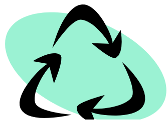
4. Grey water: Primary treatment options



The aim of grey water's primary treatment (in the case of organic contaminated water) is to separate the solids from the water – unlike the black water (from toilets) where the water itself requires further treatment for its potential pathogens. There is a wide variety of available methods, some of which are presented here below; their applications will greatly depend on amount of greywater, local legislation and discussion with project owner/s and operator/s. The main principle to keep in mind is that the water should not be allowed to rest but to go through a filter before reuse on the land. As with black water primary treatment, a final filter should be applied before drainage or reuse in the land.

Regardless of what system you use, bear always in mind that after the treatment you must make provision for proper drainage of the water in the landscape, the size of which will depend on the kind of soils. Please consult the "DRAINAGE" section.

A: Shower and lavabo/Sink water: Options

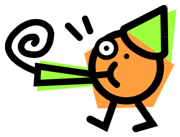
A1. Sedimentation tank

A sedimentation tank (sometimes also called "Settling tank") is generally a one-chamber tank that enables to separate the water from the floating larger particles before the water goes out directly into a drainfield or is reused You can build it in concrete or buy it prefabricated in some countries. The experience of some of our designers in tropical countries is however not in favour of these systems as by allowing the water to settle, the grey water will rapidly house organisms and pests and become septic.

Figure xxx3.7: Various models of settling

Example of calculation formula:

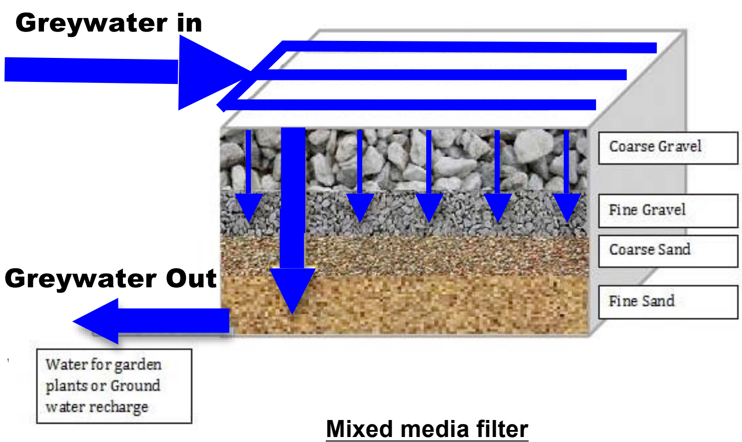
* The Draft Guideline for the Reuse of Greywater in Western Australia *(Department of Health, Water Cooperation, Department of Environment, Water and Catchment Protection, July 2002)* indicates the following guidelines:
Greywater systems that treat all greywater streams (ie kitchen, bathroom and laundry) must have a sedimentation tank that has a minimum volume of 1820L. Greywater systems that only treat bathroom and/or laundry greywater must be designed to provide at least 24 hour combined retention for the daily flow of greywater (ie: double the daily flow), with 40 litres/person/year of capacity allowed for scum and sludge accumulation.
For example:

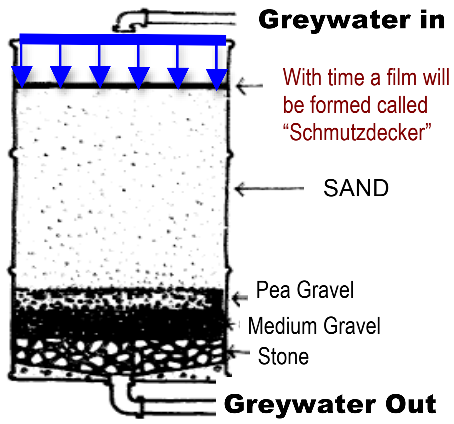


➔ If you have a house with 4 persons using 38 Liters of greywater per day = 4 persons @ 38L/person/day = 152 litres daily greywater flow
➔ Therefore the capacity of tank required is:
152L + 24 hour combined retention (ie: double the daily flow)
= 152L x 2 = 304L
Plus 40L sludge accumulation x number of persons
= 40L x 4persons = 160 litres
Adding the volume necessary for the water
= 304L + 160 = 464L sedimentation tank minimal capacity required

- **A2. Gravel and Sand Filter**

Options in this category are low-technology and easy to apply, depending on the quantity of grey water to be handled. It will be up to the designer to decide what is adequate after discussion with the project's owner and operator/s. Either systems should be protected from the rain.





Mixed media filter

In this system, the filtered material is kept throughout the bed, whereas in the *sand filter*, it will accumulate on the top layer. The media will need to be changed less often than for the *sand filter* but the entire media will need to be replaced, whereas the *sand filter* will require regular removal of the top layer only before needing complete replacement.

Slow sand filter

This system filters the greywater at a rate of approximately 0.2 – 0.5 Liters/minute/930 cm^2 (0.092 m^2) (0.05 – 0.13 Gallons per minute per square foot of surface area). It is important to remove on a regular base (or to rake through) the top layer of the sand (the Schmutzdecker) as with time it will clog the system making it anaerobic. If this filter is covered to avoid flies (it should be at least screened), you must add a pipe as chimney to aerate the system. *Courtesy: AT Microfiche Reference Library: Residental Water Re-Use by Murray Milne for California Water Resources Center Report No 46, University of California at Davis.*

Figure xxx3.8: MIXED MEDIA (Left) AND SAND FILTER (Right)
These filters above can be built in a drum (plastic, metal or in masonry). Note: It is important that the water be widely distributed on top of the beds (not a single pipe).

A3. Mulch Pits

Design criteria for these systems vary greatly according to designer experience, local terrain, and amount of greywater, but the common basis is to avoid unnecessary expensive and high-tech systems and reuse instead the greywater productively. Some of these technics are also used as grease traps (specified when it's the case). One indication of design from the Permaculture Research Institute of Australia is to have several mulch pits which will be used at different intervals in order to prevent waterlogging (if the grey water hose is left too long in one spot). It recommends mulch pits between fruit trees and if on a sloped terrain, to be placed on contour in order to double as swales. The sizing indicated is that each pit should be about 4 times the peak flow; for example if you have 100 liters of greywater coming out at once you should have a hole that is 400 Liters volume, knowing that the woody mulch will take about 2/3 of the volume. If you have sandy soils, you may consider lining the inside with plastics with a few punctured holes to allow the infiltration of water but still allowing micro-organisms to brake-down the solid matter contained in the water. *(Courtesy: http://permaculture.org.au/2009/05/20/greywater-mulch-pits/).* Bear in mind however that the volume of water versus mulch will also depend on the kind of soils on the implementation site and its permeability (if you have clay soils you may have to consider a different solution). To see how to test soil permeability, please see the section "DRAINAGE".

Photo above: 3-way valve to enable the alternative irrigation of 2 different zones to avoid waterlogging of an area (Note: here the system is not fed by gravity).

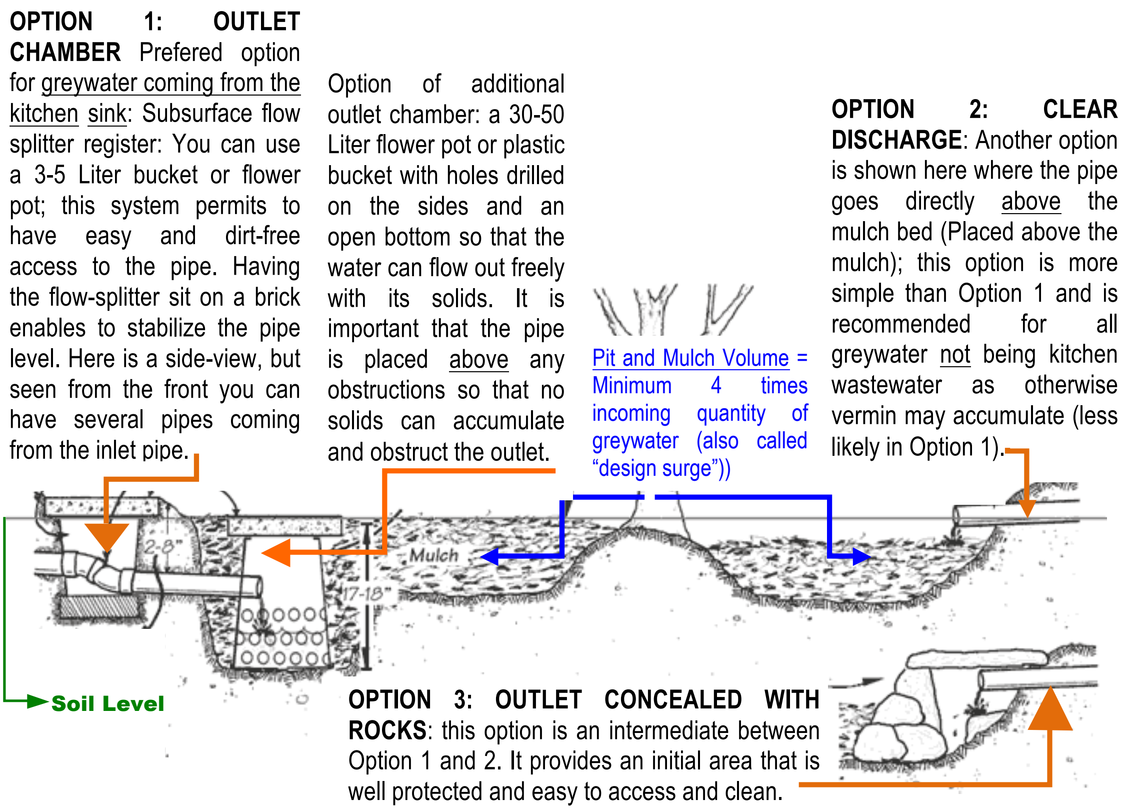
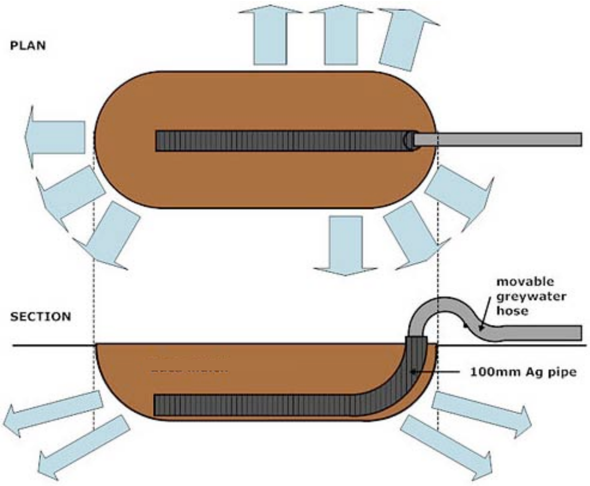


Figure xxx9: Elevation view of possible Mulch-pits inlet installations and inlet options.

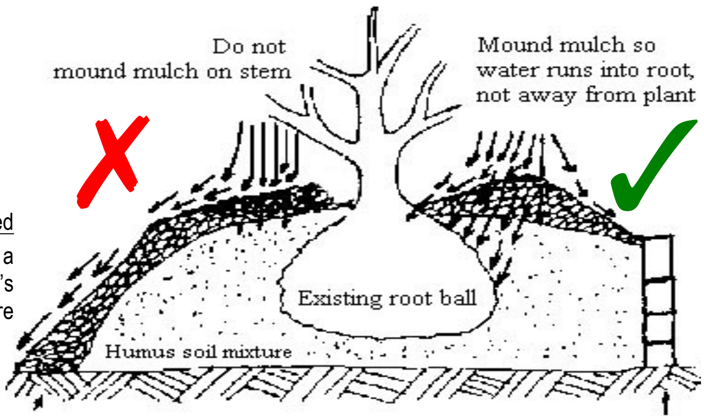


Left: Schematic of possible piping in a mulch bed

Here the water is sent from a solid pipe to a pipe with holes or with hand-made cuts to ensure good distribution throughout the mulch bed.

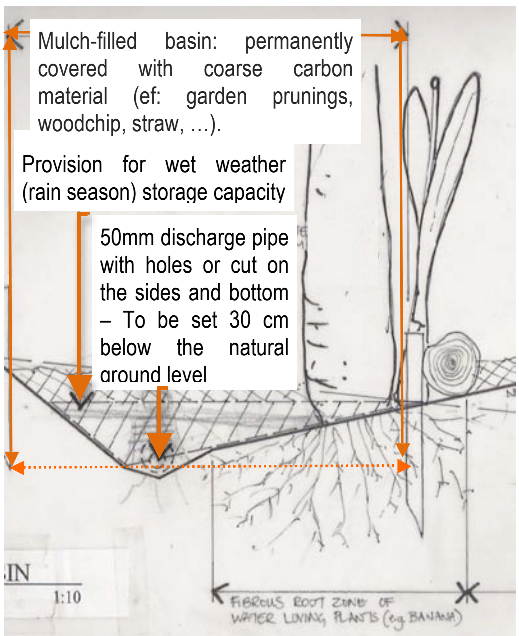
Right: Preparing of a mulch pit around a fruit tree

Left: A simple and cheap way to protect the greywater pipe from clogging by the mulch, it also permits to clean on a regular basis the accumulation of solids in that small perimeter of mulch.

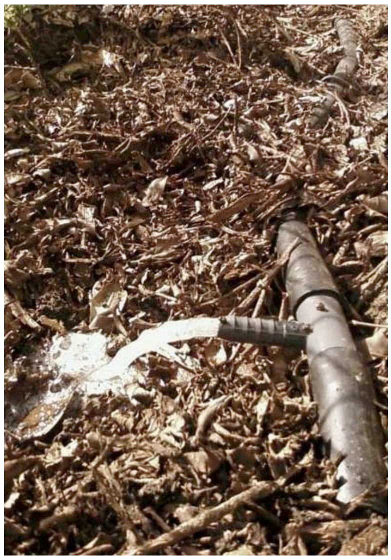


Right: Grey water directly to plant root balls via a mulch bed

Here the water is sent to a mulch bed on top of a plant's root ball. Having a knowledge of the plant's daily water needs will help you ensure that you are not under or over watering it.



Left: Mulch filled basin: the greywate pipe is placed at the bottom of the mulch bed digged at the root of water loving plants (banana, certain kinds of palms, helaconias …). *Courtesy: Permaculture Solutions*



Right: Possible piping for flow distribution (several outlets along a same line)

Figures 3.10: Examples and photos of mulch installations

A4: Gravel Bucket Filter and combinations before reuse

These are simple methods that allow the solid part of the greywater to be filtered before reuse into landscaping (or via drainage trenches) with minimal maintenance requirements. A gravel of 10-20mm is a good medium; volcanic gravel is ideal if locally available.



Gravel filled buckets

This very simple system brings the greywater into a bucket filled with gravel rocks; ideally and if locally available, volcanic rock will be used as it will be easy (light weight). The bucket can then be emptied and its gravel rinsed off on a regular basis.
Left photo: Not shown here is a pipe at the base of the bucket that leads the greywater either to a planted bed, groundwater recharge or a drainfield. ***Photo in the middle***: an earth jar (here a storage for olives) can also be adapted.

Here a plastic box is used and buried in the ground while the water passes through a small gravel filter before the water is being reused in the garden. *Photo courtesy: http://greywateraction.org*

Simplified gravel media filter

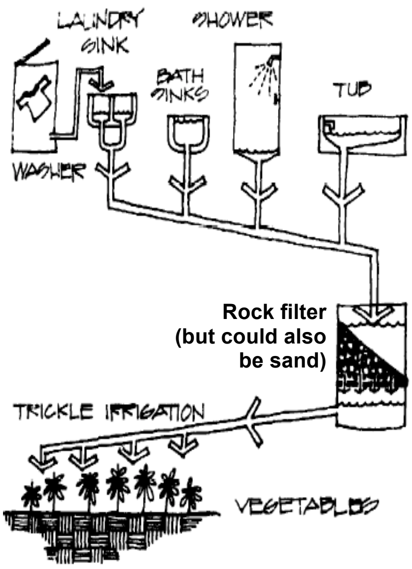
Here a simple pit is dug and filled with gravel. If this system is used it's important to cover it to avoid pest access and festering.

Figures 3.11: Examples of gravel filters



Planted boxes

Note: photos above and on the left don't show the existence of a previous filter although necessary.



Right: Schematic of overall greywater reuse after a rock filter (but could also be sand) filter.

Figures 3.11: Examples of mixed greywater filter techniques

- **A4: PLUMBING ISSUES**

Making a plumbing installation that allows flexibility as to where the greywater is sent for treatment may be a good preventive measure if you are using non-conventional treatment systems. A 3-way valve for example will allow you to be able to switch from one system to the other (during maintenance or if your alternative greywater installation is not working properly, you will have the option to send the water to the general sewage line for example).

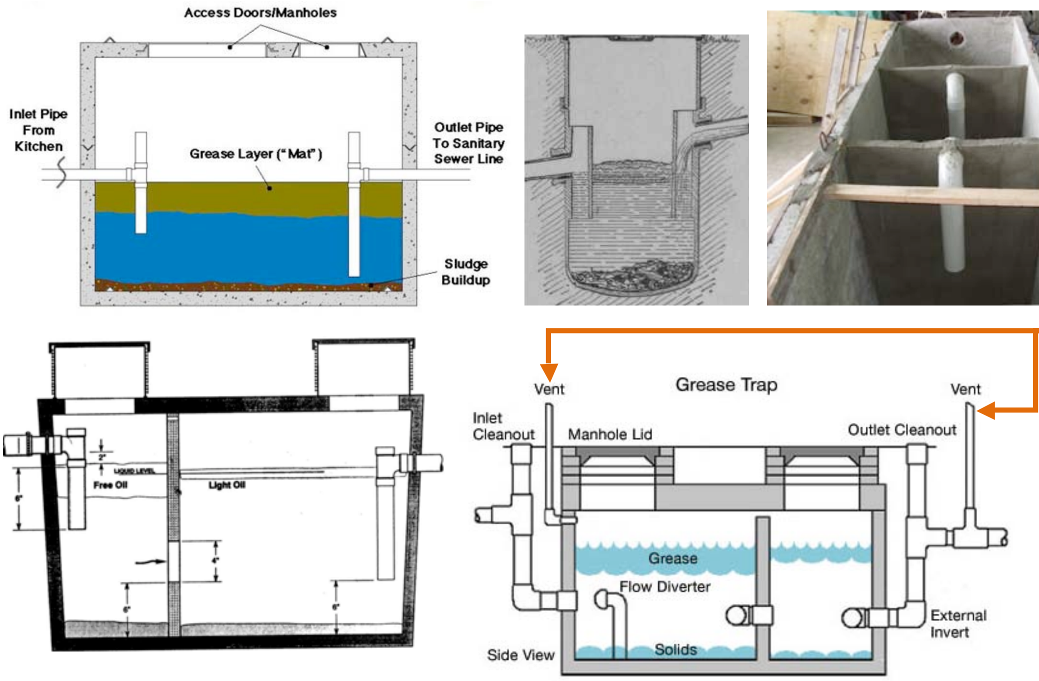
Figure 3.12: Examples of 3-way valve installations
Courtesy: http://greywateraction.org

2: Kitchen water

Grease traps are not necessary for individual houses as they can either be treated in systems as exposed in the previous section or mixed to faecal water. In the case of a restaurant however or large households where a large amount of people live, it is highly recommended.
If the greywater is to be further treated in a constructed wetland it is fundamental to add an additional filter at the end of the grease trap or entrance of the WWG unit (see section xxxx).

- **B1: 'CONVENTIONAL' GREASE TRAP**

A grease trap is a kind of settling tank that kitchen wastewater flows through before entering the sanitary sewer lines, so that thicker particles such as greases can be separated from wastewater on a regular basis. They are usually only required for restaurants, not for ordinary homes. Restaurant kitchens for example will produce large amounts of oil, grease and soap films which will clog a wastewater treatment system if not filtered out. Designs vary greatly, from one chamber to multiple chambers grease traps, square or round systems. They must be checked and cleaned often to avoid clogging! There are several different ways to calculate the size of a grease trap, of which 2 formulas are given in continuation.



It is important not to forget vents to be installed at the entrance and exit of the system in order to avoid bad smell and facilitate gaz evacuation.

Figures 3.13: Schematics of a grease trap

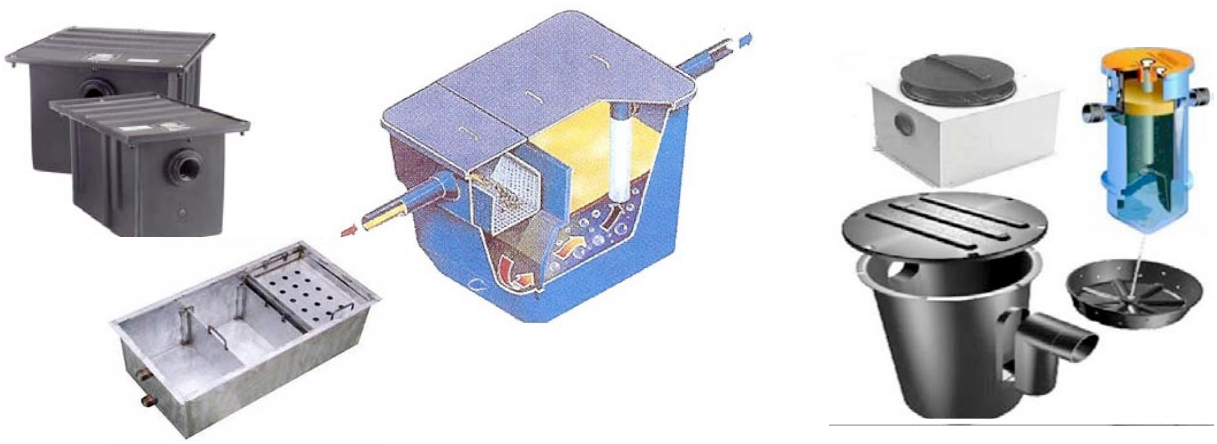


Figure 3.14: Prefabricated grease traps

Example of grease trap calculation formulas:

1/ Given by the USA based "The Uniform Plumbing Code Formula" as follows:

= NM x WF x RT x SF = Recommended grease trap size

Where:

NM = Number of meals per peak hour = Seating capacity x Meal Factor

Meal Factor depends on the establishment type:

Fast food restaurant (average time per meal: 45 min) =1.33

Restaurant (60 min) = 1

Leasure dining (90 min) = 0.67

Dinner Club (120 min) = 0.5

WF = Waste Flow Rate in gallons (for liters = WF x 3.785)

With a dishwashing machine = 6 gallons (22.71 Liters)

Without a dishwashing machine = 5 gallons (18.927 Liters)

Single service Kitchen = 2 gallons (7.57 Liters)

Food Waste Disposer only = 1 gallon (3.78 Liters)

RT = Retention time

Commercial Kitchen Waste with a dishwasher = 2.5

Single Service Kitchen for a single serving = 1.5

ST = Storage Factor

Fully equipped commercial kitchen

8 hours operation = 1

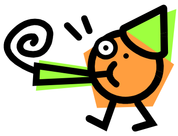
12 hours operation = 1.5

16 hours operation = 2

24 hours operation = 3

Single Service Kitchen = 1.5

➔ **For example:**
You have a restaurant with 75 seats opened 8 hour per day with a fully equipped commercial kitchen with a dishwaster:
= (75 x 1) x 22.71 x 2.5 x 1 = 4,258 Liters volume grease trap



➔ **For example:**
You have a cafeteria (activity like a fast food restaurant in terms of average time spent by the client) with 75 seats opened 8 hours per day with a fully equipped commercial kitchen with a dishwasher:
= (75 x 1.33) x 22.71 x 2.5 x 1 = 5,674 Liters volume grease trap

➔ **For example:**
You have a small cafeteria/restaurant with 20 seats opened 12 hour per day with no dishwashing machine:
= (20 x 1.33) x 18.927 x 1.5 x 1.5 = 1,132.66 Liters volume grease trap

2/ Given by the USA **based B. F. Environmental Consultants Inc** (http://www.bfenvironmental.com) as follows:

Restaurant:

(D) * (GL) * (ST) * (HR/2) * (LF) = Size Grease Interceptor (gallons)

Where:

D = number of seats in the dining area

GL = gallons of wastewater per meal (in liters: GL X 3.785)

ST = storage capacity factor (onsite disposal - 2.5), (normal - 1.7)

HR = Number of hours open (typically 8 to 10 hours)

LF = Loading Factors (1.25 for interstate freeways, 1.0 for other freeways, 1.0 for recreational areas, 0.8 for main highways and 0.5 for other highways)

Hospitals, Nursing Homes, other Commercial kitchens:

(M) * (GL) * (ST) * (2.5) * (LF) = Size Grease Interceptor (gallons)

Where:

M = meals per day

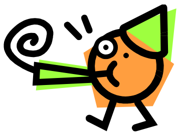
GL = gallons of wastewater per meal (in liters: GL X 3.785)

ST = storage capacity factor (onsite disposal - 2.5), (normal - 1.7)

2.5 = (constant)

LF = Loading Factors (1.25 for garbage disposal and dishwasher, 1.0 for a facility without garbage disposal, 0.75 for a facility without dishwashing, 0.5 for a facility without dishwashing and garbage disposal).

* Recommended minimum size: 750 gallons grease trap or 2,839 Liters.



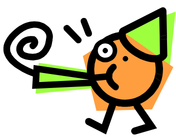
➔ **For example:**

You have a restaurant with 75 seats placed on a main highway, opened 8 hour per day and discharging 5 gallon (18.925 liters) per meal, assuming a storage capacity factor of 1.7, and a loading factor of 0.8, the minimum size of the grease interceptor tank is: (D) * (GL) * (ST) * (HR/2) * (LF) = 75 x 18.925 x 1.7 x (8/2) x 0.8 **= 7,721.4 Liters grease trap capacity**

3/ Given by the **Hong Kong Environmental Protection Department** (http://www.epd.gov.hk/epd/english/environmentinhk/water/guide_ref/guide_wpc_gt_3.html) as follows:

A	B	C	D		
AVERAGE HOURLY WATER USE (litres)	KITCHEN FLOOR AREA (square metres)	MINIMUM GREASE TRAP CAPACITY (litres)	EXAMPLE INTERNAL DIMENSIONS (millimeters)		
			LENGTH	WIDTH	TOTAL DEPTH
0 - 125		250	1200	525	600
250	8	490	1450	700	725
500	16	790	1700	825	850
750	24	1,050	1800	875	1000
1,000	32	1,220	1950	950	1000

- These measurements are clean measures, walls are not included (typically 150 mm if made in concrete).
- The liquid depth must be no greater than 1200 mm (and the total depth no greater than 1800 mm) for grease traps in the size range indicated here above.
- Exceptionally greasy waste or unusually high wastewater flows may require additional capacity or features, as may food processing factories.



➔ **For example:**

A new restaurant is being built with 30 square meters of kitchen floor area. According to the table above, the minimum size of the grease interceptor tank should be just under 1,220 liters , approximately 1180 litres.

- **<u>B2: Alternative Grease Trap options</u>**

For household or small kitchen installations, the choice can be made to proceed with more natural and productive ways to treat the grease part of the water. As it represents food for a wide range of organisms, the choice ranges from mulch bed as shown below or a small worm farm as briefly exposed in the second illustration here below.

Left photo: Here a metal container filled with 60 cm Woodchips is used for a commercial kitchen and cafeteria preparing 50-60 meals / day. The woodchips are changed 2 times per year and the treated water is drained into a fish pond. *(Courtesy: Robyn Francis).*

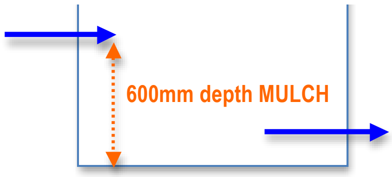


Figure 3.15: Mulch basin grease trap

Right photo: This system here is appropriate for a household and could be easily handmade

Figure 3.16: Small bucket system grease trap

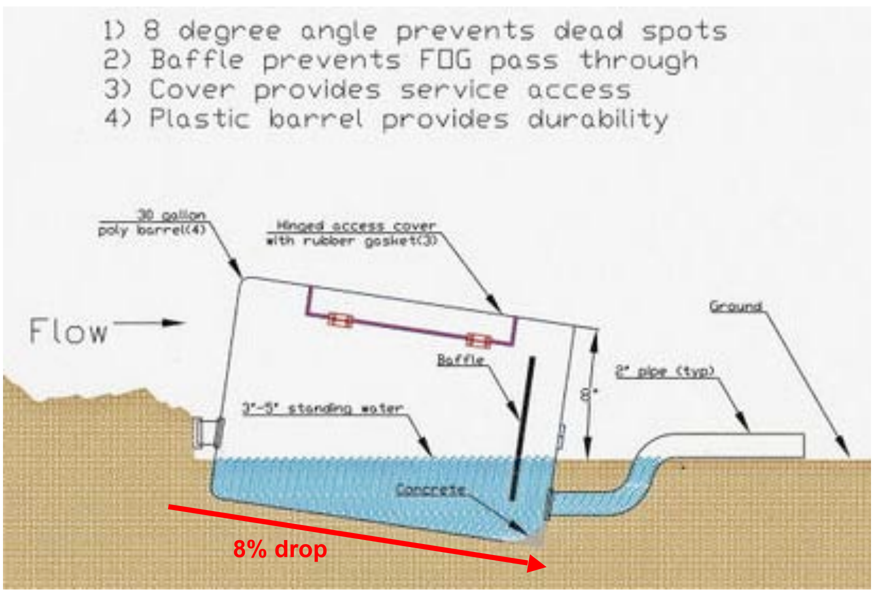


Figure 3.17: An example of a hand-made grease trap
Courtesy: Campus Center for Appropriate Technologies (CCAT)
http://www.appropedia.org

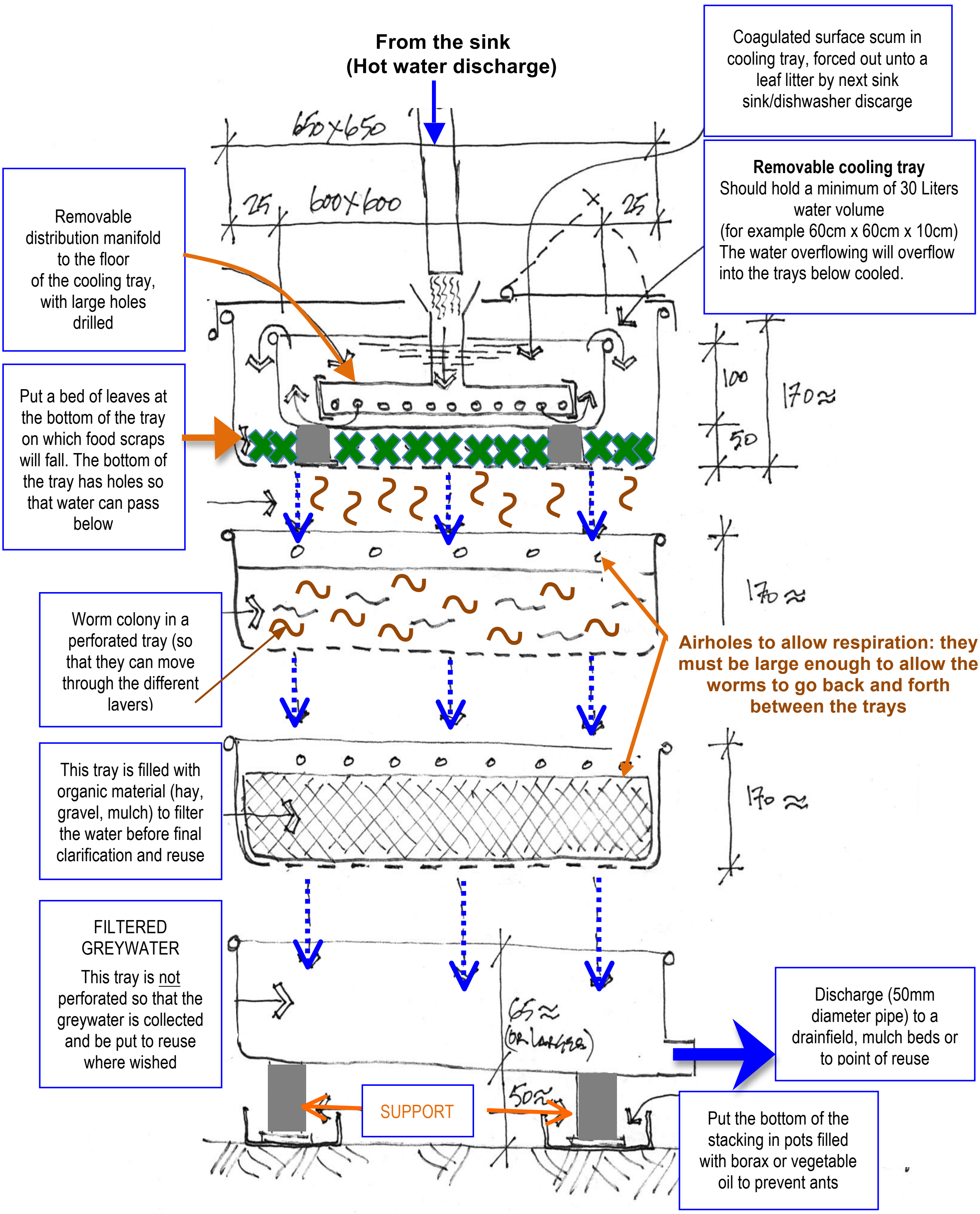


Figure 3.18: Kitchen Grey Water Grease Filter with integrated small worm farm amended to include a cooling tray.

This succession of trays that can be found in the fishing and/or food production industry; they are stackable tubs usually made in Polyethylene but can be adapted on the same concept with other materials

Note: While space is shown between the trays, they are stacked the one on top of the other

Courtesy: Permaculture Solutions with adaptation by David Hutchinson

5. Primary treatment Filters

It is important that the water arriving into a WWG unit be free from solids and large particles, therefore it is best when a filter is placed at the exit of the primary treatment – It is therefore important to check if the primary treatment (for example septic tank) comes with an inbuilt filter, and if it does not, to specify the inclusion of a filter.

Filter selection is usually a choice between ease of maintenance and price. A variety of reliable manufactured filters are available from many plumbing supply stores (see photos below), however they can be expensive and may not be available in some countries.

A simple filter can also be constructed from natural fibers (ijuk or coconut fiber) or with gravel.

A "mechanical" type filter, made of hardened plastic, will require periodic rinsing, and so will the one made of broken gravel-type material. The natural fibers filter will need to be changed more often than a commercial filter but is extremely inexpensive and makes a great compost booster once it is no longer useful in the WWG.

FILTERS INCLUDED IN PRE-FABRICATED PRIMARY TREATMENT SYSTEMS

If you use a pre-fabricated septic tank or similar system, check with the manufacturer or by looking inside the unit whether there is a filter at the exit of effluent. If not you must install one, either pre-fabricated or hand-made.

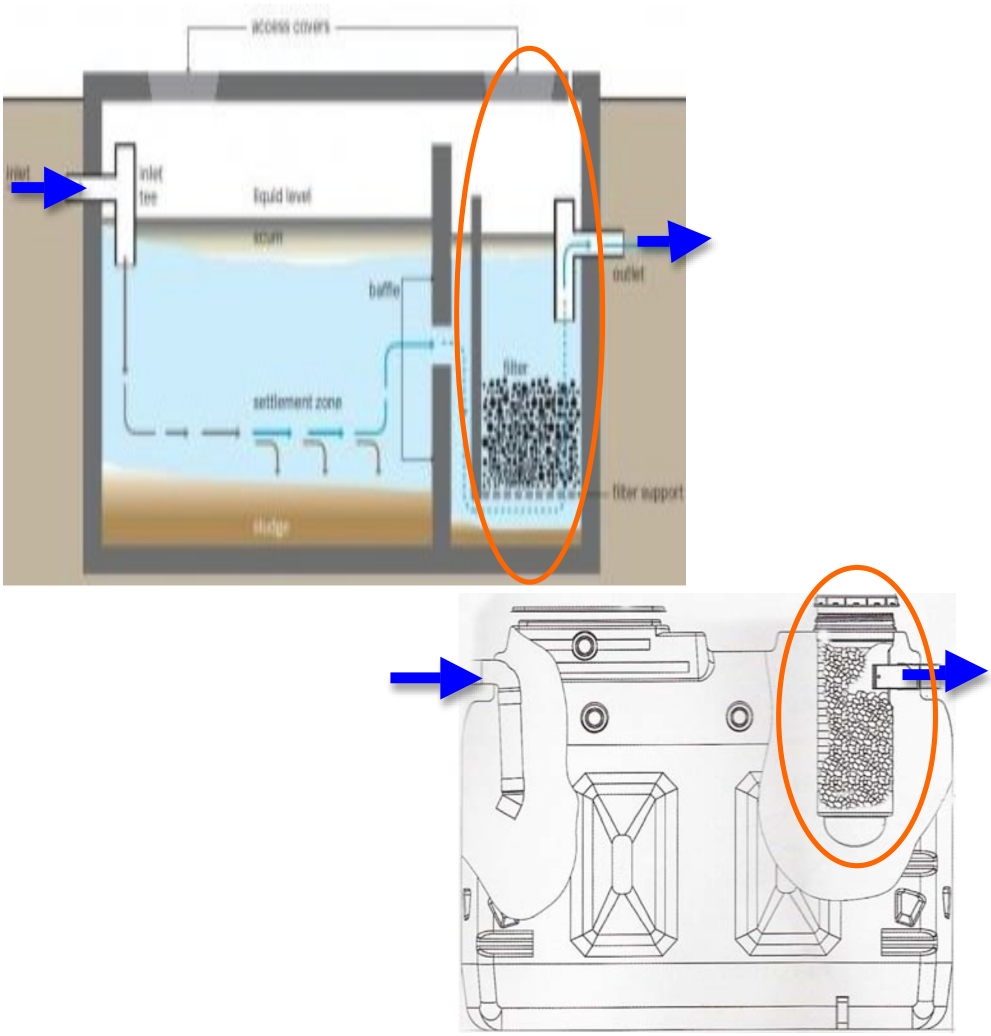


Figure 3.19: Example of pre-fabricated septic tanks that include a final effluent filter

PRE-FABRICATED FILTERS

If you use a built or pre-fabricated septic tank or grease trap for example and that it doesn't have a final effluent filter incorporated, you must install one, either pre-fabricated or hand-made. There are numerous manufacturers of pre-fabricated filters, some of which are presented here below. The advantage of a pre-fabricated filters is that it requires very simple maintenance, in the majority of cases just needing rinsing out.; in cases of pre-fabricated filters with cartridges, the cartridge may need to be changed every few month, depending on the content of the water and frequency of use.

Effluent filter in place at the septic tank outlet. To clean the filter, it is simply lifted out and hosed off, with the solids falling back into the tank.

Taylex Filter Grease (TFG)

Taylex Filter Septic (TFS)

Greywater filter for bathrooms and laundry effluent, via a small nylon bag (e.g. 200-300 µm nylon bag) Courtesy: http://www.water installations.com

Example: ZABEL filters – Model to the right: A600 Series Filter that will handle flows up to 6000 gallons (22.7 m^3) per day.

Figure 3.20: Example of pre-fabricated filters

HAND-FABRICATED FILTERS

Some options are presented in continuation for when you don't have access to a pre-fabricated filter.

Figure 3.21: Handmade Filter with Ijuk

Note: This filter can be a solution but it will degrades rapidly as the metal corrodes so we don't recommend it. This may discourage owners of the system to maintain and change it on a regular basis.

Figure 3.22: Handmade "Pipe gravel" filter

In this case you need to cap off the bottom of tank's outlet pipe (before sealing it into the tank) and make holes in it. Take a smaller diameter pipe, cap it and make holes; make a handle and fill with gravel.

! NOTE: This filter can also be made in Bamboo

Figure 3.23: Handmade Fiber (Ijuk / Palm bark) filter

This filter was made for a 45 m^3 septic tank in a village far removed from all cities with no access to pre-fabricated filters. A 500mm diameter pipe was used with a bag also hand-made, filled with Ijuk (Palm fiber), which can be pulled out easily. Bricks were placed at the bottom of the septic tank to elevate the filter.