [ft]	12 in	0.3048 m
1 yard [yd]	3 ft	0.9144 m

Metric volume		imperial
1 cu cm [cm3]		0.0610 in3
1 cu decimetre [dm3]	1,000 cm3	0.0353 ft3
1 cu metre [m3]	1,000 dm3	1.3080 yd3
1 litre [l]	1 dm3	1.76 pt
1 hectolitre [hl]	100 l	21.997 gal

Imperial volume		metric
1 cu inch [in3]		16.387 cm3
1 cu foot [ft3]	1,728 in3	0.0283 m3
1 fluid ounce [fl oz]		28.413 ml
1 pint [pt]	20 fl oz	0.5683 l
1 gallon [gal]	8 pt	4.5461 l

USA volume		metric
fluid ounce	1.0408 UK fl oz	29.574 ml
1 pint (16 fl oz)	0.8327 UK pt	0.4731 l
1 gallon	0.8327 UK gal	3.7854 l

Metric Mass		imperial
1 milligram [mg]		0.0154 grain
1 gram [g]	1,000 mg	0.0353 oz
1 kilogram [kg]	1,000 g	2.2046 lb
1 tonne [t]	1,000 kg	0.9842 ton

Imperial Mass		metric
ounce [oz]	437.5 grain	28.35 g
1 pound [lb]	16 oz	0.4536 kg
1 stone	14 lb	6.3503 kg
1 hundredweight [cwt]	112 lb	50.802 kg
1 long ton (UK)	20 cwt	1.016 t

Temperature Celcius		Fahrenheit
0 °C		32 °F
5 °C		41 °F
10 °C		50 °F
15 °C		59 °F
20 °C		68 °F
25 °C		77 °F

fruit & vegetable **planting guide**

*For Northern Hemisphere **(NH)** & Southern Hemisphere **(SH)***

Spring

NH: March, April, May | *SH: September, October, November*

Artichoke
Beans
Cantaloupe
Carrots
Collards
Corn
Cucumber
Eggplant
Garlic
Herbs
Kale
Kohlrabi
Leeks
Lettuce
Melons
Mustard Greens
Okra
Onions
Parsley
Parsnips
Peanuts
Potatoes
Pumpkins
Radish
Spinach
Squash
Strawberries
Swiss Chard
Turnips
Tomatoes
Watermelon
Zuccini

Summer

NH: June, July, August | *SH: December, January, February*

Beans
Chard
Corn
Garlic
Herbs
Lettuce
Mustard Greens
Onions
Okra
Peppers/Capsicum
Spinach
Radish
Squash
Tomatoes

Autumn/Fall

NH: September, October, November | *SH: March, April, May*

Beetroot
Bok Choy
Broccoli
Brussels Sprouts
Cabbage
Carrots
Cauliflower
Celery
Endive
Garlic
Kale
Kohlrabi
Lettuce
Mustard
Onions
Parsley
Peas
Radish
Spinach
Sugar Peas
Swiss Chard
Turnips

Winter

NH: December, January, February | *SH: June, July, August*

Asparagus
Beetroot
Broccoli
Brussels Sprouts
Cabbage
Cauliflower
Endive
Horseradish
Kale
Kohlrabi
Lettuce
Onions
Parsley
Parsnips
Peas
Radish
Rhubarb
Shallots
Spinach
Swiss Chard
Turnips

ammonia toxicity scale

Total Ammonia Nitrogen (TAN) - ppm											
Temp (°C)	pH										
	6.0	6.4	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4
4	200	67	29	18	11	7.1	4.4	2.8	1.8	1.1	0.68
8	100	50	20	13	8.0	5.1	3.2	2.0	1.3	0.83	0.5
12	100	40	14	9.5	5.9	3.7	2.4	1.5	0.95	.61	0.36
16	67	29	11	6.9	4.4	2.7	1.8	1.1	0.71	0.45	0.27
20	50	20	8.0	5.1	3.2	2.1	1.3	0.83	0.53	0.34	0.21
24	40	15	6.1	3.9	2.4	1.5	0.98	0.63	0.4	0.26	0.16
28	29	12	4.7	2.9	1.8	1.2	0.75	0.48	0.31	0.2	0.12
32	22	8.7	3.5	2.2	1.4	0.89	0.57	0.37	0.24	0.16	0.1

further reading

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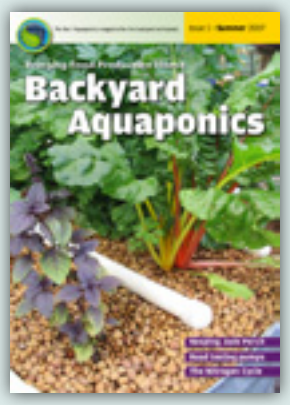

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