The top 6 things to consider when Rainwater Harvesting

GRAF®

An updated and enhanced edition of The top 6 things to consider when Rainwater Harvesting. Now including a **NEW** chapter: Rainwater Harvesting on a budget!

Plus, the full list of **21** things to remember when deciding to add a rainwater harvesting system to your home

Rainwater Harvesting | Stormwater Management | Wastewater Treatment | Garden



Learn how to do Rainwater Harvesting the **RIGHT WAY**

with the

Top 6 things to consider when Rainwater Harvesting

A guide produced by rainwater harvesting specialists Graf UK

Updated & Enhanced Edition 2021

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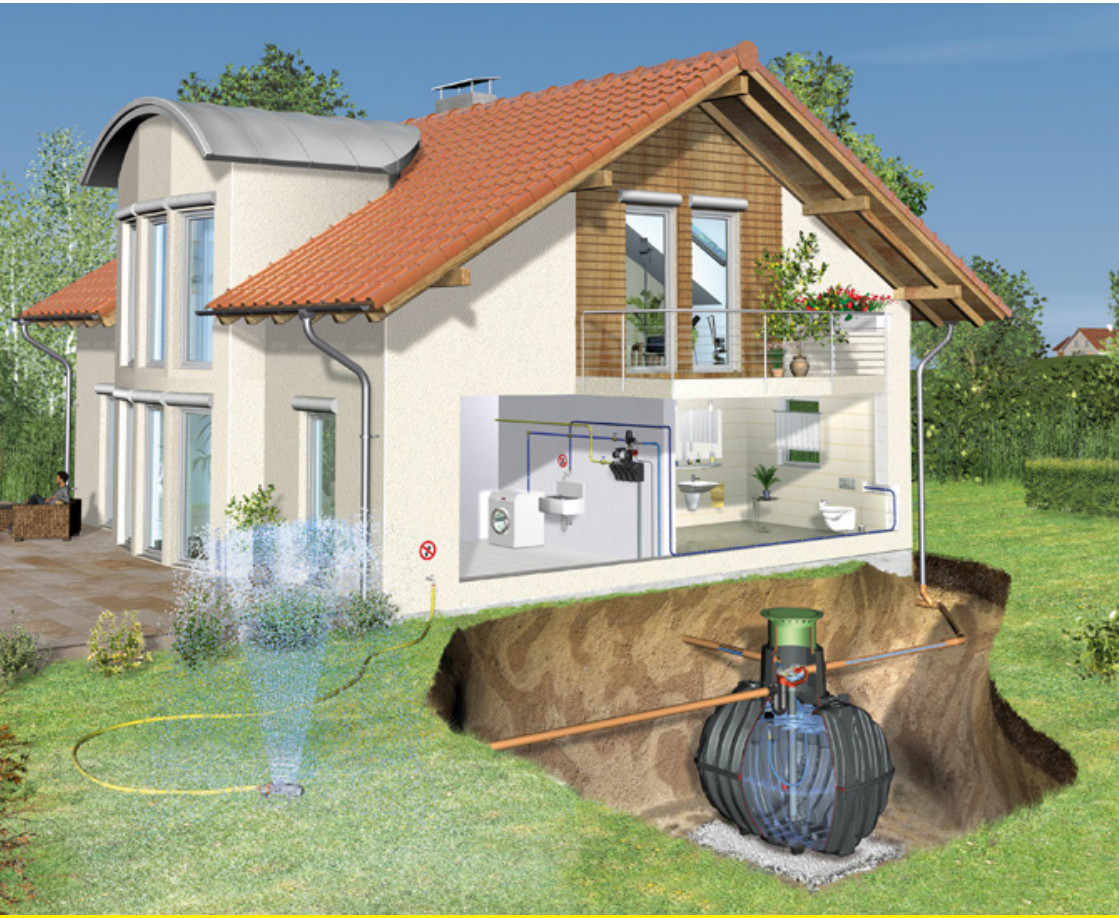
A household can substitute 50% of its mains water with rainwater

Introduction

Rainwater harvesting is a simple idea. It's not complicated. For many, many years people all over the world have been collecting rainwater and putting it to good use. The key is to do it well and plan what kind of system you want and what you want to use the water for, before installing it.

Rainwater harvesting systems can be either for full domestic use, which includes flushing WCs, supplying the washing machine, an external tap for use outside and even a sink in a utility room for cleaning water only, as well as just garden use outside with a garden only system. Typically garden only systems do not have a mains water backup operation as they provide harvested rainwater when it is available from the tank but they don't store up mains water as this would use up valuable rainwater storage room inside the tank or tanks.







Both systems can be created using either above or below ground tanks, although full domestic systems are better with below ground tanks, for reasons we'll explain further in chapter six. Rainwater harvesting usually involves collecting rainwater from the roof of a building, filtering the rainwater before it enters the storage tank, to remove the leaves and any other debris collected in the rainwater as it flows over the roof material and through the drainage pipes, and then storing it in a tank. From the tank, it is then pumped to the supply point, which could be an outside tap, a WC cistern, a header tank for an indirect supply system, or directly to a washing machine. This element depends on the type of system chosen at the time of installation. We'll discuss this more in chapter five. The final part of a system is then the mains water backup or top-up operation to provide mains water in times when rainwater levels are low, generally during the warmer summer months. Water needs to be available at all times on a domestic or commercial system (not always on garden only systems), which means there has to be a facility for mains water to back-up the rainwater supply.

There are of course many other additional parts that can be included, but these are to the users preferences, they are not necessary to provide a simple, effective, working rainwater harvesting system. When things are kept simple, they work.

Chapter 1

Graf UK – Who are we?

In 2007 we formed SCP Environmental Ltd and began importing rainwater harvesting systems from well-known German manufacturer, and European market leader, Otto Graf GmbH. We saw an opportunity to bring high quality rainwater harvesting systems to the UK and set up a niche business to supply this emerging market. At the time in Germany, rainwater harvesting systems were common-place and the market was much bigger than in the UK. This is why we chose a supplier and manufacturer who had excelled in the German marketplace and was starting to innovate and bring new products to the market which added so much value compared with alternative, particularly UK, producers.

In 2007 and 2008 we started slowly as the market began to increase in the demand for rainwater harvesting. Our focus was on the supply of domestic systems and in particular, social housing developments and smaller private developments, where there was a bigger drive towards using more sustainable products and systems. We soon started to supply to multiple dwellings on large-scale housing developments and it wasn't long before we added an installation arm to our business. The housing market at the time was slow and developments were built in phases. We would show one team of contractors (our customers) how



to install the systems and then when they came round to actually installing the systems, that team had been moved to another site and the new team doing the installation had received no training. As such, installation errors and problems occurred, so to avoid this with future business we started installing systems for our customers. Subsequently we have built up a great deal of experience and expertise in both the supply and installation of rainwater harvesting systems. We now also provide a problem solving and maintenance service for any type of rainwater harvesting system. We work with contractors, housing associations, private customers, builders' merchants, engineers and architects, and supply several hundred rainwater harvesting systems each year.

In early 2014 we became part of the Otto Graf Group of Companies and changed our name to Graf UK Ltd. This has brought us even closer to the knowledge base and years of experience of our colleagues in Germany. Graf celebrated their 50 year anniversary in 2012, and they have been producing rainwater harvesting systems since 1974. With over 40 years of experience behind our Company now, we can share with you the best practise, best products and best examples of how to use rainwater harvesting to benefit both you and the wider community.



Chapter 2

Top tip 1 – Tank size calculation

The right tank size is important for two reasons. Firstly you don't want the tank to be too big and collect more water than you will actually use because there is a risk that the water will sit in the tank for long periods of time and this is not advisable. Secondly, you don't want to install a tank which is too small if you've got the ability to use the maximum amount of rainwater that you can collect.

We use the advice given in the British Standard Code of Practise document when we provide tank size calculations. This provides three approaches to how a rainwater harvesting tank size can be calculated in order for it to suit the property on which it is being installed. We use the intermediate approach, which is the middle of the three, which is neither really simple nor overly complicated. There are only three pieces of information which are required to calculate the tank size using this method.

1. The roof collection area
2. The rainfall figures in the geographic region the property is located
3. How many people will be living in the property once it is complete

On the following page is an example of the calculation for a 3 bed property, built in Oxfordshire.

Also, here's a note from BS8515 to describe this approach to the tank size calculation;

> *"To apply the intermediate approach to sizing the rainwater harvesting system for non-potable domestic use, storage capacity should be calculated from the following equations (as shown on page 7) and should be the lesser of 5% of the annual rainwater yield or 5% of the annual non-potable water demand."*

Tank size calculation (using the intermediate approach as detailed within BS8515: 2009) for a 3 bed, 5 person property, built in Oxfordshire (using 650mm as the annual average rainfall), with a roof collection area of 125m2. Here's the calculation...

5% of the annual rainwater yield should be calculated using the equation:

$Y_R = A \times e \times h \times \eta \times 0.05$

where:

Y_R is the annual rainwater yield (L);
A is the collecting area (m^2);
e is the yield coefficient (%);
h is the depth of rainfall (mm);
η is the hydraulic filter efficiency.

A	=	125	m^2	YR	=	A	x	e	x	h	x	η	x	0.05
e	=	0.8	%	3087.5		125.00	x	0.8	x	650	x	0.95	x	0.05
h	=	650	mm			↓								
η	=	0.95				3087.5 Litres								

5% of the annual non-potable water demand should be calculated using the equation:

$D_N = P_d \times n \times 365 \times 0.05$

where:

D_N is the annual non-potable water demand (L);
P_d is the daily requirement per person (L);
n is the number of persons.

P_d	=	50	L	D_N	=	P_d	x	n	x	365	x 0.05
n	=	5		4562.5		50	x	5	x	365	x 0.05
				↓							
				4562.5 Litres							

So, the tank in this example would be based on the lesser of the two figures circled in red. Therefore, a tank size closest to 3087.5 litres will be most suitable for this property.

We use the rainfall figures that are shown in the British Standard document, which vary from 650mm up to 1250mm for regions throughout the UK. In addition to this calculation there are some other variants which we take into account.

Roof type

As shown in the above standard calculation the yield coefficient for the roof material is 0.8%, meaning 80% of the rainwater landing on the roof is collected in the tank and included in the calculation. If this is a flat roof instead of a pitched, tiled roof, this yield coefficient would be reduced to 0.5%. This is also the case for green roofs, where approximately 50% of the rainwater is absorbed into the green bed of the vegetation on the roof, meaning less is available to be collected in the tank. This level of detail won't make too much difference on the average property size but if large roof areas are being collected from it is worth considering the roof material.

Roof size

The roof size is one of the most important figures to get right in this calculation. Sometimes the whole roof is used as a collection area, and sometimes only the front or back of the house can be used as the collection area. This is especially true on existing properties where the drainage at the front of the house doesn't connect up to the drainage from the downpipes at the rear of the house. In addition to this it's worth considering if other nearby roof areas can be used as additional collection area if you have a high demand for non-



potable water. If you use a lot of water externally or you have several WCs in the house with a high number of people living in the home then it is advantageous to collect as much rainwater as possible. The more accurate the square metre collection area is calculated the better, in order to get this tank size calculation right for the property.

It is also worth mentioning that the tank should be sized on the property measurements rather than the current owners. For example, if a couple are building a new home which they are going to live in, just the two of them, then their non-potable water demand will be reasonably low. However, if they're building themselves a four or five bedroom home then the system installed should be sized on the maximum occupancy level in case the house is sold in the future and may then be occupied by more people. This way the system is useful to the future owners of the property, rather than just suiting the current owners who don't have such a high need for as much water.

When carrying out tank size calculations for developments with multiple dwellings it is possible to combine roof areas and install a shared tank to reduce the costs of installing a rainwater harvesting system. In this case, the roof areas will still be used as the collection area but they will be combined with adjoining houses, depending on the drainage layout, to maximise the amount of rainwater collected for a row of properties. The tank will then be installed in the most suitable area, which would be a communal area if at all possible, to remove any issues around access to the tank, and the demand is also considered for the total number of homes being supplied from this tank. When using shared tanks for several houses it is important to consider which pump packages will be most suitable, in order that you can provide harvested rainwater and also have a mains water top-up facility that is isolated to each property. It wouldn't be ideal for example if you topped up the shared underground tank with mains water because then you'd have to somehow split the cost of the mains water amongst the properties being supplied. It's much easier in this situation to use header tank systems in each property so every house can have its own mains water backup supply. We'll talk more about this in chapter three.

Chapter 2

Top tip 2 – What are you going to use harvested rainwater for?

This may seem like an obvious question to have answered before installing a rainwater harvesting system to your home, or a new development of homes, depending on your situation, however there's more to this than you may think. Involved in the answer to this question are several things.

If you're a keen gardener and you want to provide your flowers, plants and lawn with the best water which will keep them alive and looking beautiful for longer, then you'll want to use rainwater. A garden only system can be purchased and installed for a much lower price than a full domestic rainwater harvesting system. If you want to use rainwater but keep the investment to a low budget, then either a small underground garden only system will suit, or even an above ground garden only system. Garden systems are lower in price because they don't include an automatic mains water backup to the rainwater supply. One reason for this is to be able to use the harvested rainwater even when there is a hosepipe ban. I know they're seldom in the UK but they do happen and if you love your plants and your garden, you know it still needs water whether you're allowed to use your hosepipe or not! If you have rainwater stored in an underground tank which can be pumped out and used in your garden via your hosepipe you can use it as much as you like (well, until you run out of rainwater!). It's possible to purchase and fit an above ground rainwater harvesting with over 600 litres of water storage for a couple of hundred pounds, even including the downpipe filter and pump, to provide water at 3+ Bar of pressure. This can be used for washing the car, watering plants and cleaning patios. It's surprising how far 650 litres can go if used wisely. It doesn't have to cost thousands to save and use rainwater.

Of course, if your budget is a little larger and you want to use harvested rainwater inside the property, for flushing WCs, supplying your washing machine and also your outside tap, then a full domestic system is what you need. The cost of which varies greatly depending on the size of the tank, the type of system chosen and whether you want technical

and shiny or simple and cost-effective. Much like buying anything these days, there are gold, silver and bronze options. All three do the job perfectly well but some people want the gold option as it fits their expectations and does more than the average. Once the tank has been sized around the demand and the property to which the system is being added, as we went through in chapter one, the cost of the tank will depend on the size. Of course if you want to keep the costs low then it's perfectly fine to use a smaller tank. Even if it's not the most suitable tank size, the calculation is only a guide. It would be better if all property owners installed a small 1000 litre tank rather than only some installing the perfect size tanks for their houses. It's your budget so you decide! After the tank, the biggest cost is the type of pump. We're going to talk more about pump options and price differences in chapter three, as it's one of the bigger decisions you'll make in relation to your rainwater harvesting system, therefore it's worth some serious thought.

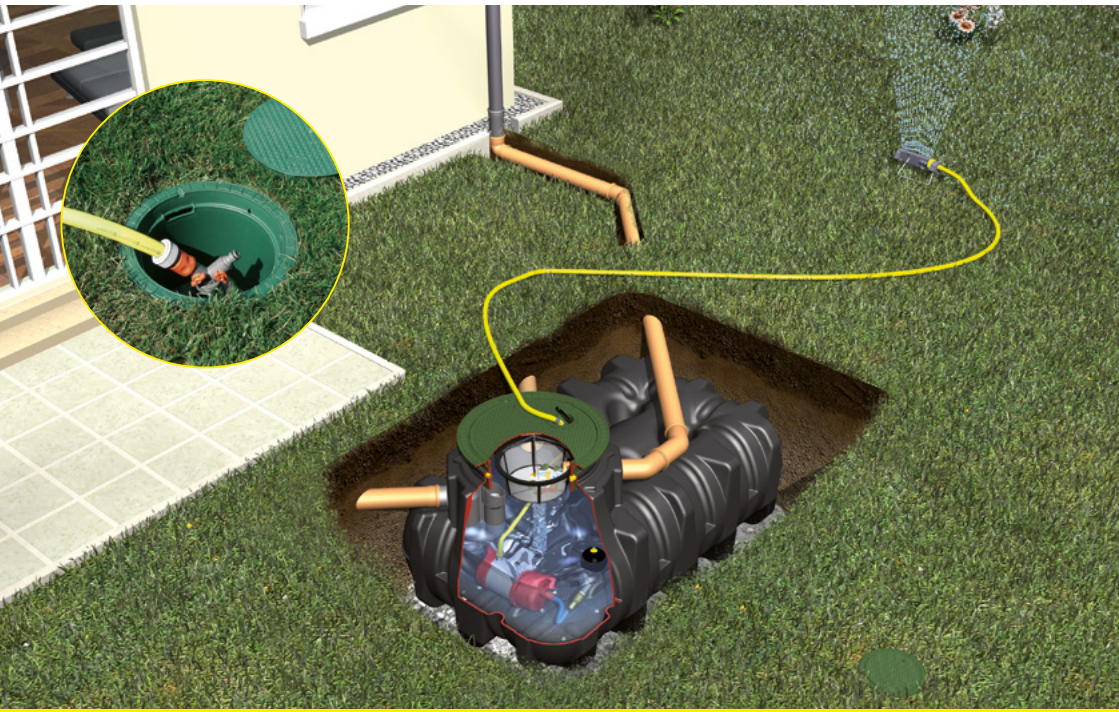


Chapter 3

Top tip 3 – Type of mains water backup unit/system

Once you have determined what you are going to use your rainwater harvesting system for, whether it's going to be garden only or a full domestic system, there are several options for pump packages.

Garden systems tend to be a more basic pump package which simply includes an external or submersible pump, a short length of pressure pipe and some way of extracting the water from the tank, so either a hose connection point, an integral hose connection box, an outside tap or a tap stand. As we said in chapter two, there doesn't tend to be a mains water back up unit for a garden system and this is what makes the garden package more of a cost effective, or lower



priced option. On a full domestic system there are several options on mains water top-up units or pump packages which can be used. The most comprehensive of which are commonly systems that have come over from Germany, and they tend to keep the pumps outside of the tanks and keep the mains water top up outside of the tank. They work on the basis of keeping the whole tank available for rainwater and not putting any mains water into the tank, as this is the best solution because when it does rain you then have the full tank capacity to fill with rainwater and there is no mains water which is water that you have paid for filling space inside the tank. So the way these work is they have a pump unit which is installed inside the property either in a utility room or a garage or under the stairs, or in a plant room, and there is a suction hose from the pump which has a floating ball on the end, that goes through a duct, to the tank and draws the water in to the pump which sucks the rainwater in from the rainwater tank and then pumps it directly to the toilets, washing machine or outside tap. Generally these types of pumps can only draw the water in from within around 12 to 15 metres between the tank and the pump unit so anything greater than 15





metres tends to need a booster pump inside the tank, in which case instead of the pump in the house sucking the water in, it starts to suck the water in then the pump in the tank turns on and pushes the water to the pump and then the pump unit inside the property supplies directly to the toilets and washing machine and the outlets. When the rainwater level drops on these standard 'rain manager' style systems there is a float switch connected from the pump unit to the underground tank and this float switch is positioned inside the tank so that when the rainwater level drops the float switch will switch-over and this will cause the pump to automatically change to supply mains water instead of rainwater from the tank. On these pump units there is a small mains water chamber or reservoir which stays topped up with mains water all the time and as soon as the rainwater level drops the pump switches over to supply from that mains water chamber instead, so you don't necessarily know what water is being supplied unless you look whether there is water in the tank or unless you have a level sensor showing how much water is in the mains water tank. But, you've got your continuous supply of water to your toilets, washing machine etc. so there is water readily available on demand all of the time. There are variations on this type of system; there are more comprehensive and typically more expensive systems

which have additional items built in, so these may include a level gauge to show what level of water is in the underground rainwater tank. If they have a level gauge then they tend to work on a sensor instead of a float switch for when the mains water takes over when rainwater levels are low, and then there are additional parts to these which are more technical which include inline fine filters, which are generally proposed for the washing machine connection, and there are also automatic filter cleaning units which can be added to these kinds of systems which will make the whole system more maintenance free so the filter within the underground tank has a small hose nozzle attached to the top and you can pre-set how often you want it to spray a flush of water over the filter to keep it clean from leaves and debris. These types of systems require space in the house. They are good because the pump stays out of the tank so is always accessible. So for maintenance and inspection services they can be often boxed in within a cupboard to reduce the noise, and some of them are in a polystyrene casing which reduces the noise, which some say is similar to the noise of a washing machine, but of course it is only when they are pumping water, so if a toilet flushes the pump will turn on and there will be a bit of noise when the pump is filling the cistern, this is why it can be put in a utility room or garage away from the main living area in the house.

The other advantage to these systems, as briefly mentioned earlier, is that the whole capacity of the rainwater tank stays available for just rainwater and not mains water. This also gives you the option to put a submersible pump inside the rainwater tank and connect that to your outside tap supply or your external supply, so that as we mentioned if there is a hosepipe ban you can prove that you are just using rainwater from your underground tank and continue to use that during the hosepipe ban because there is not a mains water connection to the underground tank.

There are several of these types of pump packages on the market in the UK and costs vary. They are good systems which are easily maintained and easy to look after but they do require space. They would not fit in a kitchen cupboard for example, they suit a larger house and they are all direct supply so they require power. In the event of a power cut the pump wouldn't work and you would be without supply of rainwater and mains water to the toilets and that should be considered on certain projects and it's to customers preference and opinion whether that is a big problem or not.

The other types of pump package involve a submersible pump and either a direct supply or an indirect supply system. A direct supply works in the same way as the pump package we have just been talking about where water is pumped from the rainwater harvesting tank directly to the toilets, washing machine or outside tap so this particular system is reliant on power. The difference is that the submersible pump direct supply systems don't require anything inside the property in terms of a control unit. They have a mains water back up system which has to include an air gap between the mains water connection and the rainwater tank to meet regulations which prevents

against cross contamination of rainwater into the mains water pipework, so the way this is typically done is with a length of pipe from somewhere in the house going back to the tank which contains a float switch from a mains water back unit, which comprises of a tun-dish to give you the air gap and a solenoid valve connected to a float switch which is inside the tank so as the rainwater level drops in the tank the float switch drops, the solenoid valve then opens and this allows mains water to flow through the tun-dish and by gravity supply flow back through the pipe to the tank and it tops up the main underground tank out in the garden. It keeps filling with mains water until the float switch rises as the water level rises and then when the float switch is in the upright position the solenoid valve will close and the mains water top up will stop. On these systems it's important to consider the length of distance between where the mains water back up unit is inside the house and the underground tank. From that mains water top up unit the water is only being supplied by gravity pressure so the speed it travels from the air gap arrangement to the underground tank can be quite slow, meaning that the system can be topping up with mains water for what appears to be a very long time. This depends on the type of tank, the position the float switch is tied off within the tank and the amount of height level distance between the mains water back up and the tank. Obviously the higher the mains water back up the more head of pressure is built up as the mains water travels through the pipe and into the underground tank. Once the mains water has got to the tank, all water supplied to the toilets and the washing machine and any other outlet, is supplied by the submersible pump in the underground tank. Now, it is possible to add additional items such as a level gauge so that you can see how much water is in the tank but normally these are not related to the mains water top up functionality on these systems. In some systems they can be, but quite often they are just to show the occupier of the house how much water is in the tank and it is an added visual item to the system.

The other alternative to this is a submersible pump indirect system, in which the submersible pump inside the mains water tank which works in the same way as the direct, so it's got a floating water intake on the pump which draws water in from just below the surface water level inside the tank which is where it's at its cleanest, it goes through a fine filter and it draws the water into the pump and the pump then sends it up to a header tank in the roof space of the property. A header tank is installed in the roof space and it has two connections; one for mains water and one for rainwater. There are various types of header tanks but the idea in principle is to maximise the amount of rainwater used before switching over to mains water if necessary, if rainwater is not available in the underground tank. So when rainwater is available the submersible pump will pump from the tank up via the black and green pressure pipe into the roof space and fill the header tank with rainwater. From there, on demand when toilets are flushed, the valve on the system opens and the rainwater will be supplied via gravity feed from the header tank in the loft down to fill up the toilet. It's important on this type of system that a traditional indirect header tank system

is designed into the internal plumbing of the house so that the most direct route is provided for the pipework from the header tank to the outlets so that it doesn't slow down the rate in which the water fills the cistern because it's not being pumped under pressure it's just being supplied under gravity pressure from the header tank. So, when the rainwater level drops inside the tank and isn't available for the pump to send it to the header tank the pumps dry running protection will kick in and the pump will shut off. That will mean the rainwater ball valve in the header tank will continue to drop and no water will be supplied. At this point the mains water top up would kick in which would be set at a lower position inside the header tank, and when that valve drops down that will open up the mains water supply and mains water is used to top up the header tank, making water always available to supply to toilets and washing machines etc.

The benefit of this system is that the mains water back up supply is not reliant on power so if there is a power cut in the property the pump wouldn't work inside the tank and the water level in the header tank would drop, but on a standard header tank system if it has a mechanical valve not a motorised valve, then mains water will still be allowed to top up the header tank and that can then be supplied to the toilets under gravity pressure. There are alternatives that require power so it's not one rule fits all, so it's important to understand how each individual header tank system works, but more often than not on an indirect system there is a way of ensuring there's a continued water supply with or without power so it works whether there is a power cut or a pump failure so there won't be a time when the toilets aren't being supplied with water, which is of particular importance to housing associations who have several properties who have rainwater harvesting systems and they need to keep their tenants supplied with water, and they need to be confident that they are not going to be getting phone calls about their toilets not filling or their washing machines not working, or there's a problem with the system and they don't know what it is. So these indirect systems give an added peace of mind under that scenario. Having said that, header tank systems are not everyone's preference. It's seen as quite traditional and 'old-fashioned' to put a tank of water in the loft or roof space of the property and it's not the most modern way of doing it. In certain countries it's not done at all. In Germany, for example they never use header tanks in our experience and our German colleagues say it is very unusual to put header tanks in the roof space of a property to supply water to toilets, it is not done over there and therefore they don't see it as a very attractive system at all. Having said that, the majority of their systems are installed in basements as a lot of their houses have basements or cellars, as standard and these are ideal for the location of pump packages. Of course in the UK, basements and cellars are not as common, especially not on large scale housing developments.

To summarise on types of pump packages and mains water back-up units the main thing to realise is that there is such a choice and some systems will suit particular properties better than others, so it's important to consider what best meets your needs and what you prefer the

sound of in terms of what maintenance will be required and how often you need to check the system, and if you need to do anything with the system at all. So the main point in this chapter would be to consider all options and not just opt for the lowest price system that gets proposed because that might not be the case in the long run, depending on whether it's an individual private build for your own home or whether you are building a housing site development of a number of homes, there will always be a level of maintenance required on any type of system but this can be minimised by choosing particular products and pump packages that are more maintenance free and that work automatically. So it is important that you understand what the options are and how they work so you can determine what works best for you.

Top tip 4 – Type of tank

When you know what size of tank is required from the tank size calculation, there are then several options on the market supplied in the UK. Many manufactured in the UK, some imported from Germany and other European countries, and many different shapes and options to suit different specific applications.

One first important consideration is the ground water level on the site that you are going to be installing the system. So how high is the water table underneath the ground? There are low profile shallow tanks specifically manufactured for this reason and application which can be completely submerged in ground water and still work and can still be guaranteed by manufacturers to stay in the ground, even though the pressure of the ground



water surrounding the tank in the wrong situation with the wrong tank could cause the tank to pop up out the ground. When tanks are installed in ground water they normally have some holes going through the tank vertically, and they are normally surrounded by gravel so that the ground water can surround the tank and pass up through it, and not build up pressure from underneath and around the sides which pushes against the tank and causes it to go upwards. When the ground water table is high it's important to design the drainage around the tank to try and remove that groundwater from being immediately around the tank if possible, and often perforated pipe is used for this in a circular position around the tank to collect it. The groundwater goes into this pipe and is taken away either to the nearest drainage point or somewhere ideally several metres away from the tank, where the flow of water can be directed away from the tank to reduce any risk and build-up of water immediately surrounding the tank. Another important consideration is whether the rainwater harvesting tank you choose requires a concrete backfill or a granular gravel backfill. Sometimes this depends on the type of tank, or the depth in which the tank is being installed, and it can depend on the loading which is going to be imposed on top of the tank. So if it was going to be installed in a driveway, or access road, or car park on certain developments, or whether it's just going to be in the garden, these different things have to be considered. Tanks that require a concrete surround will take longer to install and often installation costs are more expensive due to this additional time, and due to the cost of the concrete in the first place. Tanks that require a gravel surround can generally be installed

in half a day or 1 day, depending on the size of the tank and whether you have all the equipment available at the same and right time. But because the gravel can simply be backfilled and compacted in layers as you go up you don't have to wait for concrete to go off and set, it's a much quicker process. It's important though that installation instructions are followed so that manufacturer's warranties will still be in place once the tank has been installed. Many tanks are provided with 15+ years manufacturer's warranties, but all of which would be void if their installation instructions are not adhered to so it's important that if you're installing the tank, or your builder or contractors are, that these instructions are followed to the letter to make sure that the responsibility lies with the manufacturers even once the tank is in the ground.

Before we move away from ground water, some cylindrical tanks that go deeper in the ground are typically groundwater stable up to the half-way point on the tank, so even if the ground water is 1.5m to 2m below the surface it's still important to consider which tank is suitable in this scenario. There are many low profile tanks available now, which are shallow tanks that only require around 1m to 1.5m total excavation depth. These will always assist with high ground water table installations but it's still important to check where the groundwater level can come up to when installing these shallow tanks because different manufacturers will have different stipulations. Another important consideration on the type of tank is whether the filter is an internal integral part of the tank or whether it doesn't go in the tank at all and it's a pre-tank filter. If it's a pre-tank filter that means you're going to have two access covers, two manhole lids, in your garden or in your driveway and you need to think about the position of these. If it is inside the tank it keeps everything in the same place and you've got one lock on the top which should always be a child-proof lock. Accessing the tank means you can get to the filter, you can check the pump if it's a submersible pump system, or check the pipework if it's an internal pump system in the house which is drawing water from the tank from inside. So check what type of filter package fits inside the tank and whether it's manufactured by the same company. If it is, these are often made to suit each other and the dimensions of the filter will match the tank and there will be instructions on how these go together. If it's a company using a tank from one manufacturer and a filter from another, check that these go together well and that they fit because they won't have been designed in the same way. It's important that you look into which parts and which products are matched with another to make sure the system works as a whole.





Backfilling with a gravel surround

When backfilling a tank which does require a gravel surround or even a concrete surround, it's important with most tanks to **fill them with water inside the tank before backfilling**. Most manufacturers in our experience, would suggest this is done in layers so you would fill the tank with approximately 300mm depth of water inside the tank and then surround it with 300mm depth of gravel at the base of the excavation. Then fill a further 300mm of water inside the tank and again a further 300mm of gravel on the outside of the tank, and simply keep going incrementally in this manner until you have a tank completely full of water and completely backfilled. Again it should stipulate this in the manufacturer's instructions but these are important aspects to prevent any future issues with tanks which are really the main part of the system which is difficult to access and amend once installed.

One of the most important things to do with the tank on any rainwater harvesting installation, one of the top tips from this part of the book, is to **keep the tank as clean as possible during installation**. It's important that whoever is installing the tank, whether it's yourself, a builder or a groundwork contractor, that they realise this is a rainwater harvesting tank and not a septic tank or a wastewater treatment tank, and as such the cleanliness inside the tank is of paramount importance because when it is filled with water this water is going to be used for your washing machine, flushing toilets and your outside tap, and the water quality needs to be as clean as possible. So if dirt or soil, bits of gravel or stone, find their way into the tank during installation because the access points have not been covered, or people aren't very careful with what gets put into the tank, then this will have a detrimental effect on the whole rainwater harvesting system once it's installed. It will invariably mean that the tank has to be completely cleaned out as soon as it starts to be used because the water collected will be dirty, there may be some build-up of mud at the bottom of the tank and it will all have to be cleaned out to prevent a negative effect on the system from day one. So it's important the tank is installed with the access covered or the lid temporarily already on, but mainly that the people doing the installation are made aware that this is a rainwater harvesting system and to be careful what goes in the tank. This is a challenging part of installation because you are digging a hole in the ground and building sites are obviously full of mud and soil and dirt and gravel and often it can be wet and raining and it's challenging to make sure the tank stays clean, but it's very important.

When choosing the type of tank, you also have to decide what type of lid you require on top of the tank. On most tanks you'll have two options. The standard lid will be a pedestrian loading lid, which will be suitable for installation in a garden. This will only take pedestrians walking over it and must not be used in driveways or roads where any heavier loads can go on top of the tank. The second choice will be some form of driveway-loading lid. These are usually cast iron and will take a light traffic load, so typically a car or van, which is suitable for a driveway on a domestic property. If the tank is being installed in an access road or in a commercial property where lorries and heavy goods vehicles may pass over it, then this must be considered to ensure that the lid is suitable and that the underground tank is capable of withstanding the load of the weight above it.



Choosing the correct lid is important

Chapter 5

Top tip 5 – Maintenance

All things in life require some form of maintenance to keep them in good condition. This is true of equipment, relationships, vehicles, houses, and of course, rainwater harvesting systems. The good news is that maintenance of a rainwater harvesting system is simple and can often be done quickly and with little cost. There are several companies now who offer maintenance contracts and service agreements, and these are often a good route for home-owners to choose because these companies should know what they're doing. They should have all of the equipment to do the maintenance and if the contract is any good, then it should include a full tank clean-out at some point within the contract term. Of course, there are bound to be some which are not as good as others so choose wisely and check what is carried out on maintenance visits.

The British Standard Code of Practise document provides a suggested maintenance schedule to help owners and users of rainwater harvesting systems to keep them well maintained. Here is what they suggest;

Extract from BS 8515:2009 (British Standard for Rainwater Harvesting)...

7 Maintenance

Human entry into tanks should be avoided, wherever possible. Where entry is essential, it should only be undertaken by trained personnel with personal protection equipment suitable for confined spaces.

Maintenance procedures should be in accordance with the manufacturer's maintenance recommendations.

In the absence of any manufacturer's recommendations, the maintenance schedule given in Table 5 should be followed. The maintenance intervals listed here are for initial guidance but the frequency should be modified in the light of operational experience.

A log should be kept of inspections and maintenance.

Table 5 Maintenance schedule

System component	Operation	Notes	Frequency
Gutters/ downpipes	Inspection/ Maintenance	Check that there are no leaks or blockages due to buildup of debris; clean the gutters if necessary	Annually
Filter	Inspection/ Maintenance	Check the condition of the filter and clean, if necessary	Annually
Storage tank/ cistern	Inspection/ Maintenance	Check that there are no leaks, that there has been no buildup of debris and that the tank is stable and the cover correctly fitted Drain down tank and clean the tank	Annually Every 10 years
Pumps and pump control	Inspection/ Maintenance	Check that there are no leaks and that there has been no corrosion; carry out a test run; check the gas charge within the expansion vessel or shock arrestors	Annually
Back-up water supply	Inspection	Check that the back-up supply is functioning correctly, that there are no leaks and that the air gaps are maintained	Annually
Control unit	Inspection/ Maintenance	Check that the unit is operating appropriately, including the alarm function where applicable	Annually
Water level gauge	Inspection	Check that the gauge indication responds correctly to the water level in the tank	Annually
Wiring	Inspection	Visually check that the wiring is electrically safe	Annually
Pipework	Inspection	Check that there and no leaks, that the pipes are watertight and that overflows are clear	Annually
Markings	Inspection	Check that warning notices and pipework identification are correct and in place	Annually
Support and fixings	Inspection/ Maintenance	Adjust and tighten, where applicable	Annually
UV lamps	Inspection/ Maintenance	Clean and replace, if necessary	Every 6 months

Obviously not all systems will include all of the items listed in this table and so some of the above will not be required on some systems. As it says also, the frequency of the checks should vary in accordance with each individual situation dependent on operational experience. For example, a system which is installed on a property which is directly under a row of trees which drop leaves on the roof and fill the gutters, may need more frequent gutter and filter inspection than on a property with no over-hanging trees at all. Each situation is different and this should be considered.

Our tips for maintenance are to check the following things annually as a minimum;

1. Check the guttering on the property is clean & clear.
2. Clean the filter unit in the tank (or the pre-tank filter, whichever you have).
3. Ensure the pump is operating correctly as it should be by testing it a number of times.
4. Ensure the mains water top-up or backup system is working as it should be by testing it a number of times, moving the float-switch and simulating the absence of rainwater to make sure mains water is provided in its place.
5. Check the cleanliness of the water provided and make sure you're happy with it.
6. Check pipework connections and fittings to make sure all are tightly connected with no leaks.

We recommend that underground tanks are cleaned out regularly, with no longer than 5 years between each clean out. This is a shorter time frame than that stated in the British Standard as you will see but we believe the water quality and cleanliness should be no different when using a rainwater harvesting system to when using only mains water. To keep it clean and clear, the tank must be kept cleaned-out. It is not expensive to have the tank cleaned-out every few years and the cleaner the water going through the system, the longer all of the parts will last. When small particles of dirt and debris flow through the pump and the pipework and the valves, it all builds up and will have a detrimental effect on the overall system. The cleaner the water the better, so keep up good maintenance practise!

Chapter 6

Top tip 6 – Standards, Legislation & Regulations

We've referred to the British Standard 8515, which is the Code of Practise for rainwater harvesting in the UK, a number of times within several chapters of this book. This standard is in place to help users and installers, and retailers, of rainwater harvesting systems, ensure that systems meet certain requirements. Rainwater harvesting is not complicated and when installed correctly, there is very little that can go wrong with a system. However, as with any new technology, there needs to be standards, legislation and regulations in place to make sure that systems are fitted correctly and that the systems themselves meet with certain requirements.

The biggest concern in terms of regulatory guidance is the prevention of any cross-contamination of rainwater into the mains water pipework system. Mains water is provided to all properties throughout the country and has to be suitable for drinking, as all potable water should. Each water authority has strict standards and they have to protect their pipelines, water supply and water quality, to meet the requirements of their customers. We believe they know that rainwater harvesting is a good idea and should be a helpful contribution to the water supply throughout the country. If rainwater is captured, filtered, collected and re-used on properties throughout the UK then this relieves some of the pressure on mains water supply. It can only be used for non-potable applications, such as flushing WCs, supplying washing machines, being used externally in the garden, washing vehicles, and general cleaning inside and outside of the home, but it does provide some benefit to water authorities. It relieves some stress on the surface water drainage network for one. Many drainage networks are overloaded in the UK and increased rainfall and regular storms are causing drainage pipes to be overflowing with water at times during the year. Flash flooding increases when drainage systems become overloaded and water has nowhere to go. With increased population and increased building, more of the ground is being concreted over which reduces the natural infiltration of rainwater into the soil. When rainwater hits the roofs of buildings and surface of roads and car parks, it speedily flows to catchment pits, gullies and drainage channels to be collected and routed underground to be sent off to rivers and water courses. But during some storms,

it's all too much. The systems cannot cope.

Huge stormwater holding tanks are now being installed on the majority of all new developments, and these have to hold back the stormwater for a period of time so it can be slowly released out to the drainage network and to the water course, to prevent overloading and prevent flooding. But this just slows the cycle down. Huge volumes of water are being stored underground and not used, when more and more mains water is being used in properties throughout the country. It makes sense to use the rainwater. If every property had a rainwater harvesting tank it would reduce the amount of stormwater being dealt with in the drainage network. If this same rainwater is then put to good use inside buildings to use for the non-potable demand, then it reduces the volume of additional mains water being pumped around the country. Rainwater harvesting systems therefore tick two boxes as a minimum; they contribute to reducing the amount of stormwater overloading the drainage system and thereby help to reduce flooding, and they also allow the saving of mains water for uses which are not required. Who wants to pay to use high quality water to flush their toilet? Every time, literally flushing money down the toilet. Now it may not be too much money at the moment, and there is no great financial incentive to fit a rainwater harvesting system due to the low price of mains water supply to most counties in the UK, but this is certain to change. It's been the experience of many other countries and it's very likely to happen here too. What we must do though is make sure that the rainwater harvesting systems that do get installed help to meet these challenges and do nothing to hinder them. This is why standards and legislation is so important. Even if just one property in a county fits a mains water bypass to a system, which could allow rainwater to contaminate the mains water supply, this could filter through to the mains water supplied to thousands of homes. Potable, drinking water, wants to stay that way. Clean, suitable to drink, and use for all potable water applications. There should be no requirement ever, on any rainwater harvesting system, to have the need for a mains water bypass without an air-gap. Only when systems are installed incorrectly will this be needed or desired by the user. All systems are now provided to meet this air-gap regulation and it's in place for a very important reason. If mains water is not topping up the system in the way it should then seek advice and assistance from an experienced person or company who can help. It should never be necessary to fit bypasses which risk contaminating mains water supply.

Another important standard is the identification of pipework on a rainwater harvesting system. It is now required that all pipework be labelled and easily identified as rainwater pipe and not mains water pipe. It must be black pipe with green stripes and with RAINWATER printed on in green text. This is so that if pipes are exposed in future years then rainwater will not be connected to potable water supply points. It is also necessary to fix labels to taps that are connected by harvested rainwater supply. These must say "Not Drinking Water" to clearly show that it is rainwater not mains water being supplied. Most water authorities now have guideline documents which

are provided to clearly show installers and developers what they expect to be included to identify pipework and supply points from rainwater harvesting systems. These are not complicated and the labels and correctly marked products are not difficult to find, they help to ensure the quality of installations and maintain high standards of work which helps the rainwater harvesting industry.

Water Companies are now quite strict when it comes to meeting the standards and legislation which is now in place. This means they will often check installations meet the standards before switching on the mains water supply at new build properties. Just remember that these checks and standards are in place for good reason and they do help to make sure a high quality of system, installation and working practise is provided, which does help all who favour rainwater harvesting and want to see its wider use spread throughout the world.

Chapter 7

Rainwater harvesting on a budget!

It is our experience that many people think rainwater harvesting systems are more expensive than they actually are. Basic Garden only systems with above ground tanks, automatic submersible pumps and rainwater filters can cost under £500, and full Domestic systems with underground tanks and automatic mains water backup systems start from around £1000 for a small property. Therefore it doesn't have to cost a fortune to add this technology to your property. Of course, there are systems with added 'bells and whistles' which will cost that bit more for those users who want the best of the best, however if you're keen to know what options there are to add rainwater harvesting to your property on a lower budget then here are some ideas.



Use an above ground tank

The costly part of rainwater harvesting installations is burying the tank underground. Although the water is best kept in an underground tank, due to the temperature all year round being consistent and not allowing the water to get too warm or too cold and freeze, however systems can be achieved using above ground tanks as long as the location of the tank is considered. Ideally keep the tank somewhere out of direct sunlight to avoid it getting too hot in the summer time and consider emptying the tank to at least half-way if there is a risk of frost during the winter months.

Use a simple downpipe filter or larger filter if collecting from several downpipes, above the above ground tank.

Downpipe filters can cost considerably less than the typical in-tank filter which is supplied with most complete rainwater harvesting system packages that are suitable for roof areas of up to 350m2. If you can connect either one or two downpipes into the above ground tank then add a downpipe filter to each one, which can be less than £20 each, to make sure that the water collected inside the tank is clear of any leaves or debris that runs off the roof.

Once you've got your filtered water inside an above ground tank, you need a submersible pump which can pump the water from this tank directly to your outside tap and/or a toilet inside your property. Depending on how much roof area you have managed to collect from and route in to your tank, you may be able to connect the supply of harvested rainwater to more places but the minimum you should achieve from just one downpipe off one side or even one small area of roof will be your outside tap and if you have one, a downstairs WC. Keep the pipework as simple as possible, ideally fitting just one pipe from the submersible pump inside the tank and connecting this to the one or two outlets. The all you need is a form of mains water backup to top-up the water level inside the tank in dry periods when you're not collecting any rainwater. For this there are several options too. To automate the process you will want a float switch or level sensor of some sort, connected to a solenoid valve which will control the opening and closing of the mains water pipe to fill the tank. You will need to incorporate a tun-dish to ensure the air-gap between the rainwater tank and the mains water, so that you prevent any risk of cross-contamination into the mains water network, and this will need to be fitted in a location that enables the mains water to fill the above ground tank via gravity supply (meaning it has to be higher than the top of the above ground tank). It can be outside, as long as it is insulated to protect it against frost.

Of course, if you want to keep the budget really low, it may also be possible to do without the mains water top-up. If you're only supplying an outside tap and one of several WCs at your property with the harvested rainwater, then can you do without the mains water top-up function? You use the rainwater when it's available and you use the other facilities in your home which are connected to the mains water when the rainwater tank is empty. It all depends on what you want to spend, how convenient you want the system



to be and how automated you want to make the process. The key here is to realise that rainwater can be recycled and put to good use for a value much less than the thousands of pounds that can and has been spent on many domestic rainwater harvesting systems. If you have a budget in mind and want to see what you can achieve, it is well worth talking to some suppliers and getting some advice to find out what will work at your property. Whether you have room for one large above ground tank, or several smaller, thinner tanks linked together to create a higher storage volume, there is something that will work for most properties and where there is a desire to save water, there is certainly a way to do it on a budget.

Chapter 8

The 21 things to remember

We hope that these top 6 tips are useful to you when deciding on your rainwater harvesting system. We also promised our full list of the 21 things we consider are important to remember and think about when deciding to purchase and use a rainwater harvesting system. Here they are...

1. Tank size calculation
2. Ground conditions (of where the tank will be installed)
3. Tank location
4. Roof size
5. Type of roof E.g. Green roof, tiled roof
6. Usage – what will the water be used for?
7. Number of WCs
8. Demand
9. Type of mains water backup unit/ system
10. Budget
11. Maintenance
12. Installation, by who and how and when?
13. Type of tank
14. Speed of installation
15. When? In relation to the overall build programme
16. Where to overflow to?
17. Standards, Legislation & Regulations
18. Overhanging trees
19. Running costs
20. Filtration of water
21. Pumping distances

We've tried to incorporate many of these 21 things within the chapters of this book, but of course there are many more details we could have gone into on several of the points. Hopefully though, this list will just trigger you into thinking about some of the specifics in relation to your system or your requirements. Whether you're building your new home, renovating your existing home and adding a system, retrofitting a system to your current home, or if you're responsible for a new housing development where there will be several rainwater harvesting systems installed. The important consideration points remain the same. The scale may change but the principles are exactly the same. If you have given thought to all of these points then you're highly likely to choose a system which suits the property, or properties, and that meets the requirements in a way that will provide longevity, reliability and efficiency for years to come.

We thank you and congratulate you for your wise consideration of water use. We hope you do use rainwater harvesting in the future and hope that when you do, perhaps you'll have got some value from

these pages. If you'd like any further information on any of the above then please do get in touch.



Thank you for taking the time to read our free book 'The Top 6 Things to Consider When Rainwater Harvesting'.

We hope you found the contents of this book useful and informative. Details are provided in good faith and believed to be correct at the time of writing; however no responsibility is taken for any errors. This publication will be updated regularly; please let us know of any amendments or additions which you think may be useful for future editions.

Further information about rainwater harvesting can be found at http://www.GrafUK.co.uk



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