

Magical Orchard Grey Water Treatment Design – Introduction

During my time in Portugal in the winter of 2010/2011 I visited a few different low impact living sites, including Tarana's 'Pomar Magico' (Magical Orchard) near Lagos.

I offered to design a new grey water treatment system for her, as the present one looked a bit insufficient to me, and I wanted to do some designing work and complement the course I was due to run there.

The design was a new area for me, having not tackled a water project before, but I had time and a desire to learn some Portuguese Permaculture, and to leave the place a little better than when I found it.

I used Survey-Analyse-Design-Implement-Debrief as my design process Macro, and this write up follows that pattern as well.



Survey

Aims

1. Clean grey water from bath house outflow to enhance the ecology generally and specifically the quality of the water in the nearby well.
2. Reduce amount of fossil fuel used in irrigation (petrol generator powered water pump).
3. Educate people about grey water treatment systems.
4. Be beautiful and enhance the aesthetic qualities of the orchard.

Observations -

The Bathhouse

The main resident – Tarana – doesn't always use biodegradable toiletries.

The grey water produced is from body and clothes washing. Bathing mainly happens at night.



The Pond



The pond looks fairly dead, there are some frogs living in it.

Water goes from the bath into a 10m pipe, then flows directly into the pond in a soapy and possibly hot state.

There is a black plastic pond liner in the pond which has sunk down, apparently it has been dog ravaged and has holes in it. The frogs seem to

be using it for cover.

The pond is roundish, and therefore has a relatively small edge to volume ratio.

The pond is only a third full in winter, with 1 resident and occasional visitors. Winter is the peak of rainfall in the Algarve, so it is unlikely to fill any higher.

There is not much vertical height between the top of the pond and the bath outlet plughole.

Land Based Contexts

The Bathhouse is at the top of the land, with its water tank above it. There are 2 terraced slopes below, then the stream.

Water is precious in the summer, and lots of human and fossil fuel energy goes into watering fruit trees and gardens.



Winter water is abundant but in the present system it still needs to be piped up from the well, using electricity.

At present the water in the pond evaporates off or seeps into the ground.

There is evidence of an outflow channel from the pond towards the vines, but the water level is lower even in the peak wet season, therefore no water flows off down it.

Dogs run around and jump into the pond in the winter, and probably do so even more in the summer.

The soil is thick clay, at a valley bottom/flood plain.

The land is south east facing.

The kitchen shed is possibly being rebuilt this year.

Human contexts -

I need written up designs for staying as a listed UK tutor, and for my website.

Ludovico (another occasional visitor) is keen to do hard work.

Other wwoofers may be available.

Someone is always on site here to look after the animals.

The neighbour's dog steals pond plants out of one of the smaller ponds.

Amelias van is available.

Future contexts -

I am teaching a course here in March.

There will be a flushing toilet and a septic tank here one day.

The bathhouse floor will soon be concreted.

Tarana is possibly renting out/leasing some of the land to a Dutch person who may want to change things.

Tarana is away this summer – someone else will be guardian of the land.

Roof needs fixing on the bathhouse.

Tarana could be away for a while working full time in Almadena this month.

Tarana is looking into setting up a land owning partnership company, which may bring in new visitors/residents in the future.

Research

Where did the spoil go from digging the first pond? – nearby amongst the fruit trees.

Client questions

How often using the bath? 3 or 4 times a week

Future plans for the land? See above.

What time of day does water from bath/clothes washing outflow? At night, occasionally midday.

What budget? Minimal

What other yields from the design? Fish, edible pond life? More wildlife? Wildlife.

Ideas what to do with spoil from any digging?

What containers are still available? Large green container, blue barrel, white round thing.

Resources

Pond plants from reservoirs and nurseries.

Existing pond.

Big green water tank.

Small white water tank/pond.

Wood,

Animal cages,

Cushions,

Sofas,

Yurts,

Furniture,

Toilets,

Chairs,

Hardboard,

Toys,

Tins,

Water bottles,

Humanure,

Blankets,

Books,

Grey pipe from existing system.

Cannas.

Plastic tarps, ripped and degraded.

Shade tarp.

Fruit.

Cats.



Limiting factors

Cats.

Dogs jumping in and out of the pond.

Neighbours living close by on the other side.

Not much money available; time unsure about?

Neighbours land next door.

No rain for months in the summer.

Wild ideas

Water collection off roof.

Use design for teaching on the course – show process and do some of implementation (assembly, some digging also? Depending on numbers).

Use water for summer watering?

Reduce evaporation with plant life.

Use existing hole rather than digging more holes.

Make an island in existing pond to increase the edge.

What to do with spoil?

Put in a flow form to oxygenate and clean the water.

Analysis

1. Primary function - Cleaning the water:

Possible Water Contaminants -

Water entering the system will at times contain shampoo, soap, washing powder possibly all non-biodegradable; also clothing dyes, fabric lint, dead skin, salt, hair, mud, sand.

This is what the treatment system needs to be designed to deal with. The water will also often need cooling before interaction with the flora of the Orchard or the grey water system.



Toiletries

The toiletries used are chosen by the person using the bathhouse, and are ultimately beyond the designers control. Biodegradable products will break down more quickly into safer chemical compounds in a well designed system, and will not damage the soil and plants and are therefore preferable. It is probably beyond the scope of a domestic system to safely transform non-biodegradable toiletries, so people are to be encouraged to use only biodegradable products in the bathhouse. Such products are available in the Algarve, although they are more expensive than the cheap supermarket brands.

A sign could be placed in the bathhouse saying only use biodegradable products please, and the owner could be asked to remove all non biodegradable toiletries to create a good example. It is also possible to wash without using any cleaning products at all, or to make cleaning products yourself, eg. from pure woodash, citrus etc.

Clothing dyes

Dyes in clothes leach out to a smaller and smaller extent throughout the garments lifetime. More are released in hotter washing temperatures. It is imagined that the temperature of clothes washing is erratic, coming from a wood stove, so dyes will be released erratically whenever clothes are washed. The dyes can be fairly strong chemicals, and it is probably beyond the domestic system to transform them effectively, so there will probably still be some in the water at the end of the system. They may coat the interior surfaces of the system as they pass through, especially as the water cools in the earlier sections.

The only ways to limit fabric dye issues are to reduce the temperature of the washing water and improve the quality of the clothes washed in the system.

The first could be attempted by a sign, the second is not so practicable as it is an area people are fairly unaware of, and there is not so much readily available information on different dyes, clothes etc. Choosing non dyed fabrics is a possibility, but the expense of buying such clothes as opposed to buying/sourcing second hand clothing is big. Making clothes from undyed, purchased fabric is a cheaper but more time consuming way of solving this issue.

Fabric lint

This comes off all clothes, especially from natural fibre clothing. Natural fibre lint (wool, cotton etc) is safely and easily broken down by decomposing processes etc. Petrochemical fibres such as nylon, polyester etc are fairly physically inert and will slowly accumulate in the system as they will never break down, gathering near the start, where water is held still for periods of time, and slowly flushing through the system to a lesser extent,

Dead skin and hair

These can be dealt with by decomposing processes. The hair has a tendency to clog pipes and plugholes, and is best removed at the plughole by a small filter as exists on most bath plugholes.

Salt

From bodies, it comes in such small concentrations that it is not much of an issue. If washing wetsuits, sea salty clothes etc regularly, a different system may need to be built to protect the grey water treatment flora from being over salted.

Mud and sand

The mud is likely to be clay, which stays in suspension for days, and will probably move through the system and out the other end, back to join the clay of the soil. The sand is more likely to drop out and settle at the earliest opportunity, so this needs to be accounted for in the system, to avoid the sand clogging the water flow. The first tank will get clogged the most quickly.

Cooling

Cooling will happen at the start of the system, so any plants close to the start of the system may come into contact with hot water. The water from a bath or clothes wash should be fairly lukewarm rather than hot before it is flushed out, but occasionally hot may go straight down, though hopefully not in too large a quantity.

The issues of hot water that is too hot can be minimized by having the water enter chambers at the bottom, away from the plants at the top. The relative coolness of any materials inside the system, eg gravel and existing water, will also cool the water as it comes into contact with them. A smaller tank at the start could be sacrificial in this respect, it gets the hot blast and cools it for the later, larger tanks. A large cooling tank capable of taking a full bath of hot would be ideal. User education would hopefully prevent large quantities of hot water entering the system (another sign?)

Volume

The system needs to be able to contain at least 3 baths worth of water, as this is the usual maximum usage quantity on site. Any less and untreated water will continue to enter the pond.

2. Secondary function - Irrigation output

Relevant observations -

The pond is fairly high in relation to most of the garden, so water can be routed to most of the garden by gravity. The



shorter the distance, the easier the implementation. Many pipes and fittings of various gauges are available in the orchard already.

Near the pond on the downhill side are plum and orange trees. The oranges are not good croppers. Below these trees is the camper van, then more orange trees.

According to Tarana, the plum trees need the most irrigating in the summer, as do the various salad and veg beds. She also waters the flower beds a lot during dry periods in the winter.

Irrigation function analysis -

The grey water will be safer used on trees rather than veg beds, as it will come in a strong pulse when the bath is emptied, and may still contain some contaminants. Trees will be better at dealing with both these issues, and are less likely to pass the contaminants into their edible products than the salads/veg.

The trees are also a lot closer than the veg beds, which makes implementation easier and maintenance simpler.

The outflow pulse is best spread out over a large area rather than put into one place, so some form of leaky pipe with a low gradient will work well. Due to the high evaporation risk from the heat, the water ideally will exit the pipe underground or under a permanent mulch.

Moving the water further down the garden and keeping it as high as possible will reduce the amount of it getting back into the well through groundwater seepage, thus helping keep the well water cleaner.

This gravity powered irrigation system will reduce the amount of fossil fuel needed to power the generator to power the water pump, saving money and the environment.

3. Secondary function - Education output

Locally by putting up signs in the orchard/Tarana talking about it. Also by using it as an example design during my intro course on the site. I could also do visit to it from courses in other locations nearby.

More broadly by writing up this design and putting it on my website, which is linked to from the UK Permaculture Association as one of the few sites with designs available on it. I could refer to it as an example on other courses too.

4. Secondary function - Aesthetic output

Pond -

The existing pond could be more attractive. Removing the liner and cleaning the water to help more things grow in it will help. The existing pond is a heart shape, which is nice, but it is not very obvious at the moment. It took me a while to realise even!



Treatment system -

Any tanks themselves will be plastic looking, but with plants growing out of them. The tanks could be surrounded by hessian/rocks etc to hide their bright colours. There will probably be things growing lushly around them anyway, fed by any leakages from the system.

Irrigation pipes -

If these are underground or covered in mulch, these should have little impact once the grass has regrown. Perhaps there will be strange lush patches of grass in the summer where the water irrigates the ground...

Analysis – what elements to use to create the systems?

Possible elements to fulfil the function of water treatment -

1. Existing pond
2. Tanks on site
3. New pond/channel
4. Brought in tanks/baths etc.

Existing pond – The existing system is compromised by the dogs destroying the pond liner (it could be fenced, but that is often unsightly and would be sad for human (and canine) enjoyment and connection with the pond). Also the hot water entering the pond straight makes it challenging for beneficial organisms to thrive there. Some sort of pre pond system would deal with most of these problems, cooling and protecting the useful organisms from dogs! The pond could form a later part of the system, though it will still leach down to the well.

Tanks on site – There are 2 largish tanks, one sound blue barrel shape and a larger green water container, with a few big cracks in it. These could form some of the treatment system, though the holes in the larger tank pose a problem. It could be patched by placing a waterproof membrane inside or outside it, using the tank for structure and the membrane for watertightness. The tanks' combined volume is 4 or 5 bathloads, which is ample to cool and start treating the water. They would have to be dug in though, or placed in the existing pond as the water output from the bath is low relative to the ground at the bathhouse. Fortunately the land slopes down from the bathhouse, so the system can be run on gravity alone.

A new treatment channel or pond – these could be dug in and used to move and clean the water. Any membranes would need to be protected from dogs though, and the soil is heavy clay, so any digging will be laborious work and ideally minimised. The existing pond is there and already dug, and could maybe be altered to have separate areas/ponds/channels running through it.

Bringing in new containers – There is very little finance available to buy in materials, and the canny, financially poor Portuguese reuse materials a lot already, so there is not a stack of available second hand baths and plumbing in every town. (In rural Portugal the bin is the recycling centre

– anything half decent is left by the side of the bin for someone else to find and take away with them, or sold at one of the many second hand markets). If containers appear, they can be utilised, but until then I cannot plan to use them.

Conclusion – A system utilising the tanks on site that feeds later into the pond makes most sense given the design constraints of dogs, finance and heavy clay.

Later it strikes me that the output from the system could be diverted, in summer at least, to irrigate some of the trees nearby. It mostly evaporates in the summer anyway, leaving the pond very low, and watering is a major job that uses a lot of resource, both human and fossil fuel, in the orchard. In winter when there is less need to irrigate, it can flow into the pond and create that nice feature again.

Design

User education – Put a sign into the bathhouse explaining why not to use non biodegradable toiletries.

New water treatment system – Emplace two water treatment tanks, the first smaller and watertight, the second larger and leaky. Both filled with gravel/stone and topped with plants. A gravity led system. Originally I was going to use the plentiful white stone (Britta) that people use for roads in Portugal, then it occurred to me it was probably limestone and would create a challenging environment for our hard working microbes, so we decided to gather stones from the locality instead.



Additional contextual yields – Put in new vegetable beds around the leaky tank to use the wetter soil.

Work on the implementation as part of my Permaculture Introduction course , hopefully the assembly stage.

Explain the design process and the design as part of the course.

The treated water flows into the pond in the winter and a new leaky pipe irrigation system to water the plum trees in the summer. There needs to be a consistent drop all through the system



to allow the water to flow down it. I will measure this with a bunyip. A slow flow at the irrigation end will enable the water to spread and seep out of the leaky pipes, but its not good if it acually stops and goes stagnant inside the pipes. The pipes will need to be buried under ground to protect them from UV and to look prettier and to be low enough to create a flow.

Implementation plan

The Plan:

Groundwork preparations and guidelines

Dig when ground is soft. Cover hole to prevent drying out too much, and to make the site safe for animals and people when I am not working at it.

Keep spoil on something and covered over to prevent drying, so its soil life can stay alive and it can be reused to grow in.

Get the holes dug before the course weekend.

Components preparations

Get skin fittings and a stopcock to connect the tanks together.

Get gravel/stone for the tanks.

Get plants to put in the tanks.

Choose pipes from the ones onsite.

Collect mulch for the irrigation pipe runs?

Fit pipes together

Assembly

(during course)

Emplace the tanks.

Fill in around the tanks with earth.

Barrow gravel up and spade it in

Make the vegetable bed

(after course)

make leaky pipes

connect

place pipes

put out mulch?

put in plants

The reality:

I dug the first tank during a few visits to the Orchard when I was enlisted for dog care as well. It was hard going and the holes filled a little with water – though that helped make the clay softer too.

I didn't have/make time to dig out the second, larger tank low enough before the course, or before I left.

I wanted to set the system up before I left, but the client said she would prefer to finish it herself and have a larger capacity second tank, so I left that task with her.

I hadn't sourced the fittings before the course either, or collected the stones, so we

concentrated on collecting stones for the tanks during the course practical, a less engaging and educational task, but necessary, and a useful exploration of the value of resources and gathering them for free versus buying them.

The design was a very useful teaching tool for the design process itself however.

After the course I dug trenches for the irrigation pipes, using a bunyip to measure the drop over the pipe sections. I then chose lengths from the existing polypipe sections and connected them together. I drilled and sawed holes in the pipes where it passed near existing orange trees, to add more irrigation function. I left the trenches unfilled in, because the system was not yet tested and may require some more digging when water was properly run through the whole system. I did test the pipe section, and the level of flow seemed promising.

Bunyip* measurements during installation

18cm above at top of inlet barrel
7cm above at exit from outlet barrel
30cm below at plum dripline - 8m from outlet
so the overall fall is 37/800 or 1/21

The existing bath outflow pipe is 22cm over 5.6m =
22/560 or 1/25

So the water will flow quicker through the system than it does through the existing pipe, apart from areas where it is not uniformly laid down at an incline, which is quite likely...

** A bunyip (pictured) is a clear flexible plastic pipe attached to a stick at each end. The pipe is then filled with water, and this can be used to measure relative differences in height very accurately.*



Finale?

As I unfortunately had to leave the job unfinished (which I had reservations about, knowing how energy can flow and not flow with these projects..) I sent the client, Tarana, a step by step plan for finishing it off -

Grey water system completion plan.

Keep some kind of physical barrier around the holes to deter humans and animals from falling in until the holes are completely filled with stones, and until filled, also place a stick/rod in each so animals can climb out if they fall in

Make a sign for your visitors saying "Please only use biodegradable products in this bath house because other products will damage the bio treatment system. If it doesn't say biodegradable on the packet, it isn't biodegradable."

Dig out space for the green tub so that its top is just above the level of the top of the blue barrel. Make sure the bottom of the hole is level so the tub doesn't crack - maybe use some sand at the end to get a good surface.

Emplace the green tub, with the brass inlet hole pointing towards the blue barrel.

Connect the black pipe to the green tub below the level of the lowest part of the top of the blue tub. (so water will overflow and not return into the blue tub). The connector for doing this is tied onto the top of the blue tank.

Fill around both tanks with medium to big stones. Grade the soil above the tops of the tanks so it slopes back and won't fall into the barrels.

Fill both tanks with stones - ideally gravel sized stones, but you can use larger at the bottom (The system can be filled and used before this stage is complete, and you can do all the other steps before the tanks are full of stones too). - When tanks are nearly full, put in a variety of pond and water loving plants, then fill round their roots with small stones. It is the stones and microbes that do the cleaning work, but the plants help create better conditions for them to flourish. Plants in the green tank may get drier and die if the bath house isn't used for a while in the summer. However the blue tank should always stay quite full.

Make a better closed end on the black pipe below the plum tree. (at the moment it's just clay) - bike inner tube and jubilee clip? Maybe attach a hosepipe to it with a tap on for watering any new veg bed you make below there.

Cut and connect the grey pipe from the bath house into the inlet pipe for the blue barrel. The second inlet pipe is for one day maybe connecting the outflow from the new kitchen.

Have a bath!

Check the water is flowing through the tanks and out into the pipes okay. If it's not reaching the section below the tree, dig that pipe in a bit lower, esp at the joint, though not too low - it's designed to flood above the tree mainly, then flow to the lower section after.

When it all looks like it's working okay -

Fill around the last section of the upper pipe, just above the plum tree with stones - medium to large size is fine.

Then fill in the rest of the trenches loosely with the soil. Do not compact the soil, lots of air gaps is good. 2 stories of stones at the bottom of the trench would be a great addition if you can be bothered.

Have more baths, and keep buying biodegradable products!

Let me know how it is going! And I hope to see it in action next autumn.

When too much water in the garden becomes a problem again next autumn, cut a trench from beside the green tank through to the pond, a little below the level of the outlet pipe to the trees. Put in a pipe with a tap on and then fill back over it. This will shortcut the water back into the pond for the winter.

Debriefs

March 2011

(As I left Portugal)

Observations	How to do differently next time
The digging was fairly labour intensive	Could have used the existing dug out pond somehow?
Not much room around the leaky tank for growing useful things	Place the second tank further away from the existing pond so that its water overflow and seepage makes a larger bed for growing in?
Hurt my foot whilst digging with mattock	Be more careful/slow down in that state of adrenalised workman. Or wear better protective shoes rather than open sandals...
Digging got me into a natural rhythm – doing it before or after it is too hot at midday	
Britta problems (the stone I planned to use to fill the barrels)	Be more familiar with products during the analysis phase, I was culturally unfamiliar with this material. At least I spotted its intrinsic flaw before we ordered it, or worse, made the system with it!
I found it hard to source plumbing bits, so made the system overflow to move between tanks, which is not ideal as some water may just seep into the ground instead.	Think through the design more fully and source all parts before commencing.
Didn't make any maps or design drawings – The client trusted me to make a good design so I didn't need to present it to her formally, and as I was the 'contractor', the plans stayed in my head	
I am worried about water leaking out into pond in summer and evaporating.	I could have lined the 2 holes with a plastic sheet before putting in the tanks, which would have made it more contained, but it would be difficult to do that with the staggered digging and emplacement of the two tanks.

Debrief in November 2011

(as I head back to Portugal!!)

Observations and thoughts	Done differently
I have had no news from Tarana about whether it got finished off or not.	I could ask again, but I will be visiting soon and will find out how it has gone myself
It was quite rushed taking on this project at the end of my time in Portugal.	Make more time when doing these projects. Stacking the course in as well in the last few weeks was productive but a lot of time went to preparing for that.
Nice beneficial relationships with my course	
It feels good to leave behind something that I created in Portugal.	
The design write up can help me with my Diploma tutoring requirements – ie to have design work uploaded to the net.	
I have put off and put off writing this up, even though I knew I needed it for staying a diploma tutor	Do more writing up during the design – it was all designed in text documents on a computer, but there is always more formatting and elucidating to do. It gives me sympathy with my apprentices who have to write up 10 designs for their Diploma accreditation. And I'm pleased to finally have impetus to publish some new designs to replace the ones I wrote up on my website 4 years ago...Its all extra yields.
Photos very useful for this write up	Take more photos, especially of the earlier digging stage
I hadn't ever done a water based design before	
I'm very pleased with the irrigation addition, originally it was just a treatment project, but the Permaculture principles and design process helped me to join the systems together and create more yields.	
I hardly ever do design drawings. Probably because I design for myself most of the time, and usually I do non land-based designs like courses.	My drawings could be fun and creative, maybe done in pencil then coloured in, then scanned in. They do help to inspire clients and make write ups more accessible. I guess a timetable is a design drawing for a course...

<p>The 'Use only biodegradable products' sign was a low hanging fruit that I could easily have plucked, and it could be very effective at improving water quality, a do nothing strategy almost, removing the limiting factor of dodgy chemicals in cheap toiletries.</p>	<p>Why didn't I make one, or commission the artist friend I was travelling with to make one? Even a quick and rough temporary (haha!) one would have been a start towards a better bath house system and garden. I guess I got too caught up in the drama of digging and building.</p>
<p>I received good will, food and lodging, a good connection with the client, design experience in a different country and climate, and content for my course, but no money for doing the design or what I did of the implementation</p>	<p>It takes the pressure off me, and the client didn't have any money to spare. I had available time and enjoyed the process... I felt sufficiently incentivised and rewarded for this project, but may choose differently in future situations... It is nice to give back to the venues that shelter me on my travels, and as I haven't paid for any rent or lodgings anywhere since August 2010, I don't need so much money... just good connections with people with shelter and land :)</p>