CCWF Part 2

Cabin Clean Water Filter

Development and Description

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Development of Cabin Clean Water Filter

1.0 History of the Development of the Cabin Clean Water Filter

The Cabin Clean Water Filter (CCWF) was developed in 2017. Information on the CCWF technology and its use may be found in www.cabincleanwaterfilter.com. It is a type of BioSand Water Filter (BSF), a treatment technology developed in the University of Calgary in 1990 to treat water in disadvantaged communities worldwide including the more remote indigenous communities in Canada. This project was initiated with a very limited budget but considerable knowledge of water treatment worldwide. The history of the development of the what has come to be known as the Manz BioSand Water Filter together with details of its construction and use may be found in https://manzwaterinfo.ca/biosand-filter. The technology has proven very successful and robust as numerous projects (millions) and independent epidemiological evaluations have proven. Since 1990 there has been considerable independent research on the BSF at many universities around the world resulting in a virtual library of theses and journal articles and numerous variations in filter design using the BSF technology. With the encouragement of the Government of Canada the BSF technology was commercialized for use in rural properties and small communities in Canada. While early attempts at commercialization met with limited success the technology evolved to its present form intended to be used in similar ways to the original concrete BSF in disadvantaged rural communities but also in urban and peri-urban communities in developing countries where more affluent still have serious problems with respect to access to safe drinking water.

The original BSF design was intended to be used in the households of low-income families in developing countries – particularly the rural communities. It emulated the design characteristics of the well-established slow sand filter technology with a view that this would achieve acceptability from the professional community responsible for providing water treatment. The original concrete version of the BSF was intended to be produced near the intended consumers using locally available materials and labour. The BSF technology was provided to many individuals and organizations in specifically designed training programs. The only cost was the fee for the training. The approach was quite successful and there are millions of filters operating around the world. It is reasonable to assume that many hundreds of filters, perhaps thousands, are being constructed every day. Details of the concepts behind the design of the Manz Concrete BioSand Filter may be found in download titled BSF, Concrete Filter Design (found in this section).

Since its introduction the BSF has undergone several design modifications, besides the development of the CCWF, in response to real and perceived limitations of the original concrete design. The CCWF is intended to compliment, not replace, the quality BSFs being produced and used worldwide. The CCWF reaches people, households, communities the traditionally designed BSF technology cannot satisfy, markets that are also out of reach for most other appropriate treatment technologies.

The CCWF and its sister technologies, the Manz BSF60 and MEL Filter Systems, have unique advantages shared in the design of the CCWF. The CCWF is manufactured with very good quality control and intended to be distributed through local, traditional markets and numerous humanitarian organizations around the world. The Manz BSF60 and MEL Filter Systems are also high-quality products used to produce larger volumes of treated water for use in schools, hospitals, and communities but require considerable technical support. The MEL technologies have numerous treatment applications beyond potable water treatment.

2.0 Characteristics of BioSand Water Filters.

There are several designs for household BioSand Water Filters (BSF) that appear to function quite well. There are a few filter designs that claim to be a variation of the BSF but do not have the required design characteristics and cannot be considered types of BSF technology. A BSF must have all of the following characteristics:

1. The filter container, diffuser, standpipe, lid and media are constructed using food grade quality materials.
2. The filter will contain a filtering layer consisting of a minimum of 15 cm of clean rock particles, also known as media, as measured down from the top surface of the media. Layers of larger diameter rock particles may underlie the filtering media to provide support for the filtering layer and drainage of filtered water.
3. The rock particles comprising the filtering layer will have a mean diameter less than 0.35 mm.
4. The filter outlet system is normally a pipe that should be located such that it removes filtered water from the bottom of the filter into a vertical pipe, called the standpipe, that is located inside the filter container wall or securely attached to the filter on the outside the filter wall. The standpipe must not be located inside the filter media to avoid accidental occurrence of untreated water reaching the bottom of the media by flowing along the outside of the standpipe. Filtered water must flow freely from the filter when in operation (no valves or anything else that might restrict the flow of filtered water). When the flow of filtered water stops, there must be a layer of water at least 5 cm deep above the filter media – known as the paused depth. There should be no extensions to the standpipe outlet that would result in siphoning action that might drain all of the water from the filter.
5. A diffuser plate or basin with a flat bottom must be located 10 cm above the top of the filter media when leveled. All water that is poured into the filter must pass through the diffuser. The holes in the bottom of the diffuser must be no smaller than 3 mm diameter spaced no closer than 25 mm (so as not to disturb the surface of the media when water is added to the filter). The number of holes is dependent on the diameter or width of the filter container (must cover more than one-half the area of the bottom of the diffuser). The space above the paused depth of water in

the filter should be large enough to allow convenient addition of water to the filter with minimum user attendance.

6. Filter height must be one meter or less (convenient for household use).
7. Filter can be used as required without reduction in filter effectiveness to remove bacteria and viruses.
8. Routine cleaning of the media should not require removal of any media from the filter.
9. Only the top 5 cm or less of the media should be disturbed during cleaning using surface agitation methods.
10. Maximum surface loading of a BSF used to remove bacteria and viruses is 400 Liters per square meter of media surface.

Filters that do not exhibit <u>any one</u> of the features 1 to 10 cannot be called a variation of the BSF technology.

11. All types of BSFs will all remove 99.99% of parasites and larger organisms from the moment the filters are put into operation. This performance is not affected by the presence of chlorine in the raw water.
12. **None of the BSFs will remove 100% of the bacteria or viruses that may be in the raw water supply.** Post filtration disinfection is required to kill or deactivate bacteria and viruses which have not removed by the filtration process. Maximum removal of bacteria and viruses will occur when the biofilm develops around the media particles in the top 25 mm of media. This may require anywhere from one to three weeks depending on the nature of the raw water supply and is not visible to the naked eye. Experience indicates that BSFs will remove up to 70% bacteria (ecoli) from the moment it is put into production. Bacteria and viruses may be killed or deactivated using post-filtration disinfection such as chlorine or chlorine tablets.
13. Routine cleaning of the media should not reduce filter effectiveness to remove bacteria and viruses immediately after cleaning.
14. The effectiveness of the BSF to remove bacteria and viruses will vary depending on the quality and variability of the raw water supply, weather and how the filter is operated, cared for and cleaned. (This assumes that the filters have been produced using designs from reputable organizations and using appropriately prepared and installed media.)
15. Most practical experience with BioSand water filters is in developing countries in rural disadvantaged communities around the world. This is the most demanding use for any household water treatment technology.

3.0 Description of the Cabin Clean Water Filter

Figure 1 is a photograph of both the manual and automatically operated Cabin Clean Water Filter.

Figure 1 Photograph of the manual and automatically operated Cabin Clean Water Filters.

The Cabin Clean Water Filter treats water so that it is safe for human consumption and is aesthetically pleasing. It is designed for use in isolated homes or cabins, homes in communities without access to safe drinking water, camps, emergency supplies, boats, barges and recreational vehicles. Electrical power is not required for the manual operation. Automatically operated filters may use any available power supplies as required to provide raw water, operate valves, distribute treated water and power UV disinfection.

The Cabin Clean Water Filter is effective, compact, lightweight and portable. It is used to remove particulate matter (including iron) and disease-causing organisms from surface water (rivers, ponds and lakes), groundwater (wells and springs), captured rainwater and unsafe municipal supplies (piped or delivered). The Cabin Clean Water Filter can produce up to 12 litres of filtered water in one hour. The basic filter is manually operated and simple to clean. It is used as required. The automatic version may be used as part of a completely automated system including management of raw water supply, filter production, disinfection and treated water distribution as required by user.

Water produced by the Cabin Clean Water Filter is free of all types of water borne parasites such as Giardia and Cryptosporidium, and larger organisms such as Bilharzia and Guinea Worm and spores of infectious fungi. Most bacteria and viruses are also removed. Cholera is completely removed because it only survives in the gut of larger organisms that are easily removed. It is strongly recommended that filtered water be disinfected using chlorine tablets or household bleach or UV disinfection if available. The treated water should be safely stored

and dispensed to provide treated water that is free of disease-causing organisms. The ability of the Cabin Clean Water Filter to remove disease causing organisms has been verified by independent laboratory testing.

The Cabin Clean Water Filter will not remove most dissolved substances but does provide excellent pre-treatment for filters that do remove dissolved substances such as micro filters and reverse osmosis. The filter will remove oxidized iron (typical form) and dissolved arsenic with the iron (co-precipitation). The biosand filtration process has been proven to reduce concentration of organic pesticides.

The manual version of the Cabin Clean Water Filter is intended to be placed on a counter-top safe from unwanted disturbance. Manual operation consists of removing the lid and pouring water to be treated directly into the top of the filter Filtered water is immediately produced from the filter outlet. Automatic versions may be placed and used where convenient including under counters, in cabinets or other locations where it is not conspicuous or uses counter space. Commissioning may be manual using the kit provided with the filter or using a small pump selected specifically for the commissioning purpose.

The Cabin Clean Water Filter is constructed using food grade plastic and media that are all NSF 61 certified. The filter is 50 cm tall and 30 cm wide at the lid. When filled with media the filter and accompanying commissioning kit weigh approximately 15 kg.

The filter construction is very durable and should provide satisfactory service for many years. With normal use the media will never require replacement.

The treatment and cleaning processes used by the Cabin Clean Water Filter are similar to those used by the millions of BioSand Water Filters in use around the world for more than twenty-five years.

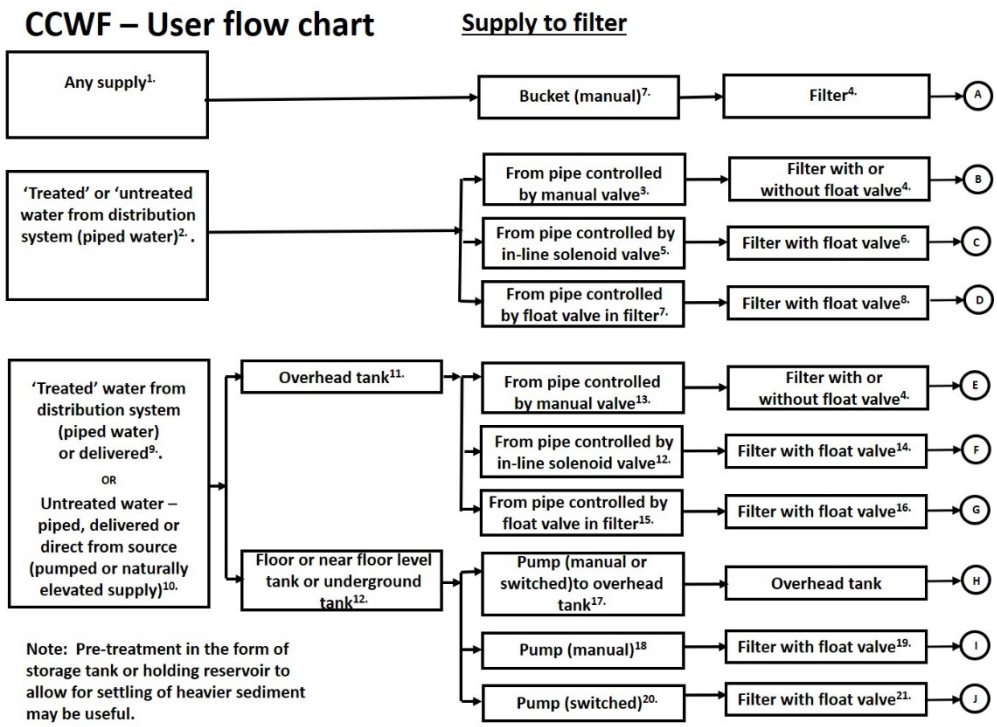
4.0 User Manual for the Manually Operated CCWF

The user manual for the manually operated CCWF provide a very good detailed description of what the technology is and how the manually operated version is used.

A downloadable copy of the manual may be found in Cabin Clean Water Filter website: **https://cabincleanwaterfilter.com/technical-information .** A copy is included in Appendix 1.

5.0 Scope of Use of the CCWF

A complete description how to use both the manually and automatically operated CCWF is summarized in the flow chart shown in Figure 2. Between the manually and automatically operated CCWFs virtually any water can be treated.



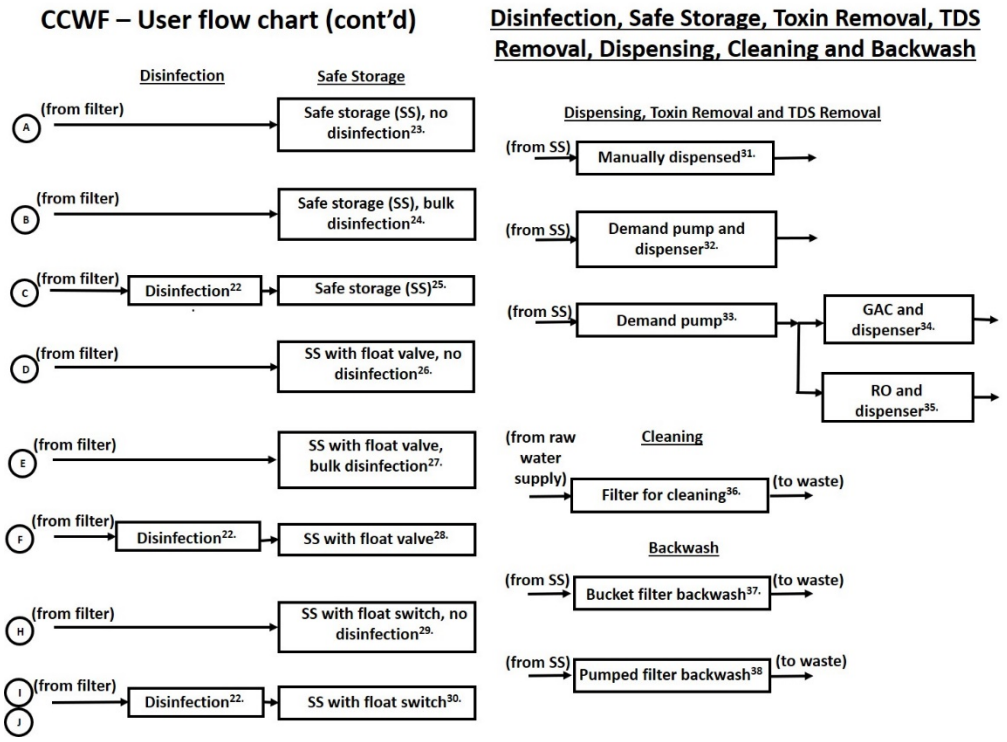


Figure 2 CCWF – User flow chart.

5.0 Manufacture of the CCWF

The Cabin Clean Water Filter is intended to be produced in very large quantities to benefit from the significant cost savings realized when manufacturing to scale.

The body, lid and diffuser are intended to be produced using plastic injection molding technology. It appears that it may be possible to use plastic feed made from recycled plastic water bottles.

The underdrain and standpipe are intended to be produced using plastic blow molding technology.

The filter media can be supplied by several filter media production facilities around the world.

The design of the CCWF is flexible and will be optimized to produce the filter at the lowest cost possible. It appears that manufacturing costs might be as low as US $20.00. This will need to be reviewed.

6.0 Comments Regarding Marketing the CCWF

The development and description of the CCWF might appear quite technical but it's use is actually quite simple and easily learned within a few minutes.

Because the CCWF is intended to marketed through local retailers, technical support is always readily available.

Appendix 1

User Manual: Cabin 'Clean Water Filter' - Canada

The Cabin 'Clean Water Filter' or CWF is a variation of the BioSand Water Filter or BSF technology in use around the world for more than twenty-five years, (See www.manzwaterinfo.ca) and previously commercialized by Davnor Water Treatment Technologies Ltd. (now defunct). The unique design of the CWF results from critical evaluation of experience with the BSF technology from consumer, manufacturer, distributor and marketing perspectives, a focussed investigation of basic filter design, and independent performance evaluation studies. The depth of the filter media has been significantly decreased (to that used in original laboratory work in the University of Calgary) resulting in a shorter, light weight filter. The CWF is cleaned using surface agitation (similar to the BSF). Impaired filter performance resulting from media compaction (when moving filter) or attempting to filter water with excessively high concentration of suspended solids can be easily restored.

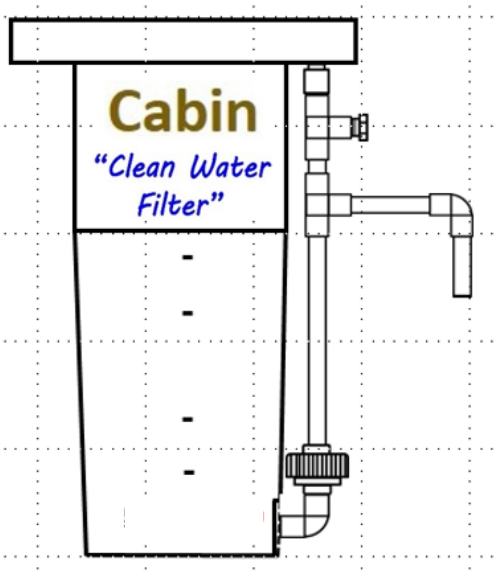
The CWF can be used to remove particulate matter and pathogens from surface water (rivers, ponds and lakes), groundwater (wells and springs), captured rainwater and melted snow. Pathogen (parasite and bacterial) removal claims have been verified by independent laboratory testing.

While the water produced by the CWF is greatly improved and may be safe to drink, it is strongly recommended that filtered water be safely stored and dispensed and be disinfected using chlorine tablets or household bleach to provide treated water that is aesthetically pleasing and 100% safe to drink.

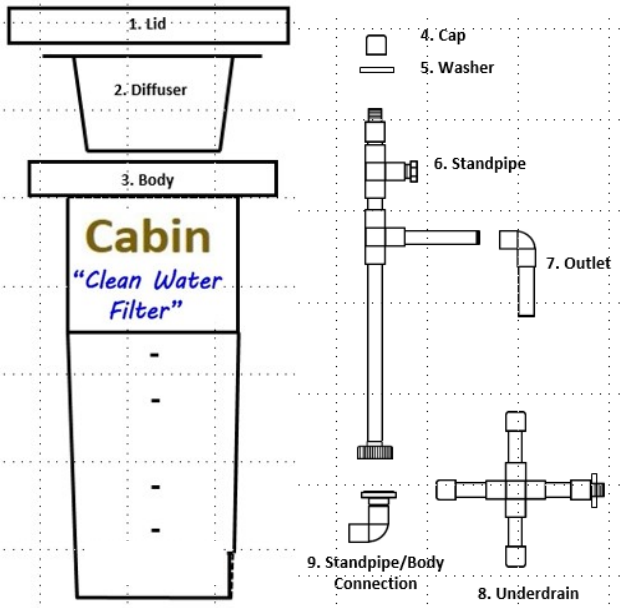
The CWF is designed to produce a maximum of 12 Litres per hour of filtered water.

CONTENTS

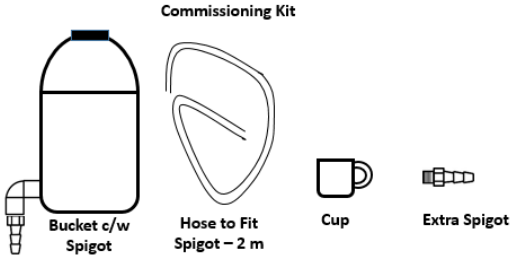
1. Assembly

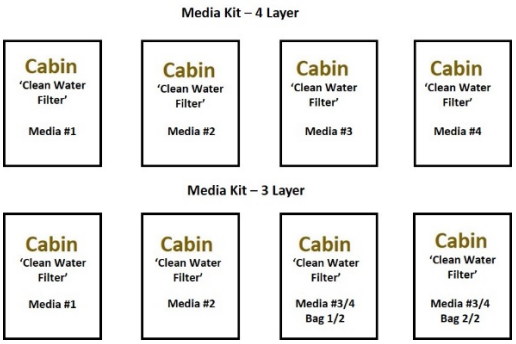


Assembled Filter

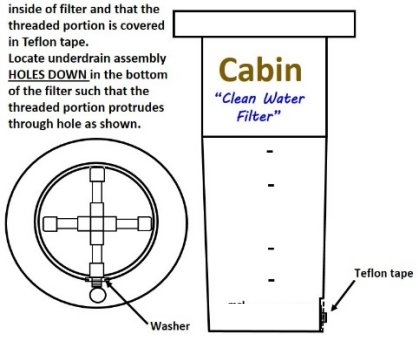


Filter Components



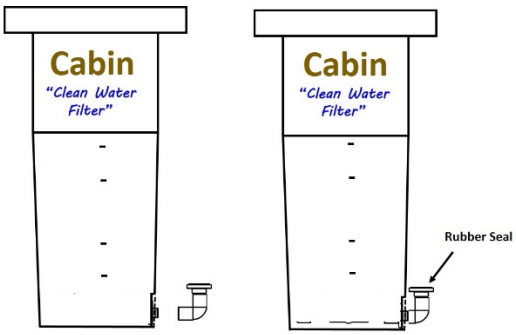


Insure that the washer is on inside of filter and that the threaded portion is covered in Teflon tape.
Locate underdrain assembly HOLES DOWN in the bottom of the filter such that the threaded portion protrudes through hole as shown.



Attach lower leg of standpipe. Tape threaded portion with Teflon tape if necessary – hand tighten.

Insure the rubber seal is present and in position.



Step 1 **Step 2**

Pass standpipe upper leg through hole on the top of the filter, Figure 1. (Insure that threaded portion has been covered with Teflon tape.)

Position standpipe as shown and loosely tighten the union, Figure 2.

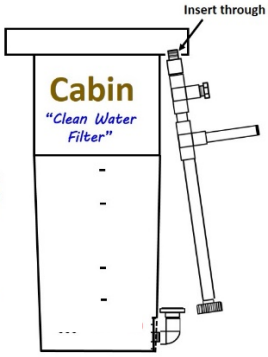


Figure 1.

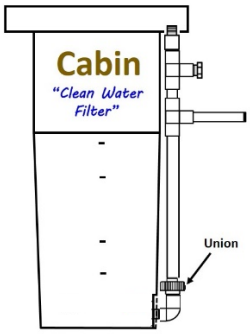


Figure 2.

Step 3

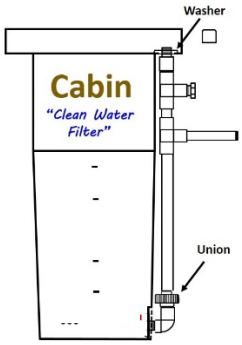
1. Place washer over threaded portion of standpipe and attach cap.

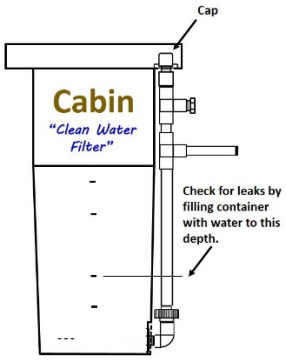
2. Hand tighten union.

3. Hand tighten cap. (May require further tightening as determined during commissioning.)

4. Add water to filter sufficient to fill it to second mark from bottom.

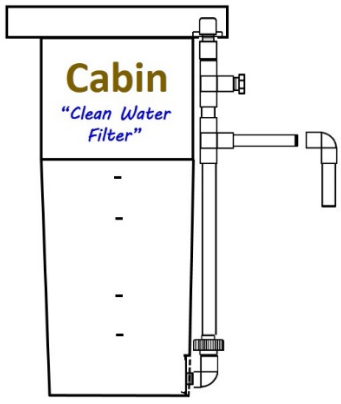
5. Check for leaks. Take corrective action as necessary.

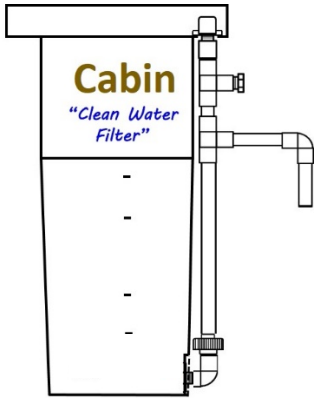




Step 4

Attach standpipe outlet.



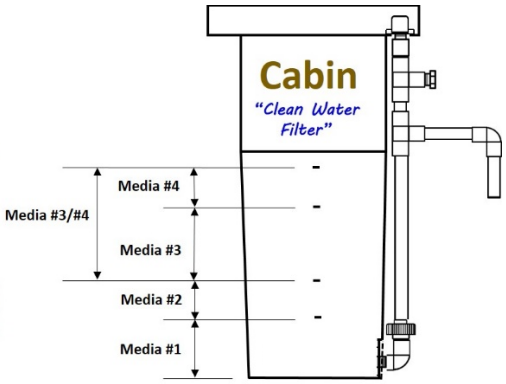


Step 5

Add media.

Media is added in the following order (see marks on filter container):

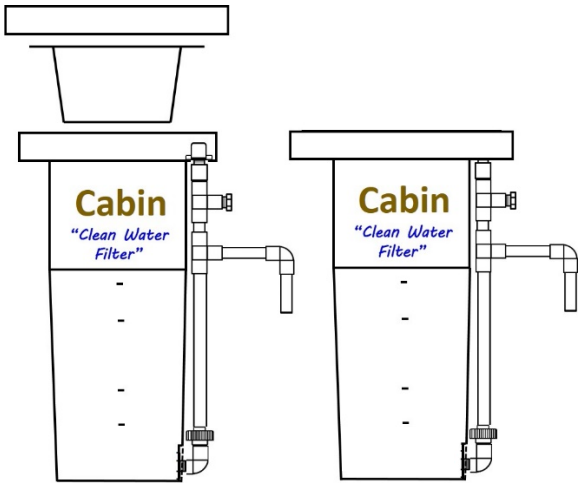
- **Media #1**
- **Media #2**
- **Media #3 (media #3/#4)**
- **Media #4 (media #3/#4)**



Step 6

1. Position diffuser.
2. Position lid.

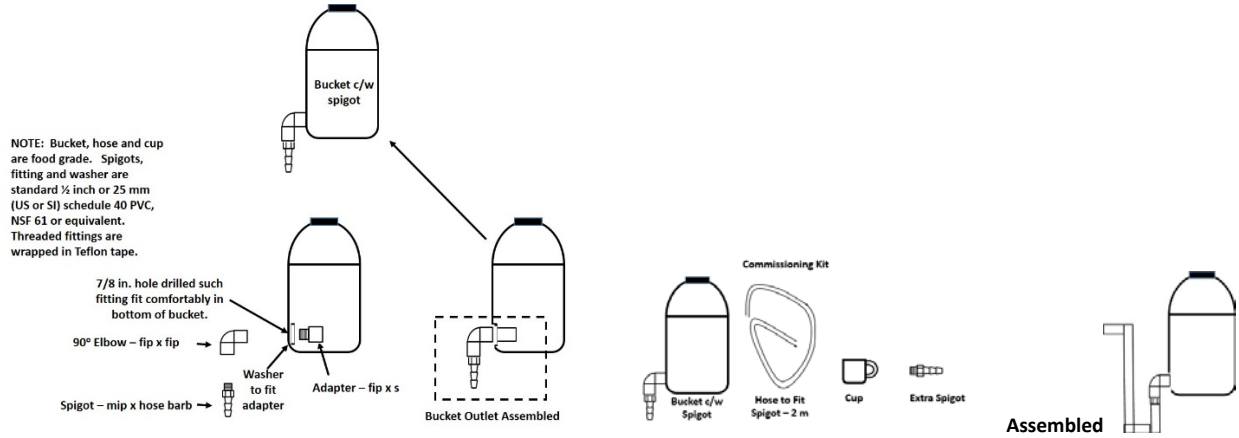
Filter is now assembled and ready for commissioning.

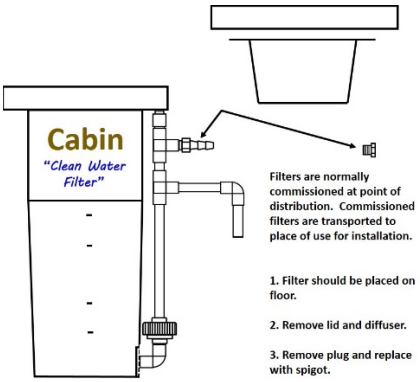


Step 7

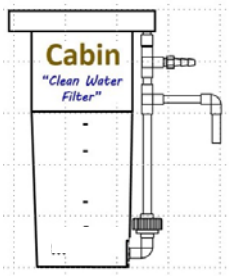
2. Commissioning

Commissioning is the process of preparing filters for use. Often filters are commissioned off-site and transported to place of use where they are re-commissioned. They can also be commissioned on-site as part of installation.

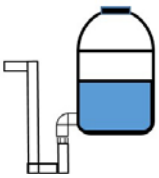




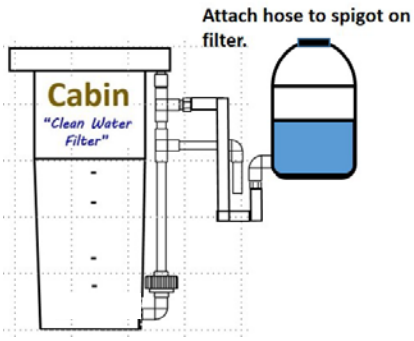
Step 1



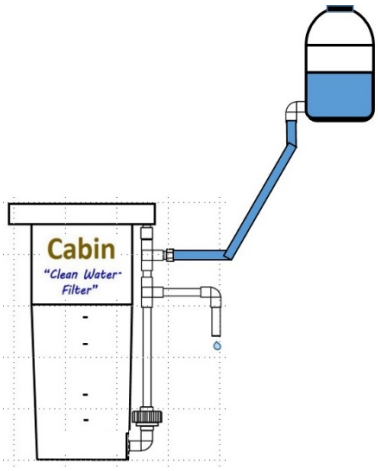
Fill bucket with water – water that has not been filtered is OK for commissioning.



Step 2



Step 3

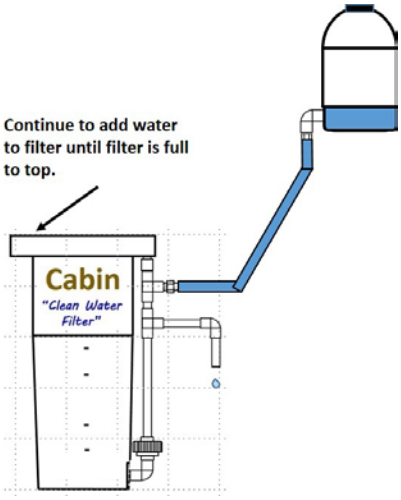


Raise bucket approximately 1.5 to 2 m above top of filter.

Water will flow through standpipe, into the underdrain and upward through the media. The media should behave like 'quick sand'. It should be possible to push your fist through filtering media down to separating media. (Do not disturb separating media.)

There will be some leakage from filter outlet.

Step 4

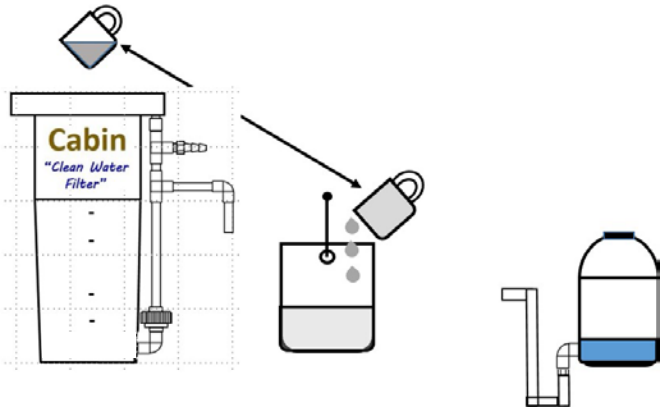


Step 5

Wait a few seconds to let media settle. Hold finger over spigot or use spigot plug to prevent water from spilling on floor.

Use cup to scoop out 'dirty water'. Remove as much water as possible.

Dispose of dirty water.



Step 6

Steps 2 to 6 are repeated 4 times.

Step 7: Rinsing
At least two buckets of untreated water are poured into filter (diffuser in place) but NOT consumed. The filtered water is disposed of. After Step 7 the filter may be considered commissioned and ready for use.

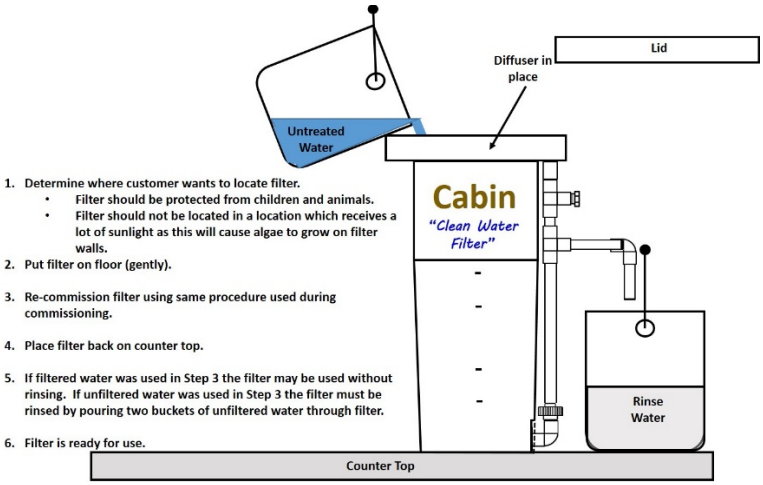
The third bucket will produce consumable water.

Filtered water should be disinfected using chlorine (tablets or household bleach).

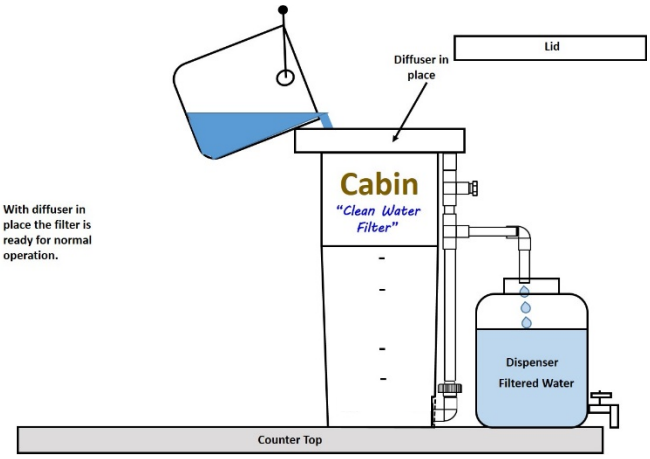
Filtered water should be stored in a closed container with provision for dispensing.

3. Installation

Installation consists of rinsing a commissioned filter prior to filter being placed into operation. If the filter has been moved after commissioning and there is reason to believe that the media has compacted the filter should be re-commissioned to restore filtration capacity as described later. Use of unfiltered water is OK.

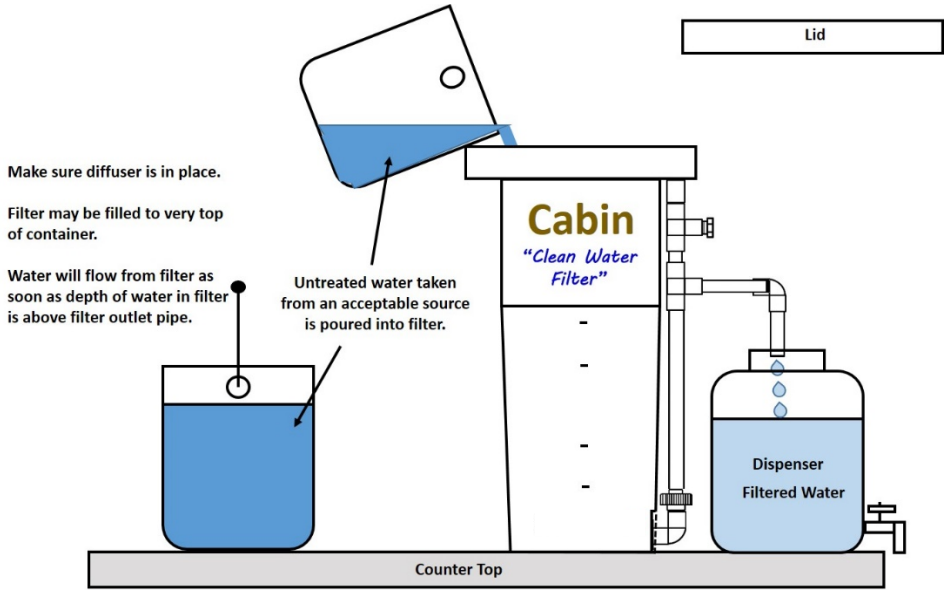


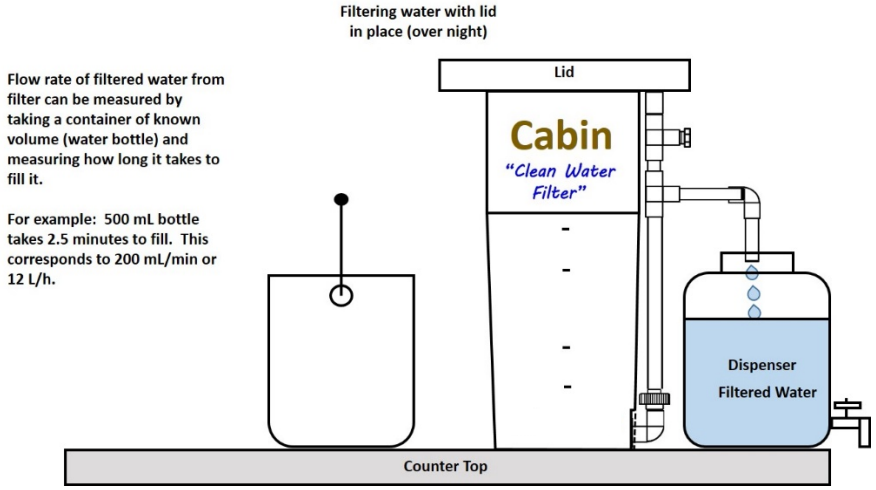
1. Determine where customer wants to locate filter.
   - Filter should be protected from children and animals.
   - Filter should not be located in a location which receives a lot of sunlight as this will cause algae to grow on filter walls.
2. Put filter on floor (gently).
3. Re-commission filter using same procedure used during commissioning.
4. Place filter back on counter top.
5. If filtered water was used in Step 3 the filter may be used without rinsing. If unfiltered water was used in Step 3 the filter must be rinsed by pouring two buckets of unfiltered water through filter.
6. Filter is ready for use.

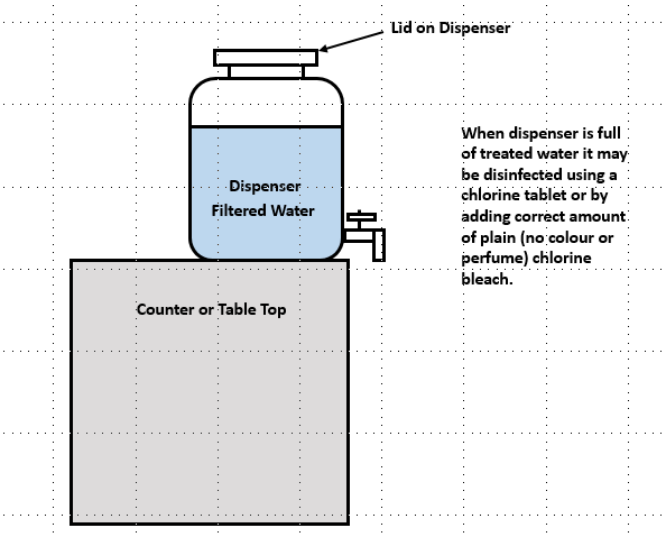


With diffuser in place the filter is ready for normal operation.

4. Operation


Lid
Make sure diffuser is in place.
Filter may be filled to very top of container.
Water will flow from filter as soon as depth of water in filter is above filter outlet pipe.
Untreated water taken from an acceptable source is poured into filter.
Cabin
"Clean Water Filter"
Dispenser
Filtered Water
Counter Top


Filtering water with lid in place (over night)
Flow rate of filtered water from filter can be measured by taking a container of known volume (water bottle) and measuring how long it takes to fill it.
For example: 500 mL bottle takes 2.5 minutes to fill. This corresponds to 200 mL/min or 12 L/h.
Lid
Cabin
"Clean Water Filter"
Dispenser
Filtered Water
Counter Top

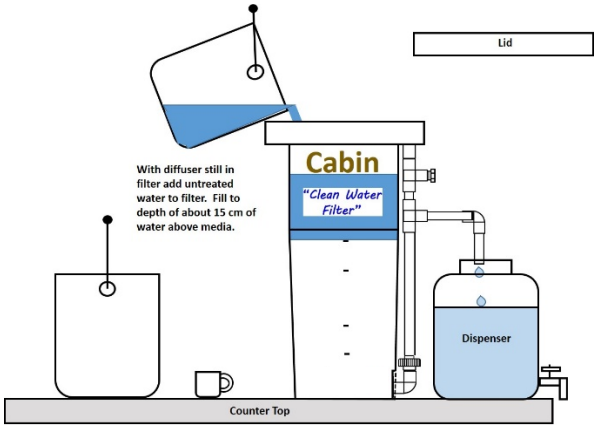


Other considerations:

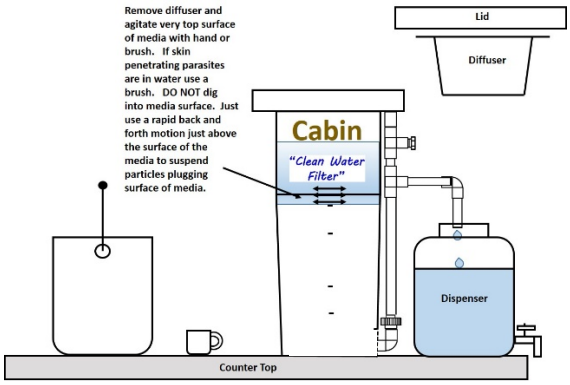
1. Filter should be protected from children and animals.
2. Filter should not be located in a location which receives a lot of sunlight as this will cause algae to grow on filter walls.
3. Filter may be moved if done very gently. Rough handling of the filter will result in media compaction, flow reduction and need for re-commissioning.
4. Do not store food in diffuser.
5. Insure lid is on filter as much as possible to avoid problems with insects, rodents and dust.
6. Ideally, the filter should be used to treat 4 litres of water every day. Simple systems can be assembled to perform this function independently.
7. De-commission the filter if it might be subject to freezing temperatures. Very simple to re-commission.
8. If filter is damaged for any reason contact local technical support.

When treating water for removal of pathogens the recommended surface loading rate is 400 L/h/m^2. Filtered water production from the CWF is approximately 12 L/h or 200 mL/min.

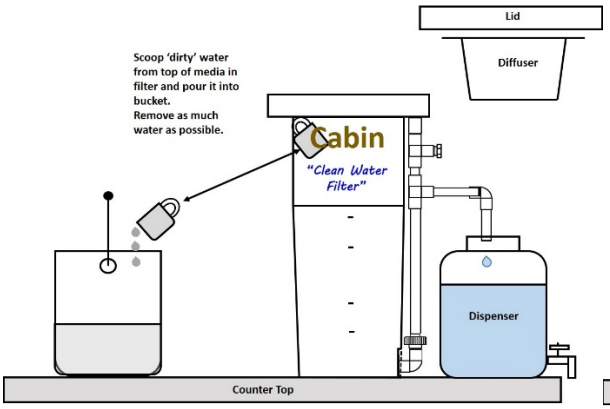
5. Cleaning



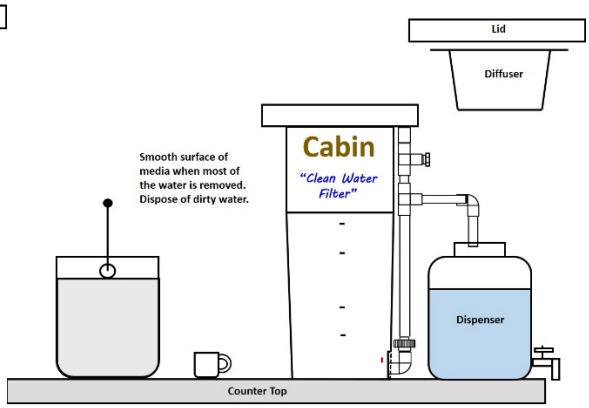
Step 1



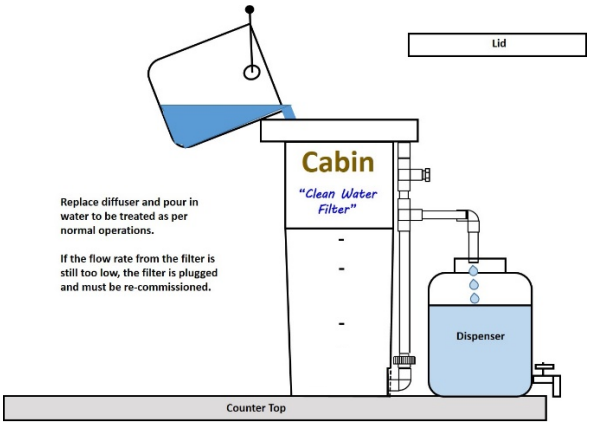
Step 2



Step 3



Step 4



Step 5

6. Re-commissioning

Re-commissioning will be required if the filter is moved resulting in media compaction, if water with very high concentration of suspended solids is provided to the filter necessitating media flushing or if for some reason the flow through the filter media is obstructed by gas bubbles. Re-commissioning is

performed using exactly the same method as commissioning. If filtered water is used the filter may be put into operation without rinsing.

7. Transporting or Moving Commissioned Filter

The filter may be transported or moved after commissioning and after used to filter water. The effect of transporting the filter will be compaction of the filter media resulting in very low production rate and disturbance of some fine material captured within the filter resulting in production of unacceptable turbidity of filtered water. Moving the filter may have identical effect. These problems can be overcome by re-commissioning the filter using filtered water and rinsing the filter until the produced water is acceptable. Note that the produced water, even with high turbidity, is not a health danger, particularly if properly disinfected.

8. De-commissioning and Re-commissioning

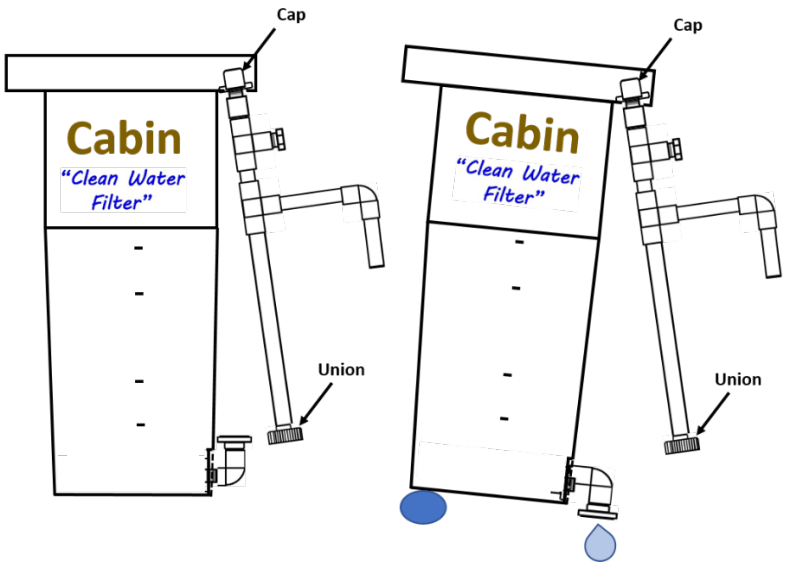
Clean filter

Loosen cap.

Undo union and tilt standpipe away from body.

Turn outlet downwards .

Tilt filter towards outlet to drain as much water as possible.



De-commissioning a filter may be desirable if the filter is subject to freezing or is not going to be used for several weeks, months or years.

Re-commissioning a filter consists of re-assembling the filter, performing a commissioning process with clean (preferably filtered) water, and rinsing the filter until the filtered water has acceptable turbidity (rinsing may not be necessary if filtered water is used). Note that the produced water, even with high turbidity, is not a health danger, particularly if properly disinfected.

9. Winterizing (Canadian conditions)

Filters are winterized using the de-commissioning process. The media will freeze and any water left in the filter will freeze without damaging the filter. Winterized filters may be placed back into operation after thawing and using the commissioning process.

10. Disinfection of Filtered Water

It is strongly recommended that filtered water be disinfected using chlorine tablets (as per manufacturer's instructions) or using unscented and uncoloured liquid household bleach (2 drops per

litre of 5% sodium hypochlorite). Chlorine taste and smell can be reduced by allowing the disinfected water to sit in the dispensing container overnight. Disinfection insures that the filtered water meets World Health Organization drinking water guidelines and that the water container that holds and dispenses the filtered water remains hygiene.