



Organic Pools **DIY MANUAL**

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HOW TO BUILD YOUR OWN
NATURAL SWIMMING POOL

Chemical Free Low Energy Water Saving
Bio-Diverse Bubble Powered Pool

David Pagan Butler

ORGANIC POOLS DIY MANUAL

By
David Pagan Butler

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The Aim of this Manual

This is a practical step-by-step guide to build your own Natural Swimming Pool. It is designed to accompany my film "Natural Swimming Pools - A Guide to Building your Own" which is available on DVD from organicpools.co.uk

This method of pool building has been devised for any practical person to undertake without having to involve specialist contractors for any part of the project. There are two main projects, a 48m² organic plunge pool and 180m² full size pool, both built to the same method. They incorporate reused materials and minimise energy expenditure to reduce the cost to us, and the environment.

In the first project we will cover every step of pool construction in detail, from beginning the excavation to bubble pump circulation, from crafting a filter with reclaimed materials to building a jetty. Equipped with this knowledge we'll see how to go on to make a full size pool.

There are many ways of creating a Natural Swimming Pool, but I want to show you a way that is simple to construct and works perfectly. From there, you can adapt it to fit in with your own ideas. This is a practical guide to get more of us started on building these pools. To date, there is no-other publication that provides this information. Indeed there are many people who would have you believe this is too complicated for the non-professional. That is nonsense. I want to show that this project is hard work but deeply rewarding and completely achievable, and along the way we'll bubble a few more myths out of the water.



Introduction

Why do we smile, or for some of us, struggle to contain our gushing beams of joy, the first time we see a natural swimming pool? Is it because inside we know this is so right, giving something back to nature by the creation of a small wilderness? Perhaps we have always secretly wanted to jump into deep luscious pools of freshwater but have been frightened off by decades of myths listing battalions of hazards awaiting any adventurous swimmer.

Today, flourishing on a tide of awareness, we see living freshwater with fresh vision. Thankfully now, we can jump in as happily as an otter.

A Natural Swimming Pool, or as I prefer to call them, Organic Pool, has got to be the most magical addition to our home. It is a beautiful place to observe nature throughout the seasons, bringing us closer to wildlife. The multitudes of species that now live in the pond are an endless fascination to my children, who spend hours observing them from the small jetty which traverses the shallows, dangling down their nets to catch water-boatmen or dragonfly larvae for a close-up look at these incredible creatures.

Then come the birds, visiting the pond in the morning and evening. The grey wagtails, skylarks, dunnocks, gold finches and the formations of swallows circling and skimming the surface to drink or bouncing with delicious splashes to bathe. Dragonflies patrol, snapping up crane flies and cabbage white butterflies and buzzing into skirmishes with intruders. House martins peck at the water's edge collecting mud for nests. Bats flit in and out of their invisibility cloaks in the evening glow reflected on the pond. And sometimes, in the skidding sunbeams of the morning, I may catch the iridescence of a kingfisher feeding on water beetles.

This pond has become another stepping-stone for wilderness. Local native flora and fauna has found its way in and flourished, increasing local biodiversity. And if we create more ponds we will contribute to re-establishing our countryside's diminishing freshwater network.

And of course the swimming! Our children are learning to swim in a healthy environment free from the unpleasant effects of disinfectants found in most pools. I imagine, one day we will look back and wonder how we ever thought it was reasonable to let our children swim in anything other than natural water.

Healthy for our ecology, healthy for us and healthy on our pocket

Until now only people with a fair amount of cash, typically from around £50,000, have been able to consider having one built for them. But there is a different way. I want to show how I built mine, an 180m² pool, for roughly £6,000 and also another 48m² pool for £2000. And knowing what I know now, I could do it for considerably less. It takes a lot of work but, after all you'll be saving tens of thousands of pounds by building it yourself, and I can't think of any work more rewarding than creating a pool. I hope after seeing my construction method, the process will be demystified and you'll think it's a project you could happily be immersed in.



Today, diggers and dreamers can make something precious; a little bit of wilderness you can dive into.

How Organic Pools work



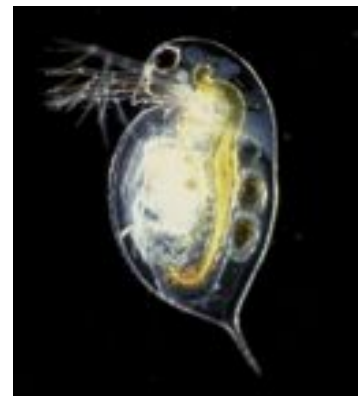
Organic Pools (Natural Swimming Pools), work with nature to provide clean healthy water for swimming. Plants and animals in the pond condition the water without the use of chlorine or other disinfectants. So the water doesn't sting your eyes, bleach your skin, corrode your teeth or make your swimming trunks fall apart. Instead, the water holds a vibrant and diverse ecosystem, teeming with micro-organisms that constantly filter and devour any human pathogen that has the misfortune to plop in.

The key to promoting a diverse eco-system is to prevent one species from dominating the pond. In a poorly created pond the usual dominating big baddy is blanket-weed. Blanket-weed (*Cladophora* superphylum) is the commonest filamentous alga forming dense swathes

over ponds in bright warm weather where phosphate and nitrate levels are high. If this happens to a pond, the last thing you want to do is slip on your costume and dive through the bright green slime. But, do not worry, if the pool is made correctly and cared for properly, this will not occur.

The key to control the growth of algae is to restrict the nutrients entering the pool. If the nutrient level is low enough, plants successfully compete with algae. As the plants grow they accumulate the nutrients in their structure and further deprive the algae from flourishing.

As well as plants there are other vital allies – the myriad of micro-organisms that make up the zooplankton living in every cubic millimetre of pond water. A lot of the small pond creatures are commonly called “water fleas”, which is a bit unfair because they are not fleas and certainly wouldn't bite. Amongst them are daphnia. These tiny crustaceans are essential to promoting clear water by filtering out, and consuming, suspended particles of algae. We need to look after them. Incidentally, this is the main reason an Organic Pool shouldn't have fish. They eat the daphnia.



daphnia

Algae, will never disappear completely, after all they are wild plants and part of the healthy eco-system, but in a properly functioning pool most of the algae will be confined to the margins or hardly visible at all.



The Structure of an Organic Pool

In the Organic pool, the area is divided into two sections, the swimming zone and the regeneration zone. The regeneration zone contains the plants so is also referred to as the planted zone. The pool in the photograph has the deep swimming zone in the middle surrounded by the planted zone. The planted zone should represent at least half of the total area of the pool, and it is here that most of the water conditioning occurs. The water is circulated, either naturally or mechanically, throughout the whole pool.

If a pool is large enough, with enough deep areas, then it can rely upon natural convection currents and surface wind movement to maintain the water circulation. The recommended minimum total surface area for such a pool is 120 m². If the pool is smaller, or the regeneration zone proportion of the whole is reduced below half, then there is increasing reliance on technical equipment to provide the circulation and filtration.

The Natural Swimming Pool industry is moving in an increasingly technical direction. Some pools now look very similar to a conventional swimming pool with not a plant or animal in sight. The more technical installations operate on a very similar principle to a rotary sewerage bed. The filtering and water purification is done by a separate biological filter bed containing a porous substrate. This is home to microorganisms that feed on the organic matter in the water. These organisms are reliant on the water being pumped through the filter to provide them with nutrients and oxygen. (If the technical system becomes faulty, these organisms can die off and quickly decay, releasing their nutrients and causing algae to bloom.) Although a frog, or any other potential coloniser will quite happily swim in such a pool without being zapped by chemicals, the pool will do less for biodiversity because it is devoid of native plants and is highly filtered. Pools with local native flora will provide habitat for wildlife as well as enhanced natural water quality resilience.

Pool Construction Design Considerations

Choosing a site for the pool

A healthy pool needs just two ingredients, water and light. Provide clean water, preferably rainwater, and plenty of sunshine then nature will dive in and do the rest. Pond plants grow best in full sun. Water lilies need around six hours of sunshine to fully flower. And people prefer to be in a sunny place with some shade to shelter in the heat. Shade can easily be created, whereas, creating sunshine is trickier.

The location of the pool is mainly determined by those needs but other practical issues may influence the decision such a drainage or access.



Swimming safely

The main difference between a pond and an Organic Pool or swimming pond is having a swimming zone that can be kept free from weeds and sediment. The big reason for this is safety. Swimmers need to be visible at all times, especially children. Swimming in a wild pond can stir up sediments from the bottom and quickly reduce the water visibility to zero. If the pool is deep, although disturbing the bottom is less likely, the lower levels of water can be extremely cold which is another hazard.

A swimming pond, with a smooth bottom to facilitate cleaning and a depth of around two metres is a far safer way to swim. Gently sloping beaches around the pool reduces the possibility of a child tumbling into water too deep for him to cope with. And most importantly, the pool needs a good fence to prevent unattended children gaining access.

Embodied energy

This is a measure of fossil fuel energy, and hence environmental cost, required to produce construction materials. I have tried to choose materials and methods with an eye to reducing the amount of embodied energy involved in the pool construction. The secondary benefit of trying to minimise the use of high-energy materials is the reduced expense. Low embodied energy materials are usually cheaper.

Historically pools have been lined with puddled clay. A clay liner has the lowest embodied energy, but if we consider the transport for the huge amount of clay needed and the effort involved making it watertight then it becomes impractical for most of us. The only realistic alternative is a synthetic pool liner. However this is expensive in embodied energy, and consequently cash.

With this as a given energy expense, the aim is to make reductions with the other materials needed for the construction. Cement is another big consumer of energy, so an obvious target to for energy saving. Hence, reducing the amount of cement used on the project has been the main method for controlling the embodied energy budget..



Warming the water

In Austria and Germany, where these pools have had the longest tradition, their summers are usually consistently sunny, and compared to the UK, hot. A big reason for them having an Organic Pool is having relatively cool water to dive into. Their summers can raise the water temperature to 30 degrees centigrade, which is too warm for comfortable swimming and not beneficial for the pond ecology. (If this is the case, deeper pools, three metres or more can be built. The deeper water keeps the water temperature from rising too quickly). Here in the UK we have different weather. In fact, we have very unpredictable weather. It changes, from day to day and hour to hour. Consequently, we hardly, if ever, have too much heat to make water in an outdoor swimming pool too hot to swim in. In fact, let's be honest, it's unheard of. Here in the

UK, the conventional bright blue tiled outdoor pools are usually a bit too cold. So, these outdoor swimming pools quite often have pool heaters. When energy was cheap, pumping heat into water only to let it radiate into space or into the ground seemed reasonable, but not now.

Solar heating

On the face of it, installing dedicated solar thermal panels to heat the swimming pond water seems sensible but let's think this through for a moment. Even if the panels cost nothing to install and were 100% efficient at collecting and delivering the heat, the hot water still ends up in the pool. The regeneration zone is doing that already; turning the sun's radiation into warm water. If we want more solar energy to contribute to the water temperature, then we just make the regeneration zone bigger and let the pool's circulation system draw it to the swimming zone. And that way, we have a bigger nature reserve as well. Once the warmer water is in the swimming zone it makes sense to preserve as much heat as possible by reducing the cooling effect from the ground. At 2 metres depth, the ground in the UK is around 11 degrees centigrade all year round, as the water temperature becomes greater than 11 degrees, heat is lost by radiating into the ground. Insulating the swimming zone's floor and walls reduces this heat loss so the water temperature has a chance to rise more quickly during sunny periods and cool more slowly on dull days.

For warmer climates the needs are different. The water needs to be restrained from getting too warm so insulation is not used as this would reduce the welcome loss of heat into the ground. The water depth for the swimming and planted zones can be increased to increase the volume to surface area ratio and relatively reduce the effects of solar heating. Shading the pool can further regulate the solar energy input into the water.

Slope

If the site slopes then it is best for the pools length to follow the contour of the land. This will minimize the amount of banking up needed on the lower side to keep it level. When it rains, surface water run off from the pond's surroundings should not be allowed to enter the water. The water will take up chemicals from the topsoil including plant nutrients, or worse still, artificial fertilizers. If these stream into the pond water, algae will flourish and blanket the pond, stealing the sun to kill off other plant competitors. Most of the uphill run off water can be deflected away from the pool with a crescent shaped berm (small bank) made from some of the soil from the pool digging.

Trees

Trees look pretty around the pond but having them nearby can shade the water and inhibit aquatic plant growth. Also, tree roots may grow under the pool and disturb the pond lining.

Leaves falling onto the pond will bring in nutrients and if excessive will disturb the pools biology to the benefit of algae. However, nets can be strung over the pool in autumn to catch most of the leaf litter if trees are nearby.

Access

The machinery for the construction will need access to the site and ample space to maneuver. Commercial Natural Swimming Pool installers usually demand a greater

space for access because they use much larger machinery. They aim to get the job done quickly and therefore maximise their turnover and profits. As a self-builder, you have a far greater flexibility to work within a space that some commercial installers would dismiss as impossible.

Planning permission

Before you start, you should talk to your local planners to see if you need to apply for permission. Normally for the UK, ponds are not an issue with planners, but it is important to check.



This beautiful example of an Organic Pool shows the flexibility of the concept. It was self-built by Bill after he attended an Organicpool.co.uk course. A "professional" Natural Swimming Pool installer had told Bill it was impossible to have a pool in his garden. A second company said they would sell him a DIY kit for £45,000. Bemused by the conflicting advice, Bill spoke to his architect who recommended coming to see me.

During his first day with me Bill experienced something akin to a "Eureka" moment. Almost immediately he started digging and within a few months he had his own pool. It cost him £6,000 saving him £39,000.

Groundwater

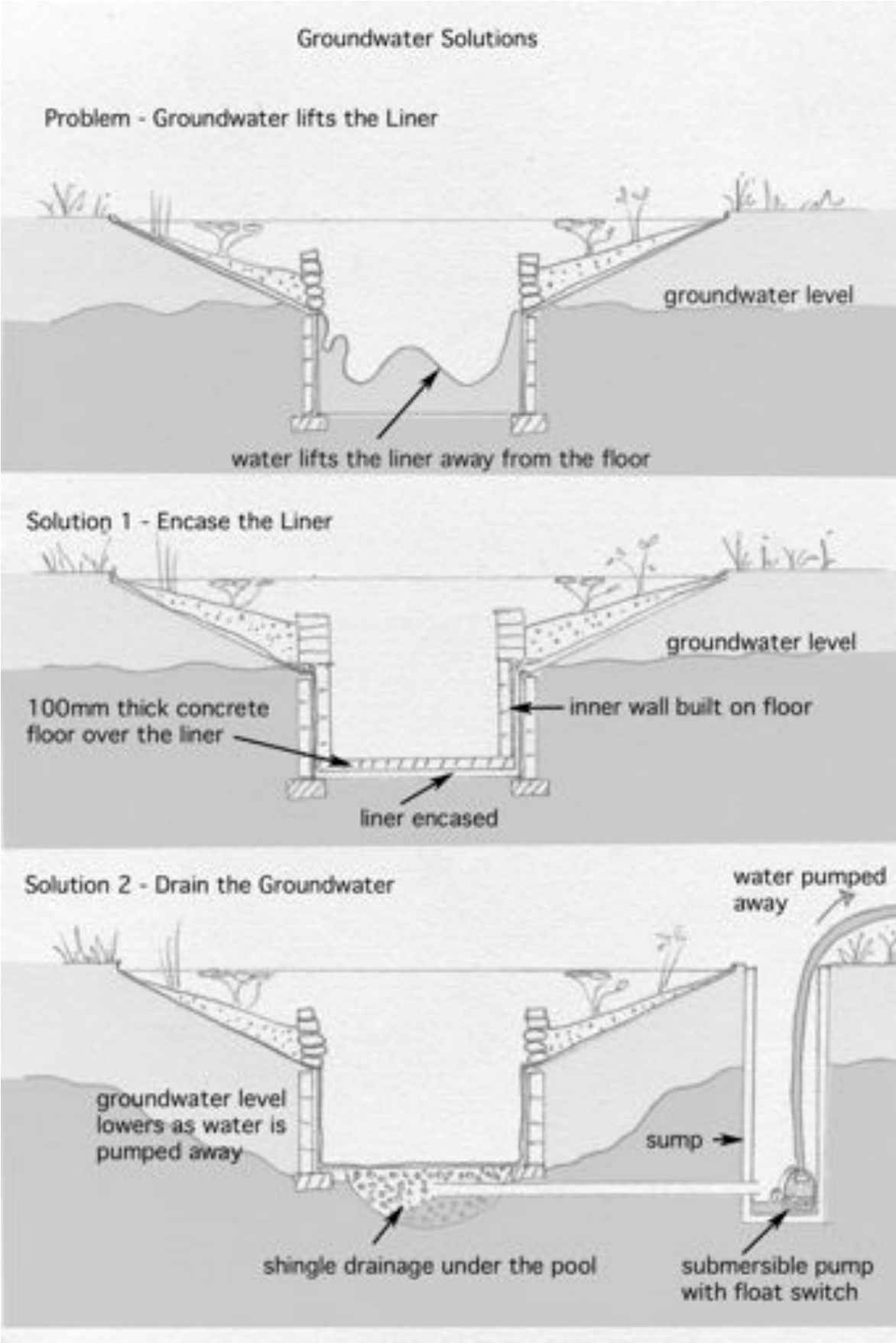
Groundwater is water-saturated subsoil. If you dig a hole through the groundwater level then the hole would slowly fill the hole with water up to that level. In fact, you would have made a well.

The depth of the below the surface of the groundwater level is an important factor for pool building. If the depth of the pool is two metres then the groundwater should never come up to within two metres below the surface. And really there should be quite a healthy safety margin to allow for extraordinary weather or flooding. If the groundwater comes up to meet the liner it can be disastrous. The upward pressure from the ground water can make the pond liner balloon and drift free. When the groundwater level lowers, the liner will drop back down, leaving it creased and distorted and under such pressure it could rip. Any carefully sculpted earthworks below the liner will also be turned to slush.

The groundwater level, or water table, is usually higher in the winter so the site may appear suitable in the summer, only to become a swamp in the winter and liquefy your beautifully shaped pond. If groundwater is a problem then the design must take this into account. There are several options: if the problem is not too severe, a soak away (a gravel bed containing perforated drainage pipes) can be created under the pool. This feeds into a nearby sump, from which the excessive ground water is pumped away. Alternatively, the liner could be encased in concrete at the depths likely to be exposed to the groundwater. Both options require more resources and effort to create so you may be better off forgetting the liner, digging a hole and leaving it to fill naturally. It may not be great for swimming but wildlife will love it.



A recently created wildlife pond fed by groundwater being enjoyed by children in the summer. The water can get a bit murky though.



Organic Pools save water

Because of the buildup of chemical residues in a conventional “blue tiled box” swimming pool, the pool needs to be drained out and the water changed from time to time. The water in an organic pool, on the other hand, never needs to be changed because it is constantly being maintained by the pool’s ecology. This equates to a huge saving in precious water resources.

Also, the pond can be constructed to take a greater depth of water than the 2m needed for swimming, say 2.3m. At times of plenty of rain, it can fill to this level and have enough reserve not to require topping up throughout leaner times. With this approach, I have managed to maintain the swimming zone to the 2m minimum depth by feeding the pool entirely with roof rainwater. Also, if needs be, the pond can store water for the garden in times of drought.



Wildlife friendly

All the animals in the pool arrive independently. The pool is designed with gently sloping beaches and combined with periodic changes in water level, these provide flora and fauna with more opportunities. Marginal plants, emergent grasses and sedges growing along the edge of the pond provide cover for animal access into and out of the water.

Low energy consumption

Until recently energy consumption has been of little concern to Natural Swimming Pool installers so few have questioned the need for so much power to circulate the pool water. A typical power rating for a swimming pool pump is 500Watts. However this bubble, system using an aquarium air pump, can move five cubic metres of water per hour, which is perfect for a pool, and it needs only 60 Watts.



Bubble Pumps

I chose to go against the flow with my choice of pool pumping method. Indeed, my pool circulation system seems to be unique, certainly in the UK. I use bubble pumps (or air lift pumps) for my pools. Bubble pumps are used in dredging ships, aquarium filters, and except for some sewerage systems, not much in between. Which is remarkable because bubble pumps have a whole list of advantages.

Zooplankton friendly.

Bubble pumps are gentle. The pool is complex eco-system kept clear by a myriad of tiny organisms constantly filtering the water for organic matter. We need to care for them as they maintain the hygienic quality of the water. Bubble lift pumps can move large volumes of water but at a very low pressure, harmless to aquatic life.

On the other hand, nearly all Natural Swimming Pools use conventional swimming pool pumps. They are not designed with consideration for any life that may have the misfortune to be thrashed through the impeller and terminate in the filter. Problems, such as algal bloom, can occur with the over pumping of these systems because the creatures that filter the water for us have been liquidized.

This advantage alone is enough to justify using bubble lift pumps but there is so much more they offer.

Self-build suitable

The plumbing is simple. The pipes are standard domestic plastic plumbing fittings, and so are readily available. They just push-fit together and the pipe is easy to cut. (With a craft knife or a special plastic pipe-cutting tool which costs around £15). And there is no need for an accredited electrician to install the pump as the compressor just plugs into a standard mains socket.



This 60 Watt aquarium air compressor can deliver 4800 litres per hour of air. It is rated to water depth of 3 metres of water but at this depth the volume of air is almost zero.

At 2.2m depth it delivers around 1500 ltr/hr

It cost around £90.

Electrically Safe

There are no electric cables in or near the pool. Just plastic pipe delivers the compressed air to the bubble pumps in the pool. And the air compressor is far easier to maintain than a swimming pool pump. It is more easily accessible; not being bolted to the bottom of a pumping chamber and it can't get blocked up with sediments drawn from the water. All it pumps is clean air

How bubble pumps work

Bubble Pumps are also called Air Lift Pumps. Pumping air into water makes bubbles. The bubbles are a mixture of air and water, which is less dense than just water alone.



A bubble pump demonstration in a jar.

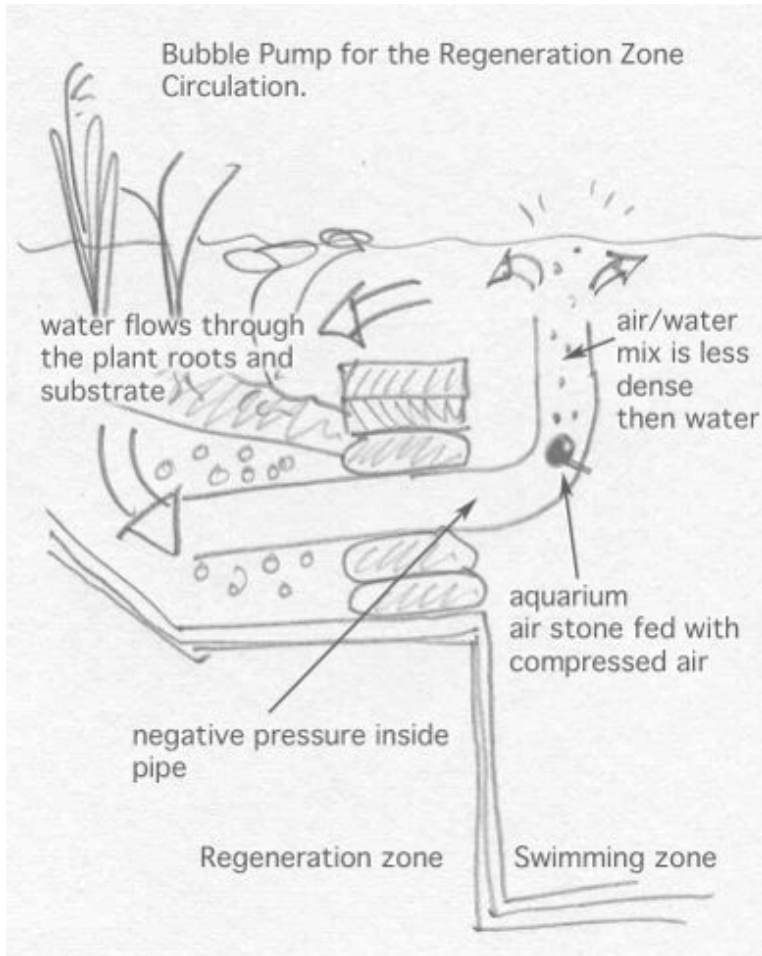
An aquarium air-stone is fed from an aquarium compressor. Bubbles and water flow over the top of the pipe. Water is drawn into the bottom of the pipe.

Being less dense, it will effectively float to the surface as the surrounding denser liquid displaces it. If the bubbles are introduced into a pipe, then the upward flow is capable of pumping large volumes of water but at low pressure (low head above water, typically 15cm). This means they don't consume much power.

Most conventional pumps found in swimming pools and natural swimming pools have fast rotating impellers driven by an electric motor. They can deliver a high head of pressure (10m upwards) at moderate volumes, which is great for fountains and waterfalls, but not for gently circulating a living body of water. And they consume, typically, 500 Watts. Alternatively, an air compressor capable circulating an equivalent volume of water would consume around 60 Watts.



A conventional swimming pool pump used in a Natural Swimming Pool. (Not mine).

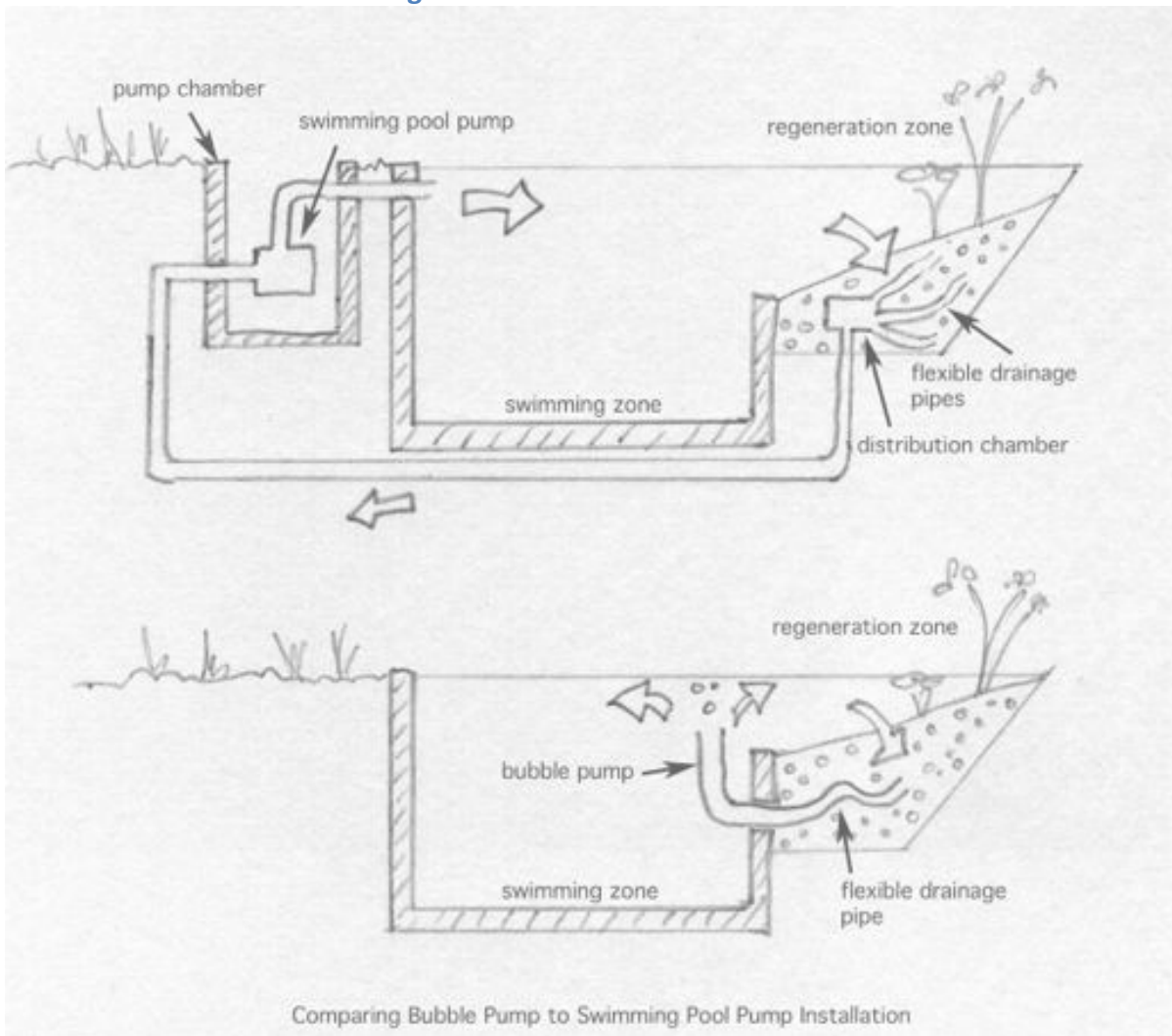


This Bubble Pump consists of a couple of lengths of 110mm dia. standard drainage pipe and a 90 degree bend fitting.

The upward flow of bubbles draws water through the pipe and through the planted zone. This increased water circulation amongst the roots helps the plants and associated micro-organisms mop up the nutrients from the pool water.



This bubble pump has a 50mm dia. aquarium air-stone fitted to the inside of the end cap. This pushes in the bottom of the 110mm dia. drainage "T" fitting. A 6mm dia. plastic aquarium air-line pipe pushes onto the air-stone's nozzle.



Comparing Bubble Pump to Swimming Pool Pump Installation

The top drawing shows a typical configuration for a Natural Swimming Pool. The conventional swimming pool pump has two conflicting needs; firstly it can only function when it is below the water level of the pool; secondly, it is powered by electricity so it needs to be kept completely dry. A separate pump chamber has to be built near the pool below water level, along with the associated ground works for the pipework (usually 50mm dia. PVC) to the pool. The relatively high velocity of the pumped water can damage the essential microorganisms in the pool. (Incidentally, the direction of water flow in the system is not consistent between installers.)

The lower drawing shows my bubble pump system. The bubbles are fed from an air compressor, mounted above water level and at a convenient distance from the pool. It has no pump chamber. Consequently, it has none of the associated long water pipe runs, so it is inherently energy efficient. (As water travels through a pipe it loses energy due to friction. The smaller the diameter and longer the length, the more energy is lost). The bubble pump draws water directly from below the regeneration zone and as the pipework is a minimum of 100mm diameter the equivalent volume of circulated water is pumped at low velocity. This not only harmless to the ecology of the pool, it is also extremely simple to implement.



Water

The quality of the water has a massive impact on the biology of the pool. It may at first sight seem counter intuitive but a wet site that may already have seasonal ponds is not a good place to build a pool. Firstly, you may destroy an existing delicate ecology. Wetlands have been decimated throughout our landscape, three quarters of them have disappeared over the last century, and so we shouldn't contribute to the loss. Secondly, ground water quality is incredibly variable and potentially contains leachate from gardens or farmland laced with artificial fertilizers and pesticides. Indeed, many countryside ponds are in a terrible state because of modern farming practices. Often layered in blanket weed, gorging on the artificial levels of phosphates that have found their way in. An organic pool should not be exposed to groundwater or surface water that has run in from around the pool. Both of these sources are too unpredictable. Commercial installers fill up their client's pools with tap water. But this is also prone to problems. In the UK phosphates are added to the drinking water to inhibit pipe corrosion in the water distribution network. Although harmless to drink, (one would hope), it is a fertilizer for plants. The plants that quickly grab the opportunity are algae or duckweed – equally undesirable for a pool. Unlike the other major biological elements - nitrogen, carbon and oxygen, phosphorus has no gaseous state under normal conditions, so has no escape route into the air. It is a problem

you'll always be stuck with. Commercial installers want to build the pool quickly and fill it quickly with tap water. So, at extra cost, they install phosphate filters. These are big tanks, (sometimes filled with iron wool) involving more construction, plumping, pumps, installation costs and consequently more profit for the installers. And all this technology consumes a lot of energy to maintain.

However, there is a simple solution: rainwater. Rainwater contains very few nutrients, providing the right conditions for balanced pool ecology. Letting the pool fill with the rain that falls upon it is the best option but this could take a healthy chunk out of your life waiting. I compromise slightly. All the rainwater that falls on our house is collected and pumped to the pools. It probably has some bird droppings washed in along the way but it works well for me. Even better, it is quite simple to construct devices to divert the first flush of roof water away, reducing the amount of detritus making its way into the pool. It may still take many weeks or months to fill the pool, but if you making the pool yourself, you should find it filling up as you are working on the project.

South Coast Water
Water Analysis Laboratory
Water supply solutions

Certificate of Analysis

Customer: Mr David Butler Issue No: 1
Company Name:

Test Schedule: H942_01820

Sample Reference: 2013043 Sample Address: As above
Sample Point: South Coast Water

Sample Comments:

Method Reference	Accreditation	Test	Test Description	Result	Units	Limits
N_CPMS	1	N_AMMONI_2	Ammonia	0.00	mg/l	
C_COLOUR	1	COLOUR	Ammonia	<0.00	mg/L as N	
N_CPMS	1	N_NITRITE_2	Nitrite	0.00	mg/l	
N_CPMS	1	N_NITRATE_2	Nitrate	0.00	mg/l	
E_FREECL	1	FREECL	Total Chlorine (Free & Tot)	0.00	mg/L as Cl ₂	
E_TOTCL	1	TOTCL	Total Chlorine (Free & Tot)	0.00	mg/L as Cl ₂	
C_COLOUR	1	COLOUR	Chlorine	0.00	mg/l	
E_COLOUR	1	COLOUR	Chlorine (Free)	0.00	mg/L as Cl ₂	
C_DSDM	1	DSDM	Chlorine Demand	0.00	mg/L as Cl ₂	
N_CPMS	1	COUPHOS_2	Copper	0.0	mg/l	
N_CPMS	1	COUPHOS_2	Copper (Total)	0	mg/L as Cu	
E_PH	1	P	Phosphate	0.00	mg/l	
E_FREECL	1	FREECL	Chlorine (Free)	<0.01	mg/L as Cl ₂	
E_TOTCL	1	TOTCL	Chlorine (Total)	0	mg/L as Cl ₂	
N_CPMS	1	IRON_2	Iron	0.00	mg/l	
N_CPMS	1	LEAD_2	Lead	0.0	mg/l	
N_CPMS	1	MAGNESIUM_2	Magnesium	0.00	mg/l	
N_CPMS	1	MAGNESIUM_2	Magnesium	0.00	mg/l	
C_COLOUR	1	MTHYS_2	Methane	0.00	mg/L as H ₂	
E_COLOUR	1	MTHYS_2	Methane	0.00	mg/L as H ₂	
E_PH	1	CRUAT_20	Other (Unidentified)	0	mg/L as Ca	
E_PH	1	PH	pH	7.00	pH Units	
N_CPMS	1	PHOSPH_20	Phosphate (Total)	0.00	mg/l	
N_CPMS	1	POTASSIUM_2	Potassium	0.00	mg/l	
N_CPMS	1	SODIUM_2	Sodium	11.00	mg/l	
E_DMSV	1	SS_T0	Solids (Suspended & Total)	0.00	mg/l	

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The laboratory water tests for my organic pool showed, not only was it perfectly safe for swimming, it was good enough to drink. It comfortably exceeded UK drinking water standards in all parameters tested.

Part of the water test results for the pool.

The Chemistry of the pool

As the pools are self contained, in terms of water flow they do not do not have a water discharge so all the substances that are introduced into the pond are retained until they are broken down, through biological activity and mineralisation. Organic matter consists mainly of the following elements: carbon (C), hydrogen (H), oxygen (O), nitrogen (N) and phosphorous (P).

Hydrogen, under normal oxygenating conditions ends up as water (H₂O). Oxygen, nitrogen and carbon are released as gaseous oxygen, nitrogen and carbon dioxide but there is no gaseous escape for phosphorous. In a natural pond this enrichment of phosphorous leads to an increase in biomass and gradually, over many decades, it can go through a process of succession to become a bog and ultimately, a woodland. Not great for swimming. (Although some natural pools, low in nutrients can last for ten thousand years.) The only way to take phosphorous out of a pond is to physically remove it. Fortunately, that is not so difficult. Trimming back over-grown plants in the autumn and putting them on the compost heap is all that is needed. This effectively reduces the total available phosphorous available in the ecological sphere of our pond. And makes good compost.

Law of minimum –J.llebig, 1862

Plant growth depends on the nutrient minimally present in comparison to all other factors.

Redfield formula: C : N : P = 115 : 15 : 1

In a pond there is plenty of carbon and nitrogen but phosphorous is often in short supply. Under these conditions, phosphorous becomes the controlling factor in determining plant growth and is subject to competition amongst them. When we say the pond should be low in nutrients for balanced conditions and optimal water quality, we usually mean it should be low in phosphorous.

Tapwater usually contains considerable levels of phosphorous, which is added to retain the hardness factors in solution and keep the distribution network free from calcification. In other words, stop the pipes furring up. By adding tapwater to a pond, we introduce unwanted levels of these soluble compounds of phosphorous and provide an opportunity for excessive algal growth. Surface runoff water from the pool's surroundings can also contain phosphorous washed from the soil, so the edges need to be constructed appropriately to prevent it entering the pool. Rainwater falling directly onto pool is the best water for filling and topping up the pool as it contains hardly any nutrients. Roof-water is a close second.

The ecology of an organic pool is formed from the local flora and fauna and the physical and chemical quality of the water.

The water quality can be categorised in terms of nutrient levels.

The trophic class is the measure of the phototrophic production in a standing body of water. Increasing nutrient levels in a pond correspond to the following stages:

Oligotrophic: Few nutrients and little phototrophic production with hardly any zoo or phytoplankton. A newly filled organic pool will be in this state but as there is a tendency towards nutrient enrichment, it will soon become mesotrophic.

Mesotrophic: Moderate level of nutrients and plankton and moderate plant growth. Most swimming ponds are in this category.

Eutrophic: The water is rich in nutrients and productive supporting many zooplankton, including our friends daphnia. This water may be cloudy early in the year but as the zooplankton becomes more active, filtering the floating algae, it clears. Many swimming ponds are in this category, characterised by very good plant growth.

Hypertrophic: The level of nutrient enrichment is high leading to vigorous algae growth. Algae blanketing the water can kill off submerged oxygenating plants and lead to organic matter rotting under anaerobic conditions. Hydrogen sulfide and methane may develop.



Trophic Class	P-total (µg/l)	Inorganic nitrogen mg/l	pH	Visible depth approx. (m)	Oxygen Content (%)
oligotrophic	<25	<0.4	6-7	3-6	80
mesotrophic	10-30	0.3-0.65	7	2-6	50-100
eutrophic	30-100	0.5-1.5	>7.4	1.5-3	5-40
hypereutrophic	>100	>1.5		0.5-1.5	0-10

Phosphorous in the pool.

Phosphorous is a fascinating element and essential ingredient for life, indeed the double helix of DNA relies on a phosphate ester bridge that binds the helix together. It also has a multitude of other biological functions: energy storage within cells (ATP), calcium phosphate for bones and teeth, exoskeleton of insects, phospholipids in biological membranes. The list is so much longer but we get the picture. Life needs phosphorous.

In a freshwater pool, the other nutrient elements, carbon, oxygen, hydrogen and nitrogen are usually abundant but phosphorous is relatively scarce so its availability becomes the limiting factor to the biological productivity of the pool. It is as if life in the pool has got a kit of parts ready to get growing but it is just awaiting special delivery of phosphorous. It arrives periodically, parcelled up in differing forms reflecting the variety of life around the pool; bird droppings, toad spawn, leaves, pollen, petals, discarded bikinis. The bacteria in the water naturally decompose all of this flotsam and the resulting inorganic nutrients, including phosphorous, are recycled and assimilated into plant growth, maybe even back into flower petals. However, it would be best to pick out a bikini. (A synthetic material may take four hundred years to rot but hidden within the fabric maybe residues of washing powder, which usually contains, guess what ... phosphorous.)

The balance of nutrient recycling in the pool, although robust and adaptable, can be disturbed by a shock to the system from a sudden influx of nutrients. This can happen after a downpour of rain if a poorly constructed pool allows run-off water to flow in from the surrounding soil. The rapid intake of nutrient rich water from the soil can overwhelm the pool's ecology.

(Unlike Nitrogen, phosphorous is transported mainly by runoff. This occurs because phosphorus has a high affinity for soil particles and does not leach through the soil column. From this fact, it's easy to see why rainy weather in an agricultural area, or a fertilized garden, can pose a major problem for a pond.)

The pool should be constructed to prevent run-off water entering the pool otherwise the following sequence of events can unroll like a big green carpet.

The soluble phosphates from the soil entering the water primarily benefit the organisms that can react quickly to the opportunity, the filamentous single celled algae. They quickly multiply, cover areas of water with a blanket of algal growth and suppress the light reaching the submerged plants. The submerged plants can't photosynthesise so they can't grow and compete for the soluble nutrients in the water. The algae, floating on the surface, are sitting pretty in the sunshine. They have light and more nutrients for themselves as they increasingly cover the pool. The submerged plants die and decompose to provide even more nutrients to the water. As these oxygenating plants are killed off, the oxygen levels in the water plummet and consequently the aquatic animals die. This contributes to more organic matter added to the nutrient soup.

Just when you thought it couldn't get any better for the algae, it does. The algae is now so thick the lower layers of the algae die and decompose along with all the other dead organic material in the pool, but because the oxygenating plants have also been turned to mush, the oxygen level in the water is very low and under these conditions, the



This village pond is typical of most ponds throughout our countryside nowadays. It has too many nutrients flowing into the pond causing excessive plant growth. Algae often dominate this pond.

decomposition of organic matter becomes anaerobic. This anaerobic decomposition generates acidic conditions and so the pH of the water drops from being slightly alkali (around pH 7.5) to being acidic (below pH 7). This drop in pH can kick off another sequence involving our key character, phosphorous, entering somewhat unexpectedly from below stage via an unlocked trap door.

The clay rich sediments in the pool contain lots of aluminium. This element is very attractive to phosphorous, so it remains is bound to the aluminium and unavailable as a plant nutrient. But guess what? When the pH lowers the aluminium loosens its grip and the phosphorous slips into the water. Spiking the water with another influx of phosphorous. The water is now so nutrient rich is has become a huge anaerobic digester sealed under a thick blanket of algae. Not the most beautiful of natures creations and not great for swimming. When it gets this bad, no one will need that bikini.



How to Create an Organic Pool

Counter to the conventional wisdom on building Natural Swimming Pools, that pools have to be at least 80m² to function, I wanted to show that even a very small pool, using my methods, is viable and biologically stable.

I'll show you my building techniques used to create this 48m² plunge pool. Armed with this knowledge, you'll be able to build a larger pool of any size.

And of course, as I have built these pools myself, the methods I've developed are entirely geared to self-building. No need for professional contractors to fit the liner, plumbing or electrics. Indeed there is no electricity near the pool at all. The pool's novel circulation system is powered by bubbles so it is incredibly quiet, delightful to look at, and completely safe.

This method of pool building works. The water is clean and clear and has been tested to show it even meets UK drinking water standards.

If you would like to know more please buy the full 160 page version of this pdf from organicpools.co.uk



If you after all of this you're eager to learn more then you could come to one of my courses and talk pond stuff and drink loads of tea.

I'll have details on my website:

www.organicpools.co.uk

I have also produced a DVD of these projects to accompany this manual:

Natural Swimming Pools, A Guide to Building Your Own, DVD, David Pagan Butler, Permanent Publications

Available from organicpools.co.uk

Let's dig ponds back into our landscape!

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